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STRESS-RELIEVED SEAL STRUCTURE FOR ARCUATE FLUORESCENT LAMP OR THE LIKE

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FIG. 1.

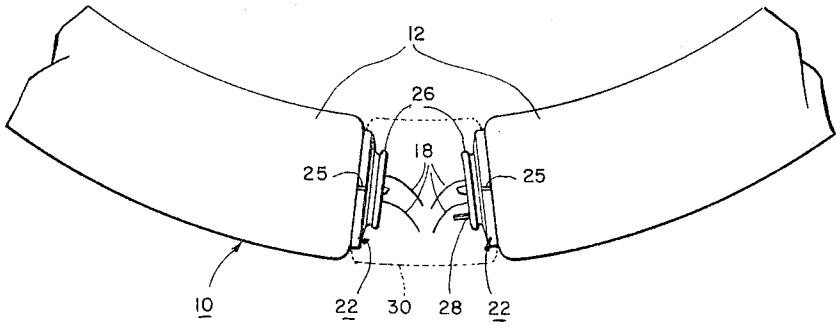


FIG. 2.

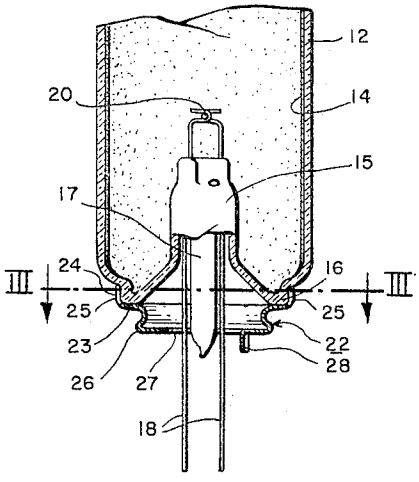
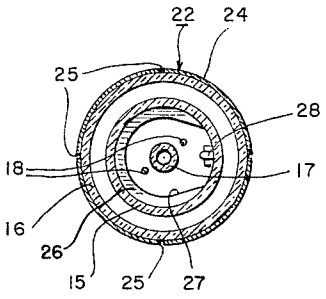


FIG. 3.



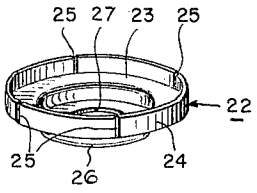


FIG. 4.

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STRESS-RELIEVED SEAL STRUCTURE FOR ARCUATE FLUORESCENT LAMP OR THE LIKE

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This invention relates to electric lamps and has particular reference to an improved end cap-and-seal structure for fluorescent lamps of circular configuration.

In the manufacture of circular fluorescent lamps it is the present practice to seal a metal header or cap to each end of the lamp envelope to facilitate gripping the envelope when it is bent into circular configuration. One of the caps is also provided with a tab for limiting the rotation of the lamp base relative to the envelope. Such end caps are customarily made from an iron-chromium alloy which seals well to the lamp envelope and remains sufficiently rigid after the sealing operation to fulfill the aforementioned requirements. However, the coefficient of expansion of these end caps is considerably more than that of the so-called "lead" glass from which the lamp envelopes are customarily fabricated. As a result, strains are induced in the glass-to-metal seal during the sealing operation (and sometimes even after the lamp is completed and is being shipped or stored) which are frequently severe enough to crack the seal. Since such seal cracks destroy the integrity of the lamp envelope, contamination of the lamp atmosphere results, thus ruining the lamp and creating a serious shrinkage problem.

It is accordingly the general object of the present invention to provide an improved glass-to-metal seal for fluorescent lamps or the like which will enable the lamps to be fabricated and then shipped and stored without developing cracks due to temperature variations.

Another object is the provision of a seal structure for an arcuate fluorescent lamp that includes a metal end cap and can be fabricated on a mass-production basis with a minimum of shrinkage due to cracked seals.

The foregoing objects and additional advantages that will occur to those skilled in the art are achieved according to the present invention by providing at least one slot-like opening in the rim or collar of the end cap which enables the collar segments to flex freely with the glass to which they are joined and thus automatically relieve the strains in the finished seal produced by temperature variations.

A better understanding of the invention will be obtained from the accompanying drawing, wherein:

FIGURE 1 is a fragmentary elevational view of a circular fluorescent lamp, the base being shown in dotted outline to show the improved end cap and seal of the present invention more clearly;

FIG. 2 is a fragmentary sectional view on an enlarged scale through one end of the lamp prior to the bending and basing operations;

FIG. 3 is a cross-sectional view along the reference line III—III of FIG. 2, in the direction of the arrows; and

FIG. 4 is a perspective view of the improved end cap shown in the preceding figures.

While this invention can be used with advantage in various types of devices that require a glass-to-metal seal between components having different coefficients of expansion, it is especially adapted for use in fluorescent lamps of circular configuration and has, accordingly, been so illustrated and will be so described.

THE INVENTION

With specific reference to the drawing, in FIG. 1 there is shown the basal end portion of a circular fluorescent lamp **10** that embodies the present invention and comprises a vitreous envelope **12** the ends whereof are sealed to metal end caps **22** and joined together by a suitable arcuate base **30** (shown in dotted outline) which spans the opening between the envelope ends and completes the circular configuration of the lamp. As shown, one of the caps is provided with a protruding tab **28** that interlockingly engages a recess (not shown) in the base and limits the rotation of the base relative to the envelope in the well-known manner.

As shown more particularly in FIG. 2, the inner surface of the envelope **12** is coated with the usual layer **14** of suitable UV-responsive phosphor and a re-entrant stem **15** is sealed to each end of the envelope. The ends of the envelope are flared inwardly toward the stem **15** thereby providing a constricted neck portion **16** and an adjoining annular shoulder at each end of the lamp. A pair of lead-in wires **18** are sealed through the stem and connect the cathode **20** located within the envelope **12** with suitable contacts provided in the base (not shown).

The envelope also contains the usual charge of mercury and an ionizable starting gas, such as argon or the like, that are introduced through an exhaust tube **17**. As shown in FIGS. 2 and 3, the outer surface of the constricted neck portion **16** is sealed to the metal end cap **22** in the usual manner during lamp assembly. A circular fluorescent lamp of this type and a suitable base construction is disclosed in U.S. Patent No. 2,802,191, issued August 6, 1957, to L. L. Nicolaro, and entitled "Base For Electric Lamp."

As shown more particularly in FIG. 4, the improved end cap **22** comprises a circular stamping of sheet metal having an annular end wall **23**, an upstanding rim portion or collar **24** that extends transversely from the end wall, and an annular boss **26** that projects from the opposite face of the end wall and is provided with an opening **27**. One of the caps has a protruding tab **28** (see FIGS. 1 to 3) that is struck from the portion of the boss **26** that is removed to form the opening **27**. The end wall **23** and collar **24** define a cylindrical cavity which snugly receives the sealed neck portion **16** of the lamp envelope.

In accordance with the present invention the cap collar **24** is provided with at least one opening such as a slot **25** that extends inwardly from its periphery to the end wall **23** or body of the cap **22**, as shown most clearly in FIG. 4. The collar is preferably split by four such slots spaced approximately 90° apart around the periphery of the cap. The collar is accordingly divided into arcuate segments that are free to flex and "breathe," so to speak, with the neck portion **16** of the envelope as it expands and contracts with changes in temperature. The difference in the rates of expansion and contraction of the enclosed neck portion **16** and cap collar **24** is thus automatically compensated for. Hence, strains induced in the glass-to-metal seal by changes in temperature are immediately relieved and the lamp remains free from seal cracks, even when subjected to an extremely wide range of temperatures.

Experience has shown that it is very important that no burrs or rough edges be left on the cap after the slotting operation since such surface imperfections tend to weaken the seal and initiate cracks.

Specific example

As a specific example of one form of the invention, in the case of a 32 watt circular fluorescent lamp having an envelope approximately 1¼ inches in diameter (T10) the end cap was fabricated from iron-chrome sheet stock approximately 12 mils thick and had a collar that was approximately 1 inch in diameter and about 57 mils wide. The slots were approximately 40 mils (1 millimeter) wide and spaced 90° apart. Iron-chromium alloys are well known and are used in this particular application because of their ability to withstand the sealing temperatures without losing its rigidity or becoming excessively oxidized. The alloy used in this particular embodiment had a coefficient of expansion of 105×10^{-7} cm./cm./° C. and the following composition; carbon 0.12%, manganese 0.60%, silicon 0.50%, nitrogen 0.10% to 0.17%, chromium 27.00% to 29.00%, and the remainder iron.

The envelope was fabricated from so-called "lead" type glass that is usually employed for this type lamp and has a coefficient of thermal expansion of 89×10^{-7} cm./cm./° C. Such lead glasses are well known and a typical composition is as follows:

	Percent
SiO_2	68
PbO	15
Na_2O	10
K_2O	6
CaO	1

The substantially stress-free glass-to-metal seal provided by the slotted cap of the present invention also affords another possible advantage in that it may permit the envelope to be made from so-called "lime" glass which is less expensive than lead glass but has a higher coefficient of expansion. Such lime glasses are also well known and a typical composition is approximately as follows:

	Percent
SiO_2	72
Na_2O	15
CaO	9
MgO	3
Al_2O_3	1

Such lime glasses have a coefficient of expansion of 92×10^{-7} cm./cm./° C.

Test data

Comparative tests have shown that the use of a slotted end cap in accordance with the present invention reduces the shrinkage due to cracked seals during manufacture by about 9%.

The improvement in the ability of lamps fitted with slotted caps to withstand extreme variations in temperature is illustrated by the following test conducted on 32 watt circular fluorescent lamps. In this test, one group of thirty test lamps was made with slotted end caps and two groups of controls of thirty lamps each were manufactured at the same time as the test lamps, one group of controls being run through the machine immediately preceding the test group and the second set of controls immediately following. During manufacture the first control group developed two cracked seals (6.7% defects), the second control group developed one cracked seal (3.3% defects) whereas the test group had no cracked seals.

Seven lamps from each group were then placed in a deep freeze, held for one week at −10° F. and then removed and immediately plunged into boiling water. One of the control lamps developed a cracked seal whereas none of the test lamps did.

The remaining 20 lamps were then returned to the deep freeze and held for another week at −10° F. Upon removal they were allowed to return to room temperature and were then examined for cracked seals. Two of the control lamps developed cracks whereas none of the test lamps were affected.

Three of the test lamps that were subjected to the aforementioned "deep freeze" treatment were then put up on life test and burned at rated voltage for 1470 hours. All of them remained clean indicating that no contamination of the lamp atmosphere had occurred and that the envelopes were free from cracks.

Summary

It will be appreciated from the foregoing that the objects of the invention have been achieved by providing an improved end cap and seal structure for fluorescent lamps of arcuate configuration which materially reduces the shrinkage due to cracked seals during and after lamp fabrication. The improved glass-to-cap seal inherently compensates for differences in the expansion of the cap and envelope and thus improves both the quality and useful life of the lamps, particularly under varying temperature conditions.

While one embodiment has been illustrated and described, it will be appreciated that various changes in both the configuration and organization of parts may be made without departing from the spirit and scope of the invention. For example, the slotted base collar **24** can be partly or completely embedded in the constricted neck portion **16** of the envelope **12** instead of merely being sealed to the outer surface thereof.

We claim as our invention:

1. In an electric lamp or the like, a seal structure comprising;

a vitreous envelope having a closed end portion, and

a cap having a metal rim portion that has a different coefficient of expansion than the vitreous material from which the envelope is made and is joined directly to and forms a seal with the closed end portion of said envelope,

said rim portion having an opening therein that extends from its periphery inwardly toward the body of said cap and thereby permits the rim segments of said cap to flex with the joined envelope portions under varying temperature conditions.

2. The seal structure set forth in claim **1** wherein the rim portion of said cap comprises a collar that encircles the end portion of said envelope and is sealed directly to the outer surface thereof.

3. In a fluorescent lamp, the combination of;

a glass envelope having a tubular neck portion at one end, and

a metal end cap having a collar that encircles and is joined directly to the neck portion of said envelope and forms a glass-to-metal seal therewith,

said cap having a higher coefficient of expansion than the enclosed neck portion of said envelope, and

said collar having a slot therein that extends inwardly from its periphery toward the body of said cap and thus permits the collar segments to flex sufficiently to relieve strains produced by temperature variations during and after the sealing operation.

4. The combination set forth in claim **3** wherein;

said collar has a plurality of slots therein located at preselected points around its periphery.

5. The combination set forth in claim **3** wherein;

said envelope is composed of lead glass, and

said end cap is composed of iron-chromium alloy.

References Cited by the Examiner

UNITED STATES PATENTS

728,060	5/1903	Whipple	313—318
2,056,157	10/1936	Buttolph	313—318 X

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