May 14, 1963 P. G. HEROLD ET AL 3,089,973

ELECTROLUMINESCENT DEVICE

Filed March 22, 1961

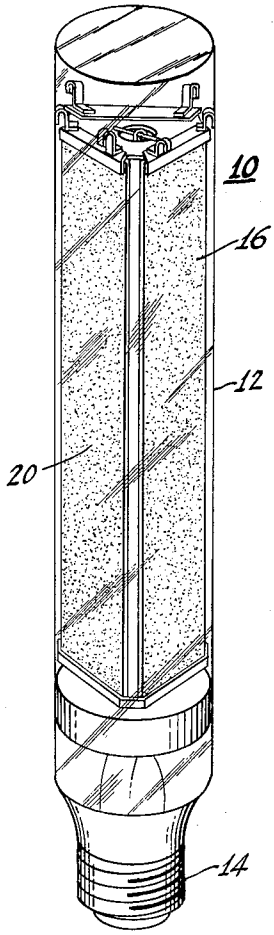


Fig. 1.

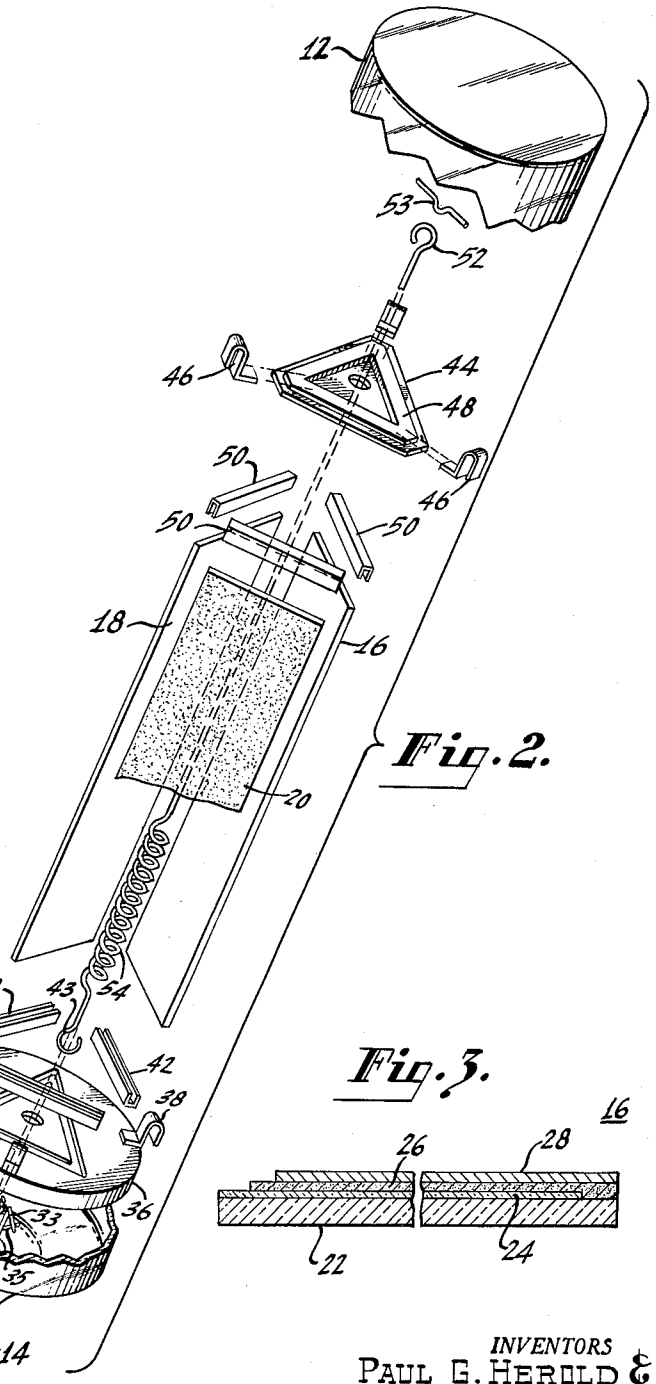


Fig. 2.

Fig. 3.

INVENTORS
PAUL G. HEROLD &
RICHARD A. NOLAN

BY L. A. Larsen

ATTORNEY

United States Patent Office 3,089,973 Patented May 14, 1963

3,089,973

ELECTROLUMINESCENT DEVICE

Paul G. Herold and Richard A. Nolan, Lancaster, Pa., assignors to Radio Corporation of America, a corporation of Delaware

Filed Mar. 22, 1961, Ser. No. 97,686
7 Claims. (Cl. 313—108)

This invention relates to lighting devices or lamps. In particular, this invention relates to an improved electroluminescent lamp.

In the prior art, there are many known types of lighting devices or lamps. Examples of these lamps are the conventional incandescent lamps and the conventional fluorescent lamps. Another type of lamp, which has been more recently discovered, is the electroluminescent lamp.

For certain uses, the life a lamp must be extraordinarily long. For example, a lamp which is to be used to illuminate a safety exit, or the location of an emergency telephone, and other such locations, should have an extraordinarily long life so one can be confident that these locations are properly identified in cases of emergency. Another type of installation in which it is highly desirable to use a lamp having an extraordinarily long life is an installation of the type wherein a lamp is positioned in an inaccessible location so that the cost of replacing such a lamp is very high.

Of the types of lamps described above, the electroluminescent lamp has been found to have a rather long life. When failure of an electroluminescent lamp does occur, it has been found that the cause of the failure is due primarily to either an electrode becoming disconnected, when the lamp is subjected to vibration, or because of moisture penetration into the lamp structure.

As is obvious, if an electrode becomes disconnected, or if a connection is faulty, the lamp either ceases to give light or the amount of light is substantially reduced. One of the primary causes for partially or completely disconnected electrodes is an environment in which the lamp is subjected to vibrations. One of the connections in an electroluminescent lamp is to a transparent electrode. Since a connection is difficult to preserve, a rugged electrode mount structure must be provided in order to prevent this connection from becoming ruptured when the lamp is to be used in an installation involving appreciable vibration.

Another frequent cause of the failure of an electroluminescent lamp is moisture penetration. The exact phenomenon that occurs when an electroluminescent lamp absorbs moisture is not clearly understood. An actual chemical change in the electroluminescent phosphor, or its binding agent, may occur. Nevertheless, the result of moisture penetration is the development of an area that is black in color and which does not produce light. It is known that this black area is not an electrical open circuit or an electrical short circuit between the two electrodes.

It is therefore an object of this invention to provide a novel, rugged, safety lamp having a relatively long life.

This and other objects are accomplished in accordance with this invention by providing a plurality of electroluminescent panels rigidly mounted within a single hermetically sealed envelope. The sealed envelope contains a dry gaseous atmosphere. Besides excluding moisture, a purpose of this atmosphere is to keep the arcing resistance high.

The invention will be more clearly understood by reference to the accompanying single sheet of drawings, wherein:

FIG. 1 is a perspective view of a lamp made in accordance with this invention;

FIG. 2 is a partially exploded perspective view of the lamp shown in FIG. 1; and,

FIG. 3 is a sectional view of one of the panels shown in FIGS. 1 and 2.

Referring now to FIG. 1, the lamp **10** comprises an envelope **12** having a conventional base **14** fixed thereto. The base **14** may comprise conventional central and screw thread, or bayonet type outer shell contacts made of a material such as brass or aluminum.

Within the envelope **12**, are three electroluminescent panels **16**, **18** and **20**. Each of the electroluminescent panels, one of which is shown in an enlarged sectional view in FIG. 3, comprises a support member **22** which may be of a material such as glass. On the support member **22** there is provided a light transparent conducting electrode **24** which may be made of a material such as rhodium, tin oxide, or gold. On the transparent conductor **24** there is provided an electroluminescent phosphor **26** which may be a material such as copper activated zinc sulfide in a suitable binder, such as a polymerized epoxy resin. On the electroluminescent phosphor **26** there is provided a conductor **28** which may be made of an electrically conducting material such as aluminum. It should be understood that other known structures can be used for each of the electroluminescent lamps, e.g., a conducting support plate can be used instead of the glass member **22** and the conductor **24** and the conductor **28** made light transparent. Also, the conductor **28** may be made light transparent so that light is emitted from both sides of the electroluminescent panels.

Referring now to FIG. 2, each of the three separate electroluminescent panels **16**, **18** and **20** is positioned within the envelope **12** so as to emit light outwardly through transparent support member **22** and through the walls of the envelope **12**.

The electroluminescent lamp **10** comprises a reentrant stem **30** (FIG. 2) positioned within the base **14** and through which is sealed two lead-in wires or pins **32** and **34**. A third rod **33** is sealed into the reentrant stem for support purposes. The lead-in pin **32** is connected to the outer shell of the base **14** and to an apertured, electrically conducting lower end plate **36**. The rods **32** and **33** each include a bracing rod **35** to further ruggedize this structure. The bent portion of the rods **32** and **33** support the lower end plate **36** and are welded thereto prior to sealing.

The end plate **36** functions as a heat shield during the manufacturing steps in which the envelope is sealed to the stem. During this step, as well as others, the electroluminescent panels or plates **16**, **18** and **20** should be maintained at temperatures below 150° C. The end plate **36** functions, during the tube sealing process step, to thermally isolate the electroluminescent plates from the glass-to-glass seal that is made between the stem **30** and the envelope **12**. Thus, the lower end plate **36** functions as a heat shield.

The end plate **36** is centrally positioned within the envelope **12**, and is rigidly held in this position, by means of a plurality of bulb spacers **38**. The lower end plate **36** includes three straight grooves arranged in a triangular array **40**. Each groove **40** is for the purpose of supporting one end of each corresponding one of the three electroluminescent panels **16**, **18** and **20** each with a corresponding interposed channel member **42**.

Positioned between the end plate **36** and each of the electroluminescent panels is one of the three low resistance flexible, channel member **42**. The channel members **42** may be made of a low resistance rubber, for example, rubber having a resistivity of approximately 7 ohm-cm. has been found satisfactory. Each of the channel members **42** makes firm physical contact with a corresponding one of the electroluminescent panels **16**, **18** and **20** when

the channel is placed over an end of one of the panels and the channel member is forced into the corresponding groove 40 on one side of the lower end plate 36. Also, each of the channel members 42 makes good electrical contact with a different one of the electrodes 24, which are exposed on one end only of each of the electroluminescent panels 16, 18 and 20 (see FIG. 2). Any panel may be inserted however. Thus by inserting each of the panels 16, 18 and 20 into a rubber channel member 42, which is then pressed into one of the grooves 40, in the lower plate 36, a rigid structure, having a good electrical contact with each of the electrodes 24, is provided.

The upper end of the lamp 10 is similar to the lower section in that an apertured upper end plate 44 is provided and is rigidly positioned within the envelope by means of a plurality of bulb spacers 46. The upper end plate 44 includes three grooves 48, arranged in a triangular array. Also, three low resistance rubber channel members 50 are provided to make firm physical contact with the upper ends of the electroluminescent panels 16, 18 and 20. The electrically conducting rubber channel members 50 each make good electrical contact with the respective metallic conductor 28 on this end of each of the panels 16, 18 and 20. During assembly, after assembly the lower end as described above, the upper rubber channel members 50 are pressed on to the upper end of the electroluminescent panels 16, 18 and 20, the upper plate 44 is then pressed on the channels 50 so that the channels 50 firmly enter the corresponding grooves 48. A spring loaded hook 52, hooks on to a wire brace 53, which in turn presses on the top of the upper end plate 44. This loading is provided by a spring 54 under tension which exerts a pull between the lead-in 34 by means of a hook 43 hooked thereto and the end plate 44. This spring tension maintains the bottom and top end plates in physical and electrical contact with the rubber channel members which ride in the respective grooves and thus the electroluminescent panels 16, 18 and 20 are rigidly positioned. The upper end plate 44 is electrically connected to the spring which is in turn electrically connected to the lead-in pin 34, which is connected to the other contact of the base 14 and thus functions both as an anchor for one end of the tensioned spring 54 and as a terminal and contact element. The panels are thus connected in parallel relationship.

When the structure described has been made, the rigid assembly of the three electroluminescent panels is inserted within the envelope 12 and the envelope is baked at a temperature of approximately 70° C. for a period of time of approximately 20 minutes to remove all moisture from the envelope and from the various electrodes and supports. After the envelope is sealed, it is flushed with a dry gas, e.g. nitrogen, or evacuated after sealing and, in both instances, a dry gas, for example nitrogen, having a dew point of approximately —70° C., is bled into the envelope through the exhaust tubulation (not shown). Since one of the principal limitations on the life of prior electroluminescent lamps is moisture penetration between the electrodes 24 and 28, an electroluminescent lamp which is in a hermetically sealed envelope, from which moisture has been excluded, will tend to have an extremely long life.

It has been found that, if the envelope 12 is evacuated, the electroluminescent plates will tend to arc when operated in a vacuum at standard operating voltages, after a relatively short period of time. The reason for this is that the epoxy resin-electroluminescent phosphor tends to give off gases. Once the amount of gas given off is sufficient to partially destroy the vacuum, arcing or a corona type discharge is likely to occur at relatively low voltages. Thus, for long life, a dry atmosphere should be provided within the envelope. The dry atmosphere is provided at approximately atmospheric pressure, so that any further gases released by the epoxy resin will increase the gas pressure and thus increase the voltage required for arcing to occur. Arcing between the plates does not occur in a dry atmosphere at approximately atmospheric pressure.

Another limitation on the life of conventional electroluminescent lamps is that one or more of the lamp wires may become disconnected, or at least from a poor contact with an electrode, when the lamp is subjected to vibration. As has been described, this limitation on life is avoided in a lamp made in accordance with this invention because of its rugged structure.

Also, it should be noted that there are three different lamp units connected in electrically parallel relationship. Therefore, even if one of the lamp units should become inoperative, for any reason other than an electrical short, the other two lamp units will continue to produce light. Since the structure is relatively rugged, such electrical shorts are extremely unlikely to occur.

Thus, this invention describes a novel safety lamp, or other type lamp wherein extraordinarily long life is necessary or desirable. Lamps made in accordance with this invention have operated for over 7,000 hours without any substantial decrease in brightness being observed. It should also be noted that the lamp 10 is fire proof since all of its parts are made of fire proof material.

When desired, various forms of information, such as printed signs, etc., may be provided on the electroluminescent panels by means of spraying a semi-transparent ink, for example, onto the support plate 22 through a suitable stencil.

What is claimed is:

1. An electroluminescent lamp comprising a sealed envelope, a plurality of electroluminescent panels within said envelope, and means for supporting and connecting said electroluminescent panels in electrically parallel relationship within said envelope.

2. An electroluminescent lamp comprising a sealed envelope, a plurality of electroluminescent panels positioned within said envelope, plate like electrodes within said envelope and contacting opposite ends of all of said electroluminescent panels, and means exerting tension between said plate like electrodes to rigidly secure said electroluminescent panels.

3. An electroluminescent lamp comprising a hermetically sealed envelope, three electroluminescent panels positioned within said envelope, means for rigidly supporting said electroluminescent panels within said envelope, said means comprising two end plates each having three grooves therein arranged in a triangular array, flexible low resistance material contacting the ends of each of said panels and being pressed into one of said triangular shaped grooves in each of said end plates, and means for urging said end plates toward each other.

4. An electroluminescent lamp as in claim 3 wherein said envelope also includes a dry gaseous atmosphere.

5. An electroluminescent lamp comprising a hermetically sealed envelope, a pair of apertured end plates rigidly supported within said envelope, a pair of triangular arrays of three straight grooves, each of said pair being disposed in a different one of said end plates respectively, three electroluminescent panels within said envelope, a plurality of low resistance rubber channel members each positioned on one end of one of said electroluminescent panels and each rubber member being pressed into one of said straight grooves, spring means for urging said end plates toward each other for rigidly supporting said electroluminescent panels, and a dry gaseous atmosphere in said envelope.

6. An electroluminescent lamp comprising a sealed envelope, a dry gaseous atmosphere within said envelope, at least two electroluminescent panels within said envelope, means for supporting and connecting said electroluminescent panels in electrically parallel relationship within said envelope.

7. An electroluminescent lamp comprising a sealed envelope, a dry gaseous atmosphere within said envelope, at least three electroluminescent panels in a closed array within said envelope, said electroluminescent panels be-

ing connected in electrically parallel relationship, means for supporting all of said electroluminescent panels from adjacent the ends thereof, said means including a pair of end plates and a plurality of bulb spacers whereby said panels are rigidly positioned within said envelope, and means for urging said end plates toward each other while said electroluminescent panels are positioned therebetween.

References Cited in the file of this patent

UNITED STATES PATENTS

2,509,071	Pennybacker	May 23, 1950
2,714,683	Jenkins	Aug. 2, 1955
2,779,889	Faust	Jan. 29, 1957
2,975,318	Nicoll	Mar. 14, 1961