(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 531 727 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **92113633.9**

(51) Int. Cl.5: **F21K 2/06**

(22) Date of filing: **10.08.92**

(30) Priority: **13.09.91 US 759350**

(43) Date of publication of application:
17.03.93 Bulletin 93/11

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

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(54) **Chemiluminescent lighting element.**

(57) The invention relates to a chemiluminescent device, which comprises a tube made of a flexible, light-transmitting and chemically stable material, closed at both of its ends, and which comprises at least two compartments which are filled with liquids which produce chemiluminescent light when mixed. The tube contains, between the ends, an internal diaphragm or disk, which separates the tube into said compartments. The diaphragm or disk has approximately a flat circular shape, with a cross-section which is approximately rectangular in profile, and is placed transversely with respect to the axis of the tube. The edge is in continuous contact with the interior of the wall of the tube. The elasticity, the external diameters and the internal diameters of the tube and, the diameter and the thickness of the diaphragm are selected in such a manner that the diaphragm can be tilted by simple manual pressure against the external walls of the tube, which pressure imparts a tilting torque to said diaphragm or disk and allows mixing of the contents of the compartments. The closure at both ends is a fusion of the side walls of the tube and each comprises an area lying in a substantially flat plane. The tube has a Stiffness Modulus of less than about 700 mPa and a Tensile Strength greater than about 15 mPa.

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CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my copending application, Serial Number 07/759,350, filed September 13, 1991.

Summary of the Invention

The present invention relates to a lighting unit which comprises a tube made of a specific light transmitting flexible material. This article, in it's passive state, comprises at least two compartments, each of which contains a chemical liquid which, in the active stage of the article, mix to yield a chemical reaction which generates light. The closed ends of the article are fused walls of the tube and are in substantially flat planes.

Background of the Invention

Lighting units are already known which are based on the chemiluminescent emission generated by the mixing of two liquids. One system, which is used commercially on a wide scale, is described, for example, in U.S. Patent No. 3,576,987; it consists of a first liquid solution in a hollow tube made of a light transmitting and slightly flexible plastic, and a second liquid solution contained in a glass vial or glass capillary which floats in the first solution. When the user bends the tube, the internal glass unit breaks and releases the second solution which mixes with a first solution. This system is not without drawbacks. Firstly, the device is formed by injection molding which results in the sealing of one end. However, the other end is closed by spin-welding which is time-consuming and expensive. Secondly, the presence of a sealed glass vial, or a sealed glass capillary, has an unfavorable effect on the solutions used and over long periods of time it causes changes in the solutions. The presence of glass debris, sometimes with sharp points, is not always welcomed by the users who may fear, whether correctly or incorrectly, that the external envelope could break accidentally. Finally, in the fairly frequent case of a glass container in the form of an elongated capillary, there exists the danger of premature breaking during handling operations.

In addition, systems have been proposed - some of which are commercially used - which are based on the presence of two compartments which are temporarily separate and exist in the same closed container or recipient. The separation is achieved either by a temporary pinching or folding of the container, or by the existence of a medial separation wall which can be eliminated by breaking, tearing or unclipping. Several proposals of this type have been described in U.S. Patents Nos. 3,290,017, 3,749,620, 3,539,794, 3,893,938, 3,808,414, 4,061,910 and 3,149,943 as well as in French Patent No. 87 11 296. In the above-mentioned U.S. Patent No. 3,749,620, a long list of earlier patents is given, patents which have disclosed the existance of containers with two components which are to be mixed. One should observe in this regard, to be complete, that in most cases these are not chemiluminescent liquids, and in many cases, the substances are not necessarily liquids.

Additionally, U.S. Patent Number 5,067,051 filed June 22, 1990 discloses an article comprising a flexible and light transmitting tube made of a plastic material, which is closed at both ends and which contains, between these ends, an internal diaphragm or disk, which separates the content of the tube into at least two compartments, which diaphragm or disk comprises a flat circular configuration.

While the devices of the copending application have been found to be commercially attractive, they sometimes suffer from leakage due to the fact that the end closures, which are formed by compressing the tube under heat, are a site of stress concentration due to the increased pressure inside the tube caused by the chemical reaction which takes place when the chemical components are admixed. This pressure can reach 50 psi, although most times reaches at least 10 psi. Because of the configuration of the tubular device, the stress caused by this increased pressure concentrates at the sealed ends and may result in a rupture of the device and loss of its chemical contents.

Figure 1 of the drawings represents a perspective view of the lighting element of the instant invention whereby the element 1 is divided into compartment 2 and compartment 3 by disk 4. The ends of the element contain a closure 5 which is a fusion of the side walls of the element and comprises an area lying in a substantially flat plane. Figure 2 is also a prospective view showing, in addition, attachment means 6.

Description Of The Invention Including Preferred Embodiment

It has now been found that the above described difficulties can be obviated if the seals at both ends of the device comprise a fusion of the walls of the tube and each lie in a substantially flat plane. Additionally, the tube must have a Stiffness Modulus, as determined by ASTM Test Method D-790, of less than about 700, preferably, less than about 655 mPa and a Tensile Yield Strength, as determined by ASTM Test Method D-638 using Type IV Specimen, of over about 15, preferably

over about 18 mPa.

The disk, in a profile cross-section, has an approximately rectangular section, that is, it has a reasonably peripheral sharp edge. The edge or border of the disk is placed perpendicular to the longitudinal axis of the tube, and is in close contact with the internal side of the wall of the tube, thus defining compartments, which are each filled with a liquid solution for the purpose of creating a chemiluminescent emission, when mixed.

The disk is rigid or, in any case, significantly more rigid than the material which forms the tube.

To cause the mixing, it is enough to perform a simple movement, from the exterior of the tube and without damaging it, to tilt the disk so that its plane becomes approximately parallel to the longitudinal axis of the tube. This movement can be performed, for example, by using one's fingers to impart a tilting torque to the separation disk.

For this tilting motion to be possible, the disk should not be too thick. It has been found that a thickness from about 1 to about 4 mm is appropriate for a tube with an interior diameter between about 7 and about 18 mm, i.e. the thickness of the disk should not be greater than about one half the interior diameter of the tube. With regard to the material which constitutes the disk, it is preferably selected among polyolefins, that is plastic materials which have good resistance against chemiluminescent solutions. Polyethylene is particularly indicated because its waxy surface promotes the sealing of the contact between the disk and the interior of the wall of the tube. The disk itself can be made of a rigid material, for example, a high-density polyethylene or a polypropylene.

The diameter of the disk is preferably selected in such a manner that it is slightly greater than the internal diameter of the tube and so that its border, or edge, applies pressure against the wall of the tube, and said wall applies a pressure because of its own elasticity, thus insuring a more secure sealing connection.

It may also be advantageous to grease the border or edge of the disk before the placement of the latter. This greasing facilitates the positioning, and, moreover, it improves the sealing properties. The grease used for this purpose must naturally be compatible with the chemical nature of the liquids. A silicon grease with appropriate viscosity can be used.

To improve the disk sealing properties even further - particularly when one wishes the article to be capable of tolerating a long storage time before its use - one provides, around the tube, an external ring or sheath, for example, made of a rigid plastic material or of metal. This ring or sheath is placed concentrically with respect to the tube and on the exterior of the latter, at the level of the internal disk i.e. surrounding the disk. It consists of a cylinder with a length of about 2 to about 15 mm and a wall thickness of about 0.5 to 5 mm. The internal diameter of the ring or sheath is slightly less than the external diameter of the tube, as recorded perpendicularly to the disk.

The ring or sheath is preferably made of a rigid material. It can be prepared, for example, by the injection molding of a polycarbonate material.

When a ring or sheath is used, the disk can have either the same diameter as the internal diameter of the tube or it can be slightly smaller than the internal diameter of the tube.

According to another variant, the diameter of the disk is large, but in this case again, the internal diameter of the ring or sheath should be very slightly smaller than the external diameter of the swollen tube at the position of the disk.

The slight difference in diameters which has just been described is enough to cause, according to the principle of a band reinforcement, a large centripetal or afferent compression which insures the sealing properties. This compression is absorbed by the elasticity of the material of the tube wall and somewhat by the elasticity of the disk material itself, the latter being subjected to a centripetal, or afferent force in its own plane.

To activate the article, it suffices to slide the ring or sheath in the direction of the axis of the tube, until a sufficiently large zone is cleared on both sides of the disk to permit the tilting motion which is executed manually, as described above.

If the disk diameter is slightly less than the tube diameter, the creation of a communications link between the two compartments will occur, however, automatically when the tightening ring or sheath is shifted sufficiently along the axis of the tube.

The presence of the ring or sheath also contributes to the prevention of any accidental tilting of the disk before its final use, particularly during handling operations in transport and storage.

The sliding of the ring or sheath, at the time of use, as during the assembly, is facilitated by the waxy property of the polyethylene which is the preferred material for the tube. The sliding of the ring, due to the pressure of exerts on the tube, can also cause the disk to tilt in order to activate the device.

The elongated tube into which the disk is inserted must be produced from a material which has the specifications of Tensile Yield Strength and Stiffness Modulus set forth above. Utilization of this class of material e.g. a polyolefin, e.g. linear polyethylene, polyolefin copolymers, e.g. random copolymers of ethylene and propylene or multilayer composites of polyolefin layers. Mixtures of polyolefin homopolymers and copolymers can also

be used alone or as composites. Having said balance of properties enables the fused end seals of the tube walls to withstand the pressure which builds up when the device is activated by mixing the chemical ingredients therein. The end seals should preferably be at least one and one-half times the thickness of the wall of the tube, preferably at least three times the thickness of the wall of the tube; in width and have at least the thickness of the wall of the tube. A suitable linear polyethylene is sold commercially as SCLAIR® 8405 by DuPont de Nemours and Company. These composites are prepared as known in the art e.g. by coextrusion etc. A random copolymer having suitable properties is Rexene PP9403E and a suitable multilayer composite comprises a Quantum Chemical Corp. Petrothene® LLPE GB501-01 inside layer, a DuPont Bynez^{tm} CXA 3101 ethylene based tie layer and a Rexene ethylene/propylene copolymer 235SA outside layer.

These composites are prepared as known in the art e.g. by coextrusion etc.

The chemiluminescent article which is the object of the present invention does not necessarily require that the above described tube have the same cross-section along its entire length. It is only in proximity to the disk that the cross-section must be cylindrical. At other places and, possibly, on both sides of the region where the disk is located, the contour of the tube can form any shape, so that its capacity is locally increased. The aesthetic appearance of the entire assembly of the article can thus be changed significantly. The well-known process of extrusion blowing permits the preparation of such hollow bodies made of polyolefins in a continuous, economical process.

An example of an embodiment of the invention is given below.

One takes a tube extruded from a transparent or translucent i.e. light transmitting, and flexible linear polyethylene having a Stiffness Modulus of 655 mPa and a Tensile Yield Strength of 18 mPa, with an external diameter of 12.8 mm and a wall thickness of 0.6 mm, cuts it to the desired length of 10 cm and places it vertically.

Through the lower end, one introduces a cylindrical rod made of aluminum, with a diameter of 11.6 mm, up to a distance of 40 mm from said end.

Through the upper end, one drops a disk made of a high density polyethylene, with a diameter of 12.8 mm and a thickness of 1.5 mm, with the fall of the disk being achieved by manually squeezing the tube along the path of the fall. The disk is then in a position against the aluminum rod and is wedged perpendicularly to the axis of the tube by pushing a second rod similar to the first one which was introduced beforehand through the upper end.

One can then add a polycarbonate ring with a length of 18 mm, a wall thickness of 3 mm and an internal diameter of 13.3 mm. The middle of this ring is placed at the position of the disk, in the tube. The rods are then removed, the two compartments are filled, either completely or partially, with the respective liquids which will produce the chemiluminescence when brought in communication by manual tilting of the disk, and the ends are sealed closed by application of heat and pressure into a substantially flat plane of 4.7 mm surface width and 1.2 mm thickness.

Two diaphragms or disks may also be placed in contact with each other, with the contact faces being optionally greased to facilitate their tilting.

Numerous variations which have not been described can be made to the description of the chemiluminescent article according to the invention without going beyond the inventive principle as defined in the following claims.

Claims

1. A chemiluminescent element comprising a tube made of a flexible, light-transmitting and chemically stable material, which is closed at both of its ends, and which comprises at least two compartments which are filled with liquids which produce chemiluminescent light when mixed, and contains, between said ends, at least one internal diaphragm or disk which separates the tube into said compartments, said diaphragm or disk 1) having approximately a circular shape with a cross-section which is approximately rectangular in profile, 2) being positioned transversely with respect to the axis of the tube, and 3) its edge being in continuous contact with the interior of the tube wall, the elasticity, the external and internal diameters of the tube, and the diameter and thickness of the diaphragm or disk being selected in such a manner that the diaphragm or disk can be tilted by simple pressure, manual measure or any equivalent means against the external walls of the tube, which pressure imparts a tilting torque on said diaphragm or disk characterized by the fact that the closure at both ends is a fusion of the tube side walls, said fusion comprises an area lying in a substantially flat plane and the tube has a Stiffness Modulus of less than about 700 mPa and a Tensile Yield Strength greater than about 15 mPa.

2. An element according to Claim 1, wherein the diameter of the diaphragm or disk is slightly larger than the internal diameter of the tube.

3. An element according to Claim 1, wherein an external rigid ring whose internal diameter is slightly smaller than the external diameter of the tube at the position of the diaphragm or disk, is placed around the tube, concentrically with respect to the latter, and which can be loosened by sliding in the direction of the axis of the tube.

4. An element according to Claim 3, wherein the diameter of the diaphragm or disk is equal to the internal diameter of the tube.

5. An element according to Claim 1, wherein the tube and the diaphragm or disk are made of polyolefin material.

6. An element according to Claim 3, wherein the ring is made of metal or a rigid plastic material.

7. An element according to Claim 1, wherein the internal diameter of the tube is about 8 to about 18 mm and the thickness of the diaphragm or disk is between about 1 and about 4 mm.

8. An element according to Claim 1, wherein the tube and/or the diaphragm or disk are made of an olefin copolymer.

9. An element according to Claim 1, wherein the tube and/or the diaphragm or disk are made of a composite of olefin polymer layers.

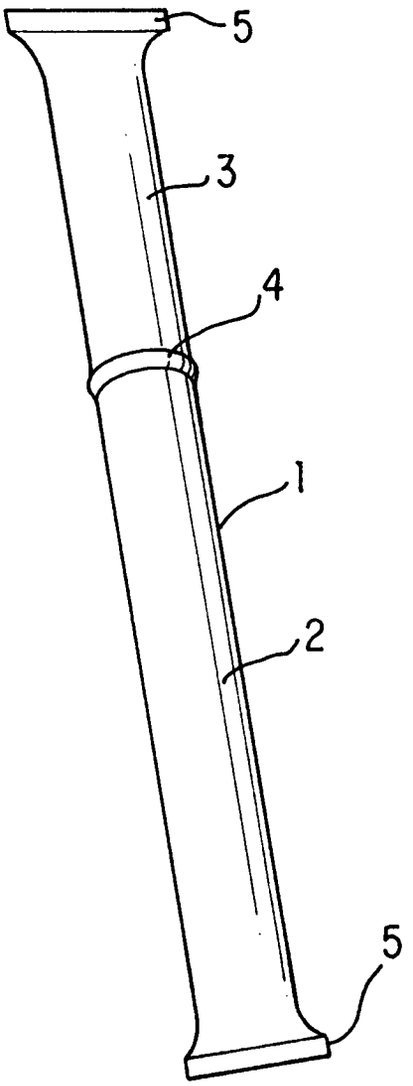

FIG. 1

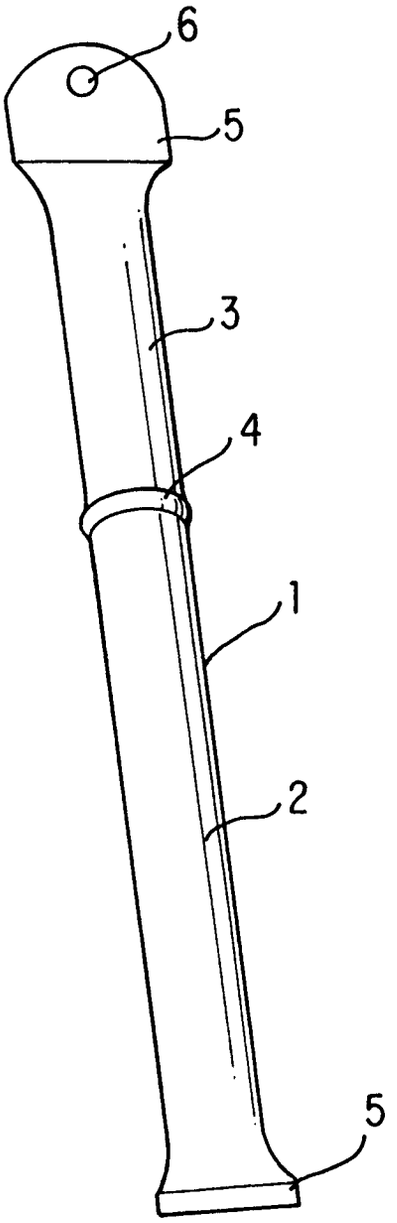

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 3633

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X,D	EP-A-0 406 551 (AMERICAN CYANAMID) * the whole document *	1-8	F21K2/06
A	US-A-5 043 851 (F.KAPLAN) * the whole document *	1	
A	US-A-3 861 072 (G.B.HOLCOMBE) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F21K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	02 DECEMBER 1992	DROUOT M.C.

CATEGORY OF CITED DOCUMENTS

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