LAMP TUBE, PROCESS FOR MANUFACTURING THE LAMP TUBE, AND ILLUMINATION APPARATUS COMPRISING THE LAMP TUBE

Figure 1
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Description

Lamp Tube, Process for Manufacturing the Lamp Tube, and Illumination Apparatus Comprising the Lamp Tube

Technical Field

The present invention relates to a lamp tube, a process for manufacturing the lamp tube, and an illumination apparatus comprising the lamp tube.

Background Art

In today's illumination apparatuses, the illumination apparatuses with a glass lamp tube as the housing are widely used. In order to improve the efficiency of the illumination apparatuses and save power, an LED light source can be installed in the glass lamp tube to replace, as a tubular retrofit lamp, the conventional fluorescent lamp. However, the circuit board carrying the LED light source, the driver, and other electronic devices such as wires also need to be placed in the tubular retrofit lamp. Thus, the user can see these internal electronic devices directly through the glass tube, which greatly affects the appearance of the retrofit lamp. Therefore, it is necessary to provide a beautiful and practical glass lamp tube as the housing of a retrofit lamp.

Summary of the invention

Thus, it is an object of the present invention to provide a lamp tube, which is easy to manufacture, has good appearance, and can replace the conventional glass tubes for use in various illumination occasions.
The lamp tube according to the present invention comprises a tube body made of glass, characterized in that, the tube body comprises a first portion and a second portion, wherein at least one of an inner circumferential wall and an outer circumferential wall of the second portion is provided with a structure for reducing transparency. In order to replace the conventional totally transparent glass tube, the circumferential wall of the tube body constituting the lamp tube is particularly processed, viz. a particular optical structure is provided in part of the region on the inner circumferential wall and/or the outer circumferential wall of the tube body, and the transparency of the region with the optical structure is lower than that of the other region. Part of the region of such lamp tube is invisible for the user, or at least cannot be seen clearly.

According to a preferred design solution of the present invention, the structure for reducing transparency is an optical layer which is individually coated on at least one circumferential wall of the second portion. Preferably, the optical layer is a reflective layer. The optical layer can be designed as a reflective layer coated on the inner circumferential wall and/or the outer circumferential wall of the tube body. The non-transparent reflective layer not only can serve as a shading layer shading some space in the tube body, but also can, in the case where there is a light source within the tube body, reflect the light from the light source through the transparent first portion towards a predetermined direction, so as to improve the light extracting rate of the first portion.

According to another preferred embodiment of the present invention, the reflective layer contains one of the following materials: silver and aluminum. Since silver or aluminum has
good reflective properties, the reflective layer containing silver or aluminum can achieve the effect of mirror-reflection.

According to a preferred design solution of the present invention, the structure for reducing transparency is a diffuse structure formed by etching the second portion. By means of the diffuse structure formed by etching, the circumferential wall of the second portion becomes unsmooth, which makes it impossible for the user to see the inside of the tube body directly or clearly.

According to a preferred design solution of the present invention, the second portion extends in a longitudinal direction of the tube body, and extends in a circumferential direction of the tube body by a predetermined angle. As the light emergent surface of a lamp tube is usually its longitudinal side surface, the transparent first portion and the second portion which at least cannot be totally transparent are designed to have a strip-like semi-tubular section. The proportion of the first portion and the proportion of the second portion in the circumferential direction can be adjusted according to practical needs, for example, in the circumferential direction, the first portion either can be equal to the second portion, or can be larger or smaller than the second portion.

According to a preferred design solution of the present invention, the predetermined angle is 180°. The upper half portion of the so-formed lamp tube in an axial direction is, for example, the second portion having a reflective surface or a diffuse structure, and the lower half portion is the transparent first portion.
According to a preferred design solution of the present invention, the inner circumferential wall is provided with a structure for reducing transparency. Corresponding to the design solution in which the structure for reducing transparency is provided on the outer circumferential wall of the tube body, the optical surface which is preferably a reflective surface can also be coated on the inner wall of the lamp tube, to serve as a shading structure on the inner circumferential wall of the second portion; or etching is performed on the inner circumferential wall of the second portion to form a diffuse structure.

According to a preferred design solution of the present invention, the lamp tube further comprises a partition board formed on the inner circumferential wall, the partition board partitioning the tube body into the first portion and the second portion. When it is necessary to dispose the diffuse structure or the optical layer within the tube body, an additional partition board is preferably disposed within the tube body, such that the first portion and the second portion are separated from each other by the partition board, which simplifies the processing on the second portion.

According to a preferred design solution of the present invention, the partition board is made in one piece with the tube body. The partition board which is made of the same material as the tube body serves to separate the first portion from the second portion, serves as a supporting board for carrying, for example, a light engine, and can also increase the thermal conductive area of the tube body.

According to another preferred design solution of the present invention, a rubber strip is arranged between the partition board and the tube body. The partition board can also be an
element additionally provided in the tube body, and in order to avoid friction or scratch between the partition board and the tube body made of glass, a rubber strip is preferably provided between them as a buffer.

The present invention also relates to an illumination apparatus comprising a light engine and a driver, characterized by further comprising the above mentioned lamp tube, wherein the light engine and the driver are arranged in the lamp tube. Such illumination apparatus has good appearance, and the user cannot directly or clearly see the driver in the lamp tube.

According to a preferred design solution of the present invention, a light emergent surface of the light engine faces the first portion, and the driver faces the second portion. The light engine carrying the light source is arranged to face the transparent first portion for sufficient and efficient illumination; and the driver which does not need to be seen is preferably arranged on a side close to the second portion in the lamp tube, in order to improve the visual effects of the illumination apparatus.

The present invention further relates to a process for manufacturing the above mentioned lamp tube, characterized by comprising the steps of: a) providing a totally transparent tube body made of glass; b) providing a retaining element retained on the tube body and partitioning, in a circumferential direction, the tube body into two portions; and c) enabling one of the two portions to serve as a totally transparent first portion, and processing at least one of an inner circumferential wall and an outer circumferential wall of the other portion, to form a structure for reducing transparency, as a second portion. The proportion of the first portion and the proportion of the second portion in the circumferential
direction are selected in accordance with the location of the electronic devices which need to be installed in the lamp tube, thus forming the second portion having relatively low transparency, for shading some of the devices which need to be installed within the lamp tube.

According to a preferred design solution of the present invention, in the step b), the retaining element is a pair of clamping arms retained on the outer circumferential wall, and in the step c), a reflective layer is coated on the outer circumferential wall to form the structure for reducing transparency. For example, it is feasible to process the region which does not need to be transparent from the outside of the lamp tube, and to form the second portion whose transparency is reduced, by directly applying a reflective layer.

According to a preferred design solution of the present invention, in the step b), the retaining element is a partition board retained on the inner circumferential wall, and in the step c), the inner circumferential wall is etched to form the structure for reducing transparency. The tube body is defined as the first portion and the second portion through the partition board, which allows simple etching process to the predetermined region defined by the partition board to form the second portion.

According to a preferred design solution of the present invention, in the step b), the partition board and the tube body are made in one piece. For example, the methods such as hot-melt method can be used to connect the glass partition board and the tube body as one piece.

According to another preferred design solution of the present invention, in the step b), a rubber strip is clamped between
the partition board and the tube body.

It shall be understood that both the above general description and the following detailed description are for illustrative and explanatory purposes in order to provide further description on the claimed present invention.

**Brief Description of the Drawings**

The drawings constitute a portion of the Description for further understanding of the present invention. These drawings illustrate the embodiments of the present invention and explain the principle of the present invention together with the Description. In the drawings, the same part is represented by the same reference sign. In the drawings,

Fig. 1 shows the first embodiment of the illumination apparatus according to the present invention;

Fig. 2 shows the first embodiment of the process for manufacturing the lamp tube of the illumination apparatus in Fig. 1;

Fig. 3 shows the second embodiment of the illumination apparatus according to the present invention; and

Fig. 4 shows the second embodiment of the process for manufacturing the lamp tube of the illumination apparatus in Fig. 3.

**Detailed Description of the Embodiments**

In the following detailed Description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in
which the invention may be practiced. In this regard, direc-
tional terminology, such as "top", "bottom", "inner", "outer" etc., is used with reference to the orientation of the Fig-
ure (s) being described. Because components of embodiments can
be positioned in a number of different orientations, the di-
rectional terminology is used for purposes of illustration
and is in no way limiting. It is to be understood that other
embodiments may be utilized and structural or logical changes
may be made without departing from the scope of the present
invention. The following detailed description, therefore, is
not to be taken in a limiting sense, and the scope of the
present invention is defined by the appended claims.

It is to be understood that the features of the various exem-
plary embodiments described herein may be combined with each
other, unless specifically noted otherwise.

In order to replace the conventional totally transparent
glass tube, the circumferential wall of the tube body 1 con-
stituting the lamp tube 10 is particularly processed, viz. a
particular optical structure is provided in part of the re-
gion on the inner circumferential wall A1 and/or the outer
circumferential wall A2 of the tube body 1, and the transpar-
ency of the region with the optical structure is lower than
that of the other region. Part of the region of such lamp
tube 10 is invisible for the user, or at least cannot be seen
clearly.

Fig. 1 shows the first embodiment of the illumination appara-
tus according to the present invention. As can be seen from
the sectional view shown in Fig. 1, the tube body 1 of the
illumination apparatus 100 with the lamp tube 10 as its hous-
ing is divided, in the circumferential direction, into two
equal portions. The upper half portion of the tube body 1 is
the second portion 3, and the first portion 2 facing the second portion 3 is the lower half portion of the tube body 1. The second portion 3 has a structure for reducing transparency, and in the present embodiment, the structure for reducing transparency is an optical layer coated on the outer circumferential wall A2 of the second portion 3. The optical layer is preferably a reflective layer 4, which has double functions of blocking light on one side and reflecting light on the other side. The light engine 21 and the driver 22 of the illumination apparatus 20 can be disposed in the lamp tube 10, as shown in Fig. 1, viz. one side of the light engine 21 carrying the light source faces the transparent first portion 2, the driver 22 is installed, in the vertical direction, above the light engine 21, and the reflective layer 4 on the outer circumferential wall A2 of the second portion 3 and the light engine 21 define the driver 22 in a region invisible from the outside of the lamp tube 10, which thereby prevents the user from seeing the driver 22 from the outside, and improves the aesthetic property of the illumination apparatus 20.

The reflective layer 4 can be a coating containing silver or aluminum. Such reflective layer 4 not only has superior light blocking effect, but also can further reflect the received light in a predetermined direction, for example, reflecting the light in the lamp tube 10 towards the transparent first portion 2, thereby improving the light intensity of the light emerging from the first portion 2.

In addition, in accordance with the sizes of the light engine 21 and the driver 22, the proportions of the first portion 2 and the second portion 3, which extend in the axial direction of the lamp tube 10, in the circumferential direction can be adjusted. When the light engine 21 has a small area in cross
section, the circumferential area occupied by the reflective layer 4 for shading the light engine 21 can be correspondingly reduced. That is, the angle by which the second portion 3 extends in the circumferential direction may be smaller than 180°, for example, only 120°. When the light engine 21 has a large area in cross section, the area of the outer circumferential wall occupied by the reflective layer 4 for shading the light engine 21 can be correspondingly increased. That is, the angle by which the second portion 3 extends in the circumferential direction may be greater than 180°, for example, can be 240°.

Fig. 2 shows the first embodiment of the process for manufacturing the lamp tube of the illumination apparatus in Fig. 1. Firstly, the totally transparent tube body 1 made of glass is provided. By means of a pair of clamping arms 7 which clamp the tube body 1 from the outside, the tube body 1 to be processed is located at a predetermined position. The clamping arms 7 can also divide, in the circumferential direction, the tube body 1 into two portions. Subsequently, at least one circumferential wall (the outer circumferential wall A2 in the present embodiment) of the inner circumferential wall A1 and the outer circumferential wall A2 of one of the two portions is processed to form a structure for reducing transparency as the second portion 3 which can be used for shading the devices placed in the tube body 1; and the other portion which is not processed serves as the totally transparent first portion 2. In the present embodiment, the structure for reducing transparency is the reflective layer 4 which is individually sprayed onto the outer circumferential wall A2 of the lower half portion of the tube body 1.

The so-formed second portion 3 has an optical layer extending in the axial direction of the lamp tube 10. The first portion
2 adjacent to the second portion 3 in the circumferential direction also extends in the axial direction of the lamp tube 10, and the first portion maintains the superior transmissivity of the tube body 1. Thus, the lamp tube 10 comprises the first portion 2 having relatively high transparency and the second portion 3 having relatively low transparency, which is opaque here.

In an embodiment not shown, part of the outer circumferential wall of the tube body can be etched to form the second portion having a diffuse structure. The outer circumferential wall of the so-formed second portion is, for example, a frosted surface or other similar optical surface, and the user cannot see, from one side of the optical surface, an object on the other side. That is, the user cannot clearly see, from the outside of the second portion of the lamp tube, the electronic devices installed in the lamp tube.

Fig. 3 shows the second embodiment of the illumination apparatus according to the present invention. The lamp tube 10 of the illumination apparatus 100 in the present embodiment comprises a strip-like partition board 5 retained within the tube body 1. The partition board 5 can be made in one piece with the tube body 1, such that the thermal contact area of the tube body 1 can be increased, which makes it easy to carry the electronic assemblies installed thereon, and to dissipate heat. Another important function of the partition board 5 is to partition, in the extending direction of the lamp tube 10, the tube body 1 into the upper first portion 2 and the lower second portion 3. The inner circumferential wall A1 of the second portion 3 at least comprises a structure for reducing transparency. Such structure for reducing transparency can be a diffuse structure 4′ formed by processing the inner circumferential wall A1 of the second portion...
3. In an embodiment not shown, such structure for reducing transparency can be an optical layer coated on the inner circumferential wall A1.

In the case where the partition board 5 is directly used as a supporting board, the light engine 21 of the illumination apparatus 20 can be preferably arranged on the top surface of the partition board 5, which allows the light from the light source on the light engine 21 to directly go through the upper first portion 2 of the lamp tube 10. Meanwhile, the driver 22 of the illumination apparatus 20 which is not desired to be seen is arranged on the bottom surface of the partition board 5, and thereby, the driver 22 is accommodated in a non-totally transparent space defined by the partition board 5 and the lower second portion 3 of the lamp tube 10. The user cannot directly or clearly see, from the outside of the lamp tube 10, the driver 22 surrounded by the second portion 3.

Fig. 4 shows the second embodiment of the process for manufacturing the lamp tube of the illumination apparatus in Fig. 3. The totally transparent tube body 1 made of glass is firstly provided, and then a retaining element for partitioning the tube body 1 into two portions is additionally provided in the tube body 1. The retaining element is shown as the partition board 5 in Fig. 3. The retaining element can be made in piece with the tube body 1, to thereby increase the thermal contact area of the tube body 1, which makes it easy to carry the electronic assemblies installed thereon, and dissipate heat. The partition board 5 can also be fixed within the tube body 1 by means of mechanical connection, as shown in the figure, or rather, two side end surfaces of the partition board 5 are pressed against the inner circumferential wall A1 of the tube body 1. In this case, in order to
reduce the abrasion between the partition board 5 and the inner circumferential wall A1, the rubber strip 6 which serves as a buffer can be particularly arranged between the partition board 5 and the inner circumferential wall A1.

Finally, the inner circumferential wall of a part of the tube body 10 partitioned off by the partition board 5 can be processed to form a structure for reducing the transparency of the part. Preferably, through the etching process, a diffuse structure 4' is formed directly on the inner circumferential wall A1 of the upper tube body 1 defined by the partition board 5. By the partition board 5 partitioning the inner circumferential wall A1, the selected region on the inner circumferential wall A1 can be etched simply and precisely, which greatly simplifies the manufacture process of the lamp tube 10.

Also, a reflective layer may be used to replace the diffuse structure, and then, a reflective layer or similar optical layers can be directly coated on the partial inner circumferential wall defined by the partition board, so as to form the second portion invisible from the outside.

In the scope of the present invention, it is feasible to provide an optical layer on only the inner circumferential wall or only the outer circumferential wall of the second portion, or to process only the inner circumferential wall or only the outer circumferential wall of the second portion into a diffuse structure; it is also feasible to provide an optical layer on both the inner circumferential wall and the outer circumferential wall of the second portion, or to process both the inner circumferential wall and the outer circumferential wall of the second portion into a diffuse structure. Further, the second portion may be designed to have an opti-
cal layer on one side and a diffuse structure on the other side.

The above is merely preferred embodiments of the present invention but not to limit the present invention. For the person skilled in the art, the present invention may have various alterations and changes. Any alterations, equivalent substitutions, improvements, within the spirit and principle of the present invention, should be covered in the protection scope of the present invention.
List of reference signs

1  tube body
2  first portion
3  second portion
4  reflective layer
4' diffuse structure
5  partition board
6  rubber strip
7  clamping arm
10 lamp tube
20 illumination apparatus
21 light engine
22 driver
A1 inner circumferential wall
A2 outer circumferential wall
Claims

1. A lamp tube (10), comprising a tube body (1) made of glass, characterized in that, the tube body (1) comprises a first portion (2) and a second portion (3), wherein at least one of an inner circumferential wall (A1) and an outer circumferential wall (A2) of the second portion (3) is provided with a structure for reducing transparency.

2. The lamp tube (10) according to Claim 1, characterized in that, the structure for reducing transparency is an optical layer which is individually coated on at least one circumferential wall of the second portion (3).

3. The lamp tube (10) according to Claim 2, characterized in that, the optical layer is a reflective layer (4).

4. The lamp tube (10) according to Claim 3, characterized in that, the reflective layer (4) contains one of the following materials: silver and aluminum.

5. The lamp tube (10) according to Claim 1, characterized in that, the structure for reducing transparency is a diffuse structure (4') formed by etching the second portion (3).

6. The lamp tube (10) according to any of Claims 1-5, characterized in that, the second portion (3) extends in a longitudinal direction of the tube body (1), and extends in a circumferential direction of the tube body (1) by a predetermined angle.

7. The lamp tube (10) according to Claim 6, characterized in that, the predetermined angle is 180°.
8. The lamp tube (10) according to any of Claims 1-5, characterized in that, the inner circumferential wall (Al) is provided with a structure for reducing transparency.

9. The lamp tube (10) according to Claim 8, characterized by further comprising a partition board (5) formed on the inner circumferential wall (Al), the partition board (5) partitioning the tube body (1) into the first portion (2) and the second portion (3).

10. The lamp tube (10) according to Claim 9, characterized in that, the partition board (5) is made in one piece with the tube body (1).

11. The lamp tube (10) according to Claim 9, characterized in that, a rubber strip (6) is arranged between the partition board (5) and the tube body (1).

12. A tubular illumination apparatus (20), comprising a light engine (21) and a driver (22), characterized by further comprising a lamp tube (10) according to any of Claims 1-11, wherein the light engine (21) and the driver (22) are arranged in the lamp tube (10).

13. The illumination apparatus (20) according to Claim 12, characterized in that, a light emergent surface of the light engine (21) faces the first portion (2), and the driver (22) faces the second portion (3).

14. A process for manufacturing a lamp tube (10) according to any of Claims 1-11, characterized by comprising the steps of: a) providing a totally transparent tube body (1) made of glass; b) providing a retaining element retained on the tube body (1) and partitioning, in a circumferential direction,
the tube body (1) into two portions; and c) enabling one of the two portions to serve as a totally transparent first portion (2), and processing at least one of an inner circumferential wall (A1) and an outer circumferential wall (A2) of the other portion, to form a structure for reducing transparency, as a second portion (3).

15. The process according to Claim 14, characterized in that, in the step b), the retaining element is a pair of clamping arms (7) retained on the outer circumferential wall (A2), and in the step c), a reflective layer (4) is coated on the outer circumferential wall (A2) to form the structure for reducing transparency.

16. The process according to Claim 14, characterized in that, in the step b), the retaining element is a partition board (5) retained on the inner circumferential wall (A1), and in the step c), the inner circumferential wall (A1) is etched to form the structure for reducing transparency.

17. The process according to Claim 16, characterized in that, in the step b), the partition board (5) and the tube body (1) are made in one piece.

18. The process according to Claim 16, characterized in that, in the step b), a rubber strip (6) is clamped between the partition board (5) and the tube body (1).
Figure 1
INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/065297

A. CLASSIFICATION OF SUBJECT MATTER

C03C15/00 C03C17/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F21K F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category* Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No.

| X | US 2012/008314 A1 (SIMON DAVID [US] ET AL) 12 January 2012 (2012-01-12) paragraphs [0023], [0024], [0026]; figures 1-6 | 1-18 |
| X | DE 20 100 013037 U1 (HARVATEK CORP [TW]) 24 February 2011 (2011-02-24) paragraphs [0004], [0015]; claim 1; figures 1-7 | 1-18 |
| X | US 2003/100935 A1 (KRATZ WALTER [DE]) 29 May 2003 (2003-05-29) paragraph [0026]; claims 1, 7, 8; figure 2 | 1-18 |
| X | CN 201 229 920 Y (MINGRONG HUANG [CN]) 29 April 2009 (2009-04-29) the whole document | 1-18 |

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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Name and mailing address of the ISA:

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