United States Patent

Coolbaugh et al.

[15] **3,670,067**

[45] **June 13, 1972**

[54] METHOD OF MAKING ILLUMINATED PANEL

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[22] Filed: **Feb. 13, 1970**

[21] Appl. No.: **11,124**

Related U.S. Application Data

[62] Division of Ser. No. 694,967, Jan. 2, 1968, Pat. No. 3,545,110.

[52] **U.S. Cl.**.....**264/154,** 40/130 M, 264/263, 264/272

[51] **Int. Cl.**.....**B28b 1/48,** B29c 6/00

[58] **Field of Search**.....264/154, 263, 267, 272, 275; 40/130 M

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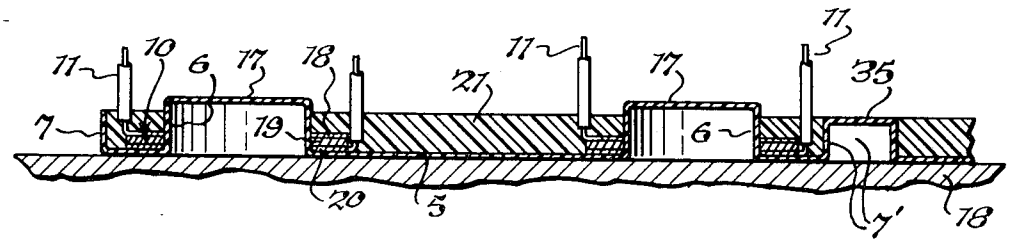
[57] **ABSTRACT**

An electroluminescent panel having a shell formed of light-transmitting material and having an indicia bearing face to be illuminated. An electroluminescent member is positioned adjacent the ace within the shell which is filled with potting compound to a level encapsulating the member. The shell can be formed with an open-ended wall extending inwardly from the indicia bearing face to provide a socket for a control member.

4 Claims, 7 Drawing Figures



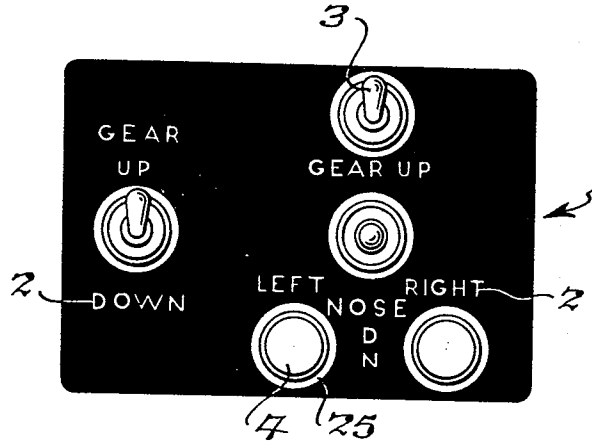


Fig. 1.

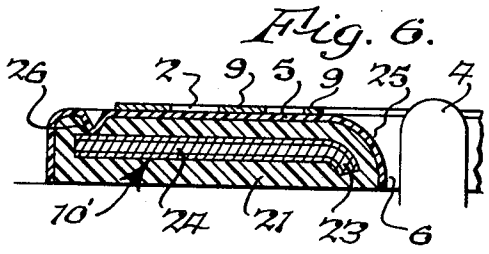


Fig. 6.

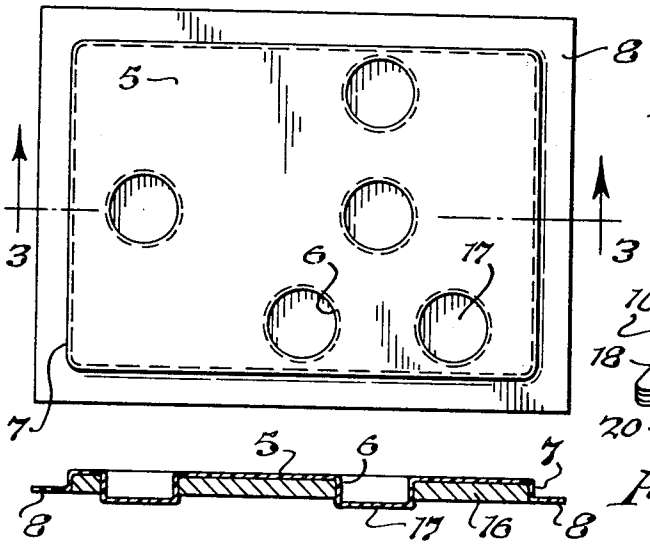


Fig. 2.

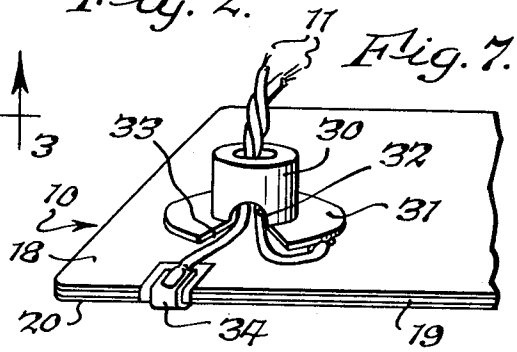


Fig. 7.

Fig. 3.

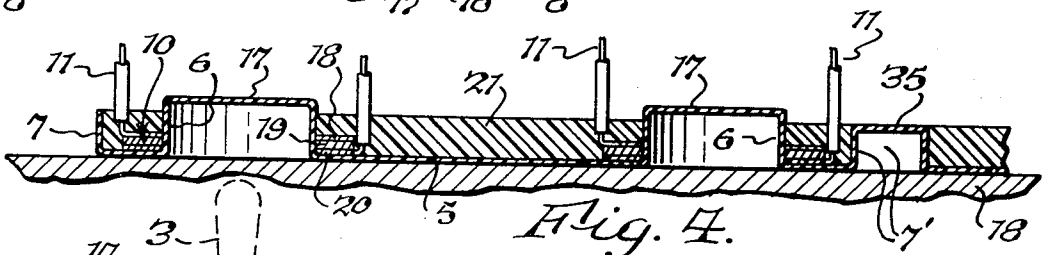


Fig. 4.

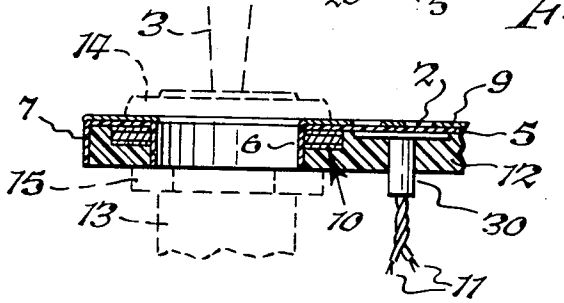


Fig. 5.

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METHOD OF MAKING ILLUMINATED PANEL

This application is a division of pending application Ser. No. 694,967, filed Jan. 2, 1968, now U.S. Pat. No. 3,545,110

BACKGROUND OF THE INVENTION

This invention relates generally to the illuminating art, and more particularly to the illumination of instrument and control panels and the like.

The illumination of instrument and control panels such as are found in automobiles and aircraft poses a number of problems. A common practice has been to direct one or more light sources onto the surface of the panel. However, such reflected light can cause considerable strain over a period of time. This is annoying, and can be quite dangerous when close attention must be paid to the panel as in the cockpit of an aircraft.

Various other arrangements have been proposed, including the utilization of special light sources. However, this can become quite complex and expensive. It has been proposed, for example, to provide a plastic panel having small incandescent lamps imbedded within the plastic, in alignment with the indicia on the panel. However, under severe stress and vibration such lamps tend to fail, because the filament is essentially a spring having a natural frequency and when the vibration frequency is such that the filament resonates it can vibrate to destruction. Once an individual lamp is destroyed, the problem of replacing it is complex and often requires replacing the entire panel section.

Electroluminescent sources of light are known, and are commercially available. They comprise metal having a ceramic coating containing phosphors which glow under conditions of electrical excitation. However, such electroluminescent members, being of capacitive-resistive nature, pose an electrical hazard. For this and other reasons such light sources have not heretofore been considered particularly suitable for panel illumination.

SUMMARY OF THE INVENTION

This invention provides a means for the effective utilization of such electroluminescent sources of light for panel illumination. In carrying out the method of this invention, the electroluminescent members are so incorporated in the panel structure as to become an integral part thereof, in a manner insuring the complete insulating of the electroluminescent member from surrounding electrically conductive materials.

The primary object of this invention is to provide a panel containing an electroluminescent source of illumination wherein the source is incorporated in the panel in an electrically insulated manner causing it to become an integral part of the panel structure,

Another object of this invention is to provide a method for accomplishing the foregoing in a relatively simple and inexpensive manner.

Still another object of this invention is to provide an electroluminescent panel of outstanding reliability and performance.

The foregoing and other objects, advantages and characterizing features of this invention will become apparent from the ensuing detailed description, reference being made to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

FIG. 1 is a front elevational view of an illuminated instrument and control panel constructed in accordance with this invention, as it would appear in use;

FIG. 2 is a top plan view of the panel shell after forming thereof;

FIG. 3 is a cross sectional view thereof taken about on line 3—3 of Flg. 2;

FIG. 4 is a view of the panel during an intermediate stage of construction;

FIG. 5 is a fragmentary, detail view in cross section, illustrating the attachment of a control member to the panel;

FIG. 6 is a fragmentary, cross sectional view of a modified panel construction; and

FIG. 7 is a fragmentary perspective view of an electroluminescent member and its leads.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring now in detail to the accompanying drawing, there is shown an illuminated panel of our invention, generally designated **1**, having indicia **2** thereon and also having control switches **3** and push buttons **4** projecting therefrom or arranged therein. It will by understood, however, that the articular panel shown in FIG. **1** is only illustrative of the many varied arrangements which can be provided in the panel of this invention.

The panel structure includes a shell of plastic material having a face portion **5** interrupted at various locations by well-defining sleeves **6** projecting rearwardly from face **5** which extends across the panel and is bounded by a peripheral skirt **7**. In the illustrated embodiment, the shell is formed of a light transmitting, synthetic plastic material, and the indicia **2** are provided by silk screening or otherwise depositing an opaque layer **9** over face **5** in a manner outlining the indicia **2**. However, other indicia forming techniques can be utilized.

An electro-luminescent member generally designated **10** having energizing leads **11** is positioned within the shell, behind face **5** and behind the indicia **2** intended to be illuminated by that particular member. In FIGS. **4** and **5**, member **10** is annular and encircles a well **6**, but the member **10** can be formed in any desired shape. Member **10** is incapsulated in the shell by potting compound **12** which fills the shell defined by face **5** and skirt **7** surrounding the wells **6**. A switch **13** actuated by the member **3** can have a face ring **14** clamped against the outer face of the panel by a nut **15** engaging the rear face thereof.

Referring now to FIGS. **2**, **3**, and **4**, the panel **1** is manufactured as follows. A master die plate **16** is made in any suitable manner, having a peripheral dimension defining the skirt **7** and having a face defining the panel face **5**. Openings are provided through plate **16**, dimensioned to provide the well defining skirts **6**. The shell is formed by taking a sheet of suitable thermoplastic material, such as for example a cellulose acetate, styrene or poly vinyl resin. The plastic sheet is heated to a state of plasticity and vacuum formed over plate **16** to the configuration shown in FIG. **3**. Such vacuum forming will be readily understood by those skilled in that art, but it will be noted that in such vacuum forming the well defining sleeves **6** terminate at their inner ends in a wall **17** which is parallel to face **5** but spaced beyond the peripheral flange **8**, for reasons which will become apparent.

The shell is removed from plate **16**, and inverted on a plate, table or other supporting surface **18** of magnetic material. The support member **18** can be permanently magnetized, or can be arranged for intermitent electromagnetic energization.

The electroluminescent members **10** can be of conventional, commercially available form. These are available in various plate forms and can be constructed in other configurations, Members **10** themselves comprise no part of our invention, and being a commercially available product well understood by those skilled in the art a detailed description is believed to be unnecessary. Suffice it to say that an electrically conductive plate **18** provides one electrode of the luminescent cell. A layer of electroluminescent phosphor material **19** is positioned between the electrode plate **18** and a second electrode **20**. The plate **20** can comprise a thin layer of electrically conducting material evaporated or otherwise superposed onto the phosphor layer **19**, which latter is suspended in a dielectric plastic.

The conducting layers **18**, **20** are connected in an alternating current circuit including the leads **11**, causing the phosphor layer **19** to emit light which is transmitted through the thin, highly translucent layer **20**. The layer **18** can be light reflecting toward the layer **20**.

In carrying out the method of our invention, the various luminescent cells **10** are positioned within the shell against the inner side of face **5**, behind the indicia to be illuminated by that cell. In FIG. **4**, two cells of annular shape are shown, encircling the sleeves **6** for illuminating indicia **2** adjacent those wells. It will be appreciated that cells **10** could comprise a single member having cutout portions to receive the various well defining sleeves **6**, or two or more cells having whatever shape is necessary to overlie the indicia **2**.

After the various cells **10** have been positioned within the panel shell, the latter is filled with a conventional electrically insulating potting compound **21** to a level above the cells **10** and preferably approaching or at the level of the peripheral flange **8**. By filling the interior of the shell with potting compound **21**, cells **10** and their connections to the leads **11** are completely incapsulated and insulated, and the connection between cells **10** and their leads **11** is reinforced by the surrounding potting compound.

As seen in FIG. **4**, the closed inner ends **17** of the wells are spaced above the level of flange **8**. After the shell has been filled with compound **21**, the inner ends of the wells are severed, preferably in or closely adjacent the outer surface of the potting compound **21**, whereupon the sleeves **6** are coextensive in length with the thickness of the potting compound, as clearly shown in FIG. **5**, and flange **8** is trimmed away. If the indicia **2** have not already been provided on face **5** of the panel, they are now provided as by silk screening onto the face **5** an opaque layer **9** of a material containing a solvent for the plastic used in making the shell. This causes the ink of layer **9** to penetrate and bond with face **5**. In applying the opaque layer, the indicia **2** are omitted, whereby they are formed by the surrounding layer **9**, in a manner well understood by those versed in this art. Obviously, the indicia can be provided in other ways.

Then, the various switches, indicator lights or whatever is to be mounted in the panel, are so mounted, and the panel is ready for use.

It is a particular feature of our invention that the luminescent cells **10** are properly and effectively positioned behind the face **5**. Even with a cell which does not encircle a well sleeve **6**, but instead is positioned between such sleeves, in spaced relation thereto, accurate positioning is insured by the utilization of a magnetic support **18**. Such cells include a magnetic material, whereby they are attracted to the support **18**. This means that the cell remains in the position in which it is placed, although it can be slid back and forth on the inner surface of face **5**, to achieve the desired positioning. Also, it means that the cell **10** can have its surface **20** tightly engaged against the inner surface of face **5**, in snug fitting engagement therewith. This is important where maximum legibility and angle of vision are required, because it precludes the entry of potting compound between cell **10** and face **5**. Such cells are relatively light weight, and if it were not for the force of magnetic attraction holding them tightly against the face **5** of the panel shell, they could be dislodged from the surface as the shell is filled with potting compound and this can interfere with the total legibility of the illuminated panel.

Also of significance is the fact that sleeves **6** not only provide a well for receiving control members or indicators, but also function to insulate the adjacent cell **10** from whatever member is positioned within the wall. In other words, in a panel as shown in FIGS. **4** and **5** it is clear that the cells **10** are completely incapsulated within the panel, bearing against the sleeve **6** and the face **5** which insulate the corresponding surfaces of the cell, and the remainder of the cell being insulated by the potting compound **21**.

Further, the potting compound fills the shell, causing the cells **10** to be united with the shell and the potting composition to provide a monolithic panel body of substantial structural integrity.

Where desired, the parcel shell can be formed to provide thin web sections **35** extending from and between illuminated sections as defined by inner skirt portions **7'**, as shown at the right-hand side of FIG. **4**. Webs **35** can provide inwardly offset panel sections in areas where the thick, encapsulated section is not desired.

Accordingly, it is seen that our invention fully accomplishes its intended objects. While only two embodiments have been described in detail, that has been done by way of illustration, it being understood that our invention is not necessarily limited thereto.

Sometimes it is desired to illuminate the socket through the wall **6**, adjacent the face **5**. This can be accomplished with our invention by using an electroluminescent member **10'** which is of the same construction as member **10** except that it includes a portion **23** which is formed out of the plane of the portion **24** which is parallel to face **5** and which illuminates the indicia **2**. The member **10'** is positioned around or adjacent the well to be illuminated, and because it faces the juncture between walls **5** and **6** it will illuminate the area **25** of the shell surrounding the outer end of the wall, as shown in FIG. **1**. This will assist the observer in locating the push bottom **4** or other actuating device positioned within the well. The juncture between face **5** and wall **6**, comprising the area **25**, can be curved in concentric relation to the light cell portion **23**.

In addition to legends, numerals and other such indicia, the illuminated panel of our invention can include an illuminated border or outline around either the entire panel or selected portions thereof. To this end, face **5** is formed with a border or frame defining groove **26** which can extend completely around the panel, for example spaced inwardly a fraction of an inch around the opaque face of the panel shown in FIG. **1**, or which can outline selected portions thereof.

To illuminate groove **26**, a member **10** or **10'** is positioned immediately behind groove **26**, adjacent indicia **2**. By silk screening or otherwise opaquing face **5** except in groove **26** and at indicia **2**, the member **10**, **10'** will illuminate the outlining groove **26** as well as the indicia **2**. The outer edge portion of face **5**, to the left of groove **26** as viewed in FIG. **6**, can be covered with the opaque layer **9**, leaving only groove **26**, indicia **2** and areas **25** uncovered and light transmitting. Also, by appropriately shaping groove **26** and the marginal portions of face **5**, a variety of asthetically pleasing, sculptured effects can be obtained.

It will be appreciated that where the electroluminescent member **10**, **10'** is adjacent but is spaced from the face **5**, as in FIG. **6**, it must nonetheless be positioned close thereto, and must be light coupled therewith. To this end, a transparent potting compound **21**, such as a suitably transparent epoxy resin is used to fill the shell after the member **10'** has been positioned therein. Prior to filling the shell with potting compound the member **10**, **10'** can be magnetically held against face **5** and groove **26**. However, where the member **10**, **10'** is large enough in area to contact groove **26** at spaced points, it will be supported by the groove at an elevation above face **5** and will be adjacent but not necessarily in actual contact with face **5** other than at groove **26**.

As previously noted, where maximum legibility and angle of vision are desired, member **10**, **10'** should be positioned tightly against face **5** to avoid the losses associated with spacing them apart. Where groove **26** is not provided, portion **24** of member **10'** can be in contact with face **5** and portion **23** in contact with area **25**.

We have found that potting compound **21** tends to slope somewhat, due to capillary attraction, whereby it will be spaced further from face **5** where it is in contact with the side wall surfaces **6** and **7**. Often it is desirable to have a back face which is parallel with the front face, for positioning against a panel. To this end, after the potting compound has set, the rear face is cut to a level representing the desired thickness of the panel. This can be accomplished by means of a router, care being taken to rout around the leads **11**.

Preferably, the electrical leads are brought together and protected by an insulating, reinforcing sleeve **30** which latter is surrounded by potting compound **21**. Sleeve **30** preferably has a lateral flange **31** providing a base which seats upon the member **10** or **10'**. Leads **11** extend through sleeve **30** and

outwardly through a side wall opening **32** therein adjacent base flange **31** which is cut away at **33** in alignment with opening **32**. This permits leads **11** to extend through sleeve **30** to member **10** or **10'** and then outwardly across the member **10**, **10'**. One lead is secured to a clip **34** which is insulated from plate **18** and dielectric layer **19** but extends around member **10**, **10'** to the opposite plate **20** in electrical contact therewith. The other lead **11** is secured to plate **18** in electrical contact therewith, as by a silver conductive epoxy adhesive, the terminal end of that lead also being held against plate **10 18** base flange **31** which is adhesively bonded to plate **18**.

When using reinforcing sleeve **30** the potting compound **21** tends to fill the interior of the sleeve through opening **32** by capillary action. The upper end of the sleeve opening is filled with a resiliently yieldable, insulating material, such as an RTV silicone resin, whereby the leads **11** are yieldably positioned within member **30**.

Reinforcing member **30** protects leads **11** both during the potting of the panel shell and after, providing a convenient means of handling the leads during the potting operation. The back face of the panel is routed or otherwise cut to a predetermined thickness, around sleeve **30** which then projects behind the illuminated panel for insertion through an opening in the panel structure adapted to receive the same.

We claim:

1. The method of making an illuminated panel having a socket opening therein which comprises forming a panel face of light-transmitting electrically insulating material having a well projecting from one side thereof, placing an electroluminescent member adjacent said one side of said face with the inner end of said well extending beyond said member, encapsulating the exposed portions of said member with an electrically insulating potting compound which extends above said member but below said well, and severing the inner end of said well closely adjacent the outer surface of said potting compound to provide an insulated socket substantially co-extensive in length with the thickness of said potting compound.

2. The method of claim **1** wherein said electroluminescent member is magnetic, and wherein said member is held in position adjacent one side of said face by magnetic means on the opposite side thereof while encapsulating said member with potting compound.

3. The method of claim **1**, together with the step of providing indicia on said face.

4. The method of claim **3**, wherein said indicia is provided by rendering said face opaque around said indicia.

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