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[54] **40 WATT FLUORESCENT LAMP**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **H01j 61/16**

[58] **Field of Search** .... 313/108 R, 109, 182, 313/185, 226

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[57] **ABSTRACT**

Luminous flux and luminous efficiency of a 40 watt fluorescent lamp comprising a ballast specified by the I.E.C. Publication 82 (covering Ballast for fluorescent lamps) is greatly improved by employing an improved tube characterized by:

having the nominal tube length of 1,200 mm and the inner diameter of 20 mm to 25 mm,

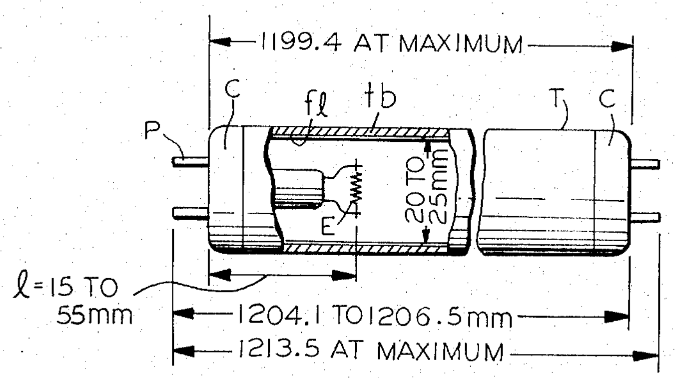
provided inside at each end of the tube with an electrode E having the length *l* of 15 mm to 55 mm inward (, from the end face of each cap C as measured as shown in FIG. 2,)

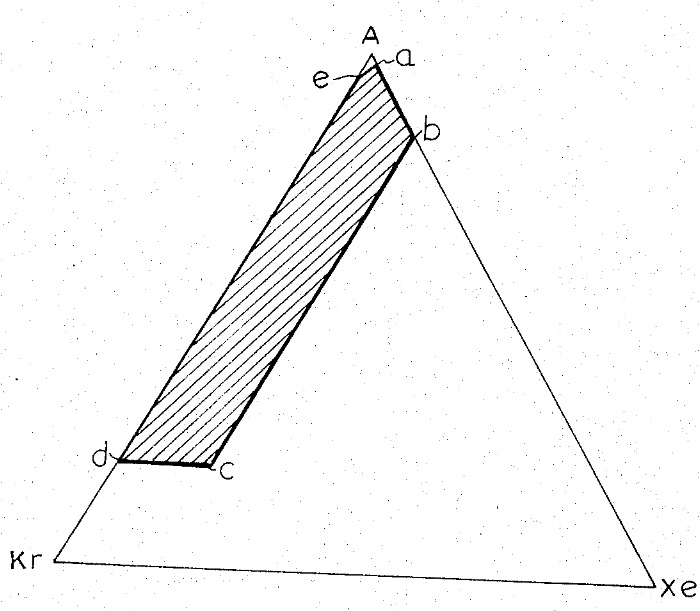
and containing mixed rare gas inside the tube, the rare gas having composition ratio represented by any point within a diagonal region defined by connecting the following points (a) to (e) and (a) with straight lines in the following order, on a trilinear chart for xenon, krypton and argon mixture:

a.	Xe: 1%,	Kr: 0%,	A: 99%
b.	Xe: 15%,	Kr: 0%,	A: 85%
c.	Xe: 15%,	Kr: 65%,	A: 20% %
d.	Xe: 0%,	Kr: 80%,	A: 20%
e.	Xe: 0%,	Kr: 5%	A: 95%

the pressure of the mixed gas being between 1.0 mmHg and 3.5 mmHg at the temperature of 20°C.

4 Claims, 3 Drawing Figures





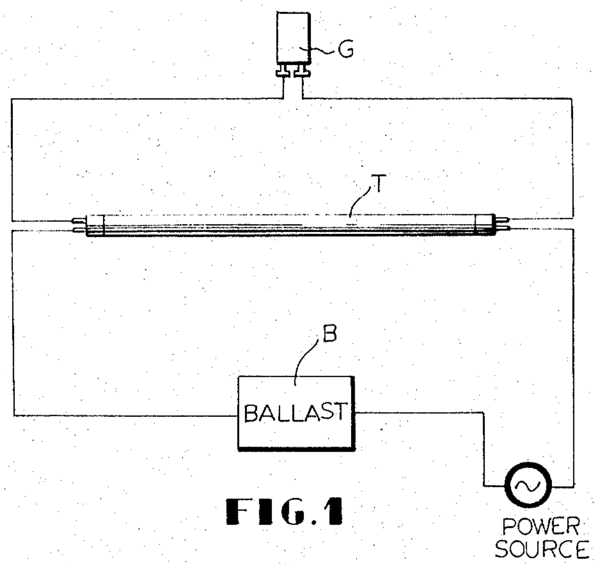


FIG.1

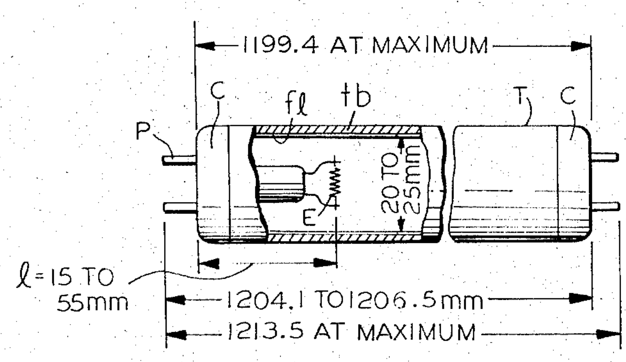
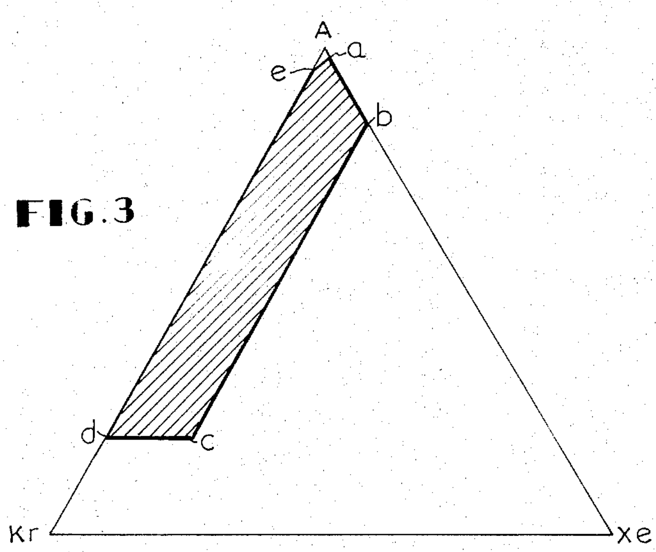


FIG.2

FIG.3



40 WATT FLUORESCENT LAMP

BACKGROUND OF THE INVENTION

This invention relates to a 40 watt fluorescent lamp, and especially to an improvement in a 40 watt fluorescent tube and its purpose is to provide improved luminous flux and efficiency of the tube and reduction in the cost, as compared with conventional 40 watt fluorescent tubes.

As is well known, fluorescent lamps are widely used in our present livelihood, and especially those of 40 watts are commanding a tremendous market. However, in general, the 40 watt fluorescent tubes of the prior art are manufactured in accordance with the dimensions of the I.E.C. (International Electrotechnical Commision) Publication 81 (for Tubular fluorescent lamps for general lighting service), namely, with a nominal tube length of 1,200 mm and an outer diameter of 38 mm, containing inside about 2 to 3 mmHg of argon gas and some quantity of mercury, fitted with an electrode at each inner end, and sealed with a metal cap at each outer end.

Further descriptions of the conventional 40 watt fluorescent lamp in current general use are as follows. As shown in FIG. **1**, the lamp comprises a ballast B, a glow starter G and a 40 watt fluorescent tube T. For the ballast B, a choke coil type ballast as specified by the I.E.C. Publication 82 (covering Ballasts for fluorescent lamps) is employed. Such ballast is hereinafter referred to as conventional ballast or ballast in current use.

SUMMARY OF THE INVENTION

The inventors of the present invention made thorough investigations for improving the luminous flux and efficiency of the fluorescent lamp by using said 40 watt fluorescent fitting-and-ballast and for reducing the cost of tube. Consequently, the inventors found that a fluorescent tube with a specified inner diameter of bulb, electrodes with specified length and enclosed gas of a specified composition ratio, showed good performance.

BRIEF EXPLANATION OF THE DRAWING

FIG. **1** is a diagram showing a general construction of a lamp with a 40 watt fluorescent tube, of the prior art as well as of the present invention.

FIG. **2** is a partially cut away side view of a 40 watt fluorescent tube of the present invention, and

FIG. **3** is trilinear chart showing the composition of mixed gas enclosed in the fluorescent tube.

DETAILED DESCRIPTION OF THE INVENTION

As a result of the research, a 40 watt fluorescent lamp of superior performance has been invented, wherein the fluorescent tube is characterized by:

having a nominal tube length of 1,200 mm, i.e., as specified for the 40 watt fluorescent tube in the I.E.C. Publication 81, and an inner diameter of 20 mm to 25 mm,

provided inside each end of the tube with an electrode E having a length *l* of 15 mm to 55 mm inward from the end face of each cap C as measured as shown in FIG. **2**,

and containing mixed rare gas inside the tube, the rare gas having a composition ratio represented by any point within a diagonal region defined by connecting the following points (a) to (e) and (a) with straight lines in the following order, on a trilinear chart for xenon, krypton and argon mixture:

a.	Xe: 1%,	Kr: 0%,	A: 99%
b.	Xe: 15%,	Kr: 0%,	A: 85%
c.	XE: 15%,	Kr: 65%,	A: 20%
d.	Xe: 0%,	Kr: 80%,	A: 20%
e.	Xe: 0%,	Kr: 5%,	A: 95%

the pressure of the mixed gas being between 1.0 mmHg and 3.5 mmHg at the temperature of 20°C.

FIG. 3 shows the trilinear chart indicating the diagonal regions.

Namely, by applying and lighting said fluorescent tube on the conventional 40 watt fitting-and-ballast in current use, which is specified by the I.E.C. Publication 82, a luminous flux of between 3,250 lm (lumens) and 3,400 lm is obtainable, in comparison with that of 3,200 lm obtainable with the conventional 40 watt fluorescent tube, that is, an increase of 1.6% to 6.3% in the luminous flux quantity. The electric power consumption of this new fluorescent tube is 36.5 watts to 38 watts, which is 5% to 9% less than the power consumption of 40 watts of the conventional 40 watt fluorescent tube. Consequently, the lamp efficiency of the fluorescent tube of the present invention becomes 85.5 lm/w to 93.2 lm/w, as compared with 80 lm/w of the conventional 40 watt tube, that is, an increase of 6.9% to 16.4% in the lamp efficiency.

The reason for the attainment of such tremendous improvements is that by lighting the combination of the fluorescent tube of this invention having the abovementioned inner diameter, the length of the electrode inward from the end face of the cap C, the composition of enclosed gases and its pressure, respectively selected within the abovementioned ranges, with the conventional 40 watt fluorescent fitting-and-ballast, the loss by the self-absorption of the resonance radiation line of mercury and the electrode wattage loss are both alleviated, thus enabling the attainment of improved luminous flux and lamp efficiency.

To explain further in detail said lamp, in consideration of the fluctuation of the luminous flux due to the variation of manufacturing conditions of fluorescent tubes, the inner diameter that affords distinctly superior luminous flux as compared with the conventional 40 watt fluorescent tubes is one smaller than 25 mm. Nevertheless, when the inner diameter becomes smaller that 20 mm, starting of the lamp with the conventional 40 watt fluorescent fitting-and-ballast becomes difficult.

Increases in the composition ratios of xenon and krypton are very effective for preventing damage to the electrodes and afford a desirable result in the life of the lamp. This is due to the fact that increases in the composition ratios of xenon and krypton reduce the cathode fall potential and alleviate the electrode sputtering by ion bombardment. On the other hand, in the case of xenon-krypton-argon mixed gas in the enclosure, if the volume ratio of xenon exceeds 10%, the luminous flux and efficiency of the lamp distinctly decrease; likewise, if the volume ratio of krypton exceeds 80%, the luminous flux distinctly decreases and its superiority to the conventional 40 watt fluorescent tubes will be lost.

In case the composition ratios of both krypton and xenon are very small, so that the point on the trilinear chart is out of the diagonal region toward point A representing 100% argon, the lamp voltage increases, making lamp starting with the conventional 40 watt fluorescent fitting-and-ballast difficult. The electrode length l, namely, the length from the tube end to the inward edge of the electrode as shown in FIG. **2**, is one of the important factors affecting the performance, so much so that the fluorescent tube of this invention characterized by the abovementioned combinations of the inner diameter, kinds of the enclosed gases and the pressure can function with the conventional 40 watt fluorescent fitting-and-ballast only when provided with a pair of electrodes conforming to the dimensional range of length l.

The fluorescent tube according to this invention having the nominal tube length of 1,200 mm combined with the inner diameter, as well as the enclosed rare gas compositions and pressure, all selected within the above-described ranges, was mounted in the conventional 40 watt fluroescent fitting-and-ballast and lit, and many experiments were made with various electrodes of different length l, and consequently, the following result was obtained. Namely, the lamp starting becomes easier with longer electrode length l. Also the difference of the electrode length l affects the luminous flux, which becomes largest with the electrode length l of 25 mm, but if the length l exceeds **55** mm, the luminous flux falls to the same level with, or even lower than, that of the conventional fluorescent tube.

Actual examples of this invention will be described as follows.

Example 1

A fluorescent tube having a length of 1,198 mm measured from one base face to another base face, an inner diameter of 22.5 mm, an electrode length l of 40 mm (i.e., the length of each tube end inward to each electrode coil inside the tube as shown in FIG. **2**), containing inside rare gas at 2.1 mmHg (at 20°C) which is a mixture of xenon, krypton and argon gases in the volume ratios of 3%, 52% and 45%, respectively, and some quantity of mercury, and coated on the inner wall with 6.0 g/cm^2 of antimony-manganese-activated calcium halophosphate phosphor, was applied to a conventional 40 watt fluorescent fitting-and-ballast to constitute a lamp. This lamp, when lit, had a lamp luminous flux of 3,350 lm, an electric consumption of 37.0 watts, a lamp current of 415 milliampere and a lamp voltage of 110 volts, resulting in a lamp efficiency of 90.5 lm/w. These results prove tremendous improvements as compared with the conventional 40 watt tube having a luminous flux of 3,200 lm, a electric consumption of 40 watts, and a lamp efficiency of 80 lm/w.

Example 2

A fluorescent tube having a tube length of 1,198 mm, measured between base faces, a inner diameter of 22.5 mm and an electrode length l of 37 mm, containing inside rare gas at 2.4 mmHg (at 20°C) which is a mixture of xenon and argon gases in volume ratios of 7% and 93%, respectively, and some quantity of mercury, and coated on the inner wall with 6.1 g/cm^2 of antimony-manganese-activated calcium halophosphate phosphor, was applied to a conventional 40 watt fluorescent fitting-and-ballast to constitute a lamp. This lamp, when lit, had a luminous flux of 3,340 lm, an electric consumption of 37.3 watts, a lamp current of 418 milliampere, a lamp voltage of 112 volts, resulting in a lamp efficiency of 89.5 lm/w and proving to be a distinct improvement over the conventional 40 watt fluorescent tube in respect of the luminous flux and the lamp efficiency.

Example 3

A fluorescent tube having a tube length of 1,198 mm, measured between base faces, an inner diameter of 22.5 mm, an electrode length l of 32 mm, containing inside rare gas at 1.8 mmHg (at 20°C) which is a mixture of krypton and argon gases in volume ratios of 61% and 39%, respectively, and some quantity of mercury, and coated on the inner wall with 6.2 g/cm^2 of antimony-manganese-activated calcium halophosphate phospher, was applied to a conventional 40 watt fluorescent fitting-and-ballast to constitute a lamp. The above lamp, when lit, had a luminous flux of 3,360 lm, electric consumption of 37.8 watts, a lamp current of 405 milliampere and a lamp voltage of 115 volts, resulting in a lamp efficiency of 88.9 lm/w and proving to be a distinct improvement over the conventional 40 watt fluorescent tube in respect of the luminous flux and the lamp efficiency.

Example 4

A fluorescent tube having a tube length of 1,198 mm, measured between base faces, an inner diameter of 22.5 mm, an electrode length l of 10 mm the enclosed rare gas consisting of xenon 3%, krypton 52%, argon 45% (P=2.1 mmHg) and some quantity of mercury was applied to a conventional 40 watt fluorescent fitting-and-ballast to form a lamp and was lit. There was no problem while the environmental temperature was above 0°C, but when the temperature went down, the starting of the lamp became difficult, and at the environmental temperature of, for instance, −10°C, full starting of the lamp required 101.5% of the rated source voltage, but 100% of the rated source voltage with the electrode length l of 15 mm. If the electrode length l exceeded 55 mm the luminous flux decreased.

The 40 watt fluorescent tube according to the present invention attains distinct improvements in the lamp luminous flux and efficiency. Furthermore, whereas the durability of this new fluorescent tube is just as good as that of the conventional fluorescent tubes, its economical advantages are incomparable due to its reduced diametral size, resulting in a saving in the costs of raw material, packing, transportation, storing, and so forth.

As described above, the fluorescent tube of the present invention, when combined with the conventional 40 watt fluorescent fitting-and-ballast, embodies many advantages through the improvements in the luminous flux and efficiency, as well as a reduction in cost, and thereby offers a great industrial contribution. Therefore, the inventors hereof make the following claims for patent.

What is claimed is:

1. A fluorescent lamp comprising a fitting and a ballast for a standard 40 watt fluorescent tube, and

a fluorescent tube comprising: a tubular glass bulb, the inner wall of which is coated with a fluorescent layer, one cap with connecting pins on each end of said bulb, the tube having a length of approximately 1,200 mm, one electrode on each end of the glass bulb, enclosed mixed rare gas and mercury inside the bulb,

said glass bulb having an inner diameter of between 20 and 25 mm, each electrode having a length of between 15 and 55 mm as measured from the end face of the cap to a coil of the electrode,

the enclosed mixed rare gas having a composition ratio represented by any point within a diagonal region defined by connecting the following points (a), (b), (c), (d), (e), and (a) with straight lines in this order, on a trilinear chart for xenon, krypton and argon mixture:

a.	Xe: 1%,	Kr: 0%,	A: 99%
b.	Xe: 15%,	Kr: 0%,	A: 85%
c.	XE: 15%,	Kr: 65%,	A: 20%
d.	Xe: 0%,	Kr: 80%,	A: 20%
e.	Xe: 0%,	Kr: 5%,	A: 95%

the pressure of the mixed gas being between 1.0 mmHg and 3.5 mmHg at a temperature of 20°C.

2. A fluorescent lamp according to claim **1**, wherein the mixed rare gas consists of krypton and argon.

3. A fluorescent lamp according to claim **1**, wherein the mixed rare gas consists of xenon and argon.

4. A fluorescent tube for use in a fluorescent lamp having a fitting and a ballast for a standard 40 watt fluorescent tube, said fluorescent tube comprising a tubular glass bulb the inner wall of which is coated with a fluorescent layer, one cap with connecting pins on each end of said bulb, the tube having a length of approximately 1,200 mm, one electrode on each end of the glass bulb, enclosed mixed rare gas and mercury inside the bulb,

said glass bulb having an inner diameter of between 20 and 25 mm,

each electrode having a length of between 15 and 55 mm as measured from the end face of the cap to a coil of the electrode,

the enclosed mixed rare gas having a composition ratio represented by any point within a diagonal region defined by connecting the following points (a), (b), (c), (d), (e), and (a) with straight lines in this order on a trilinear chart for xenon, krypton and argon mixture:

a.	Xe: 1%,	Kr: 0%	A: 99%
b.	Xe: 15%,	Kr: 0%	A: 85%
c.	Xe: 15%,	Kr: 65%	A: 20%
d.	Xe: 0%,	Kr: 80%	A: 20%
e.	Xe: 0%,	Kr: 5%	A: 95%

the pressure of the mixed gas being between 1.0 mmHg and 3.5 mmHg at a temperature of 20°C.

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