Aug. 19, 1969 TSUNEKAZU HASHIMOTO ETAL 3,462,631

FLUORESCENT LAMPS

Filed Aug. 30, 1966 3 Sheets-Sheet 1

FIG. 1

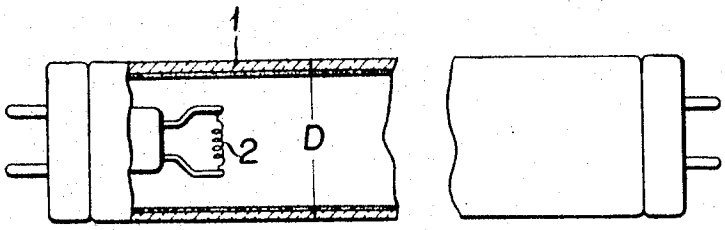


FIG. 2

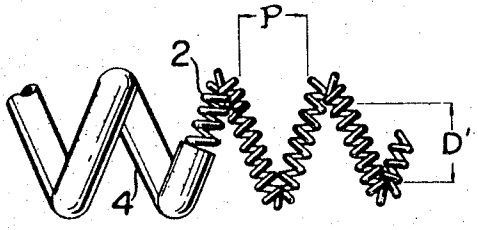
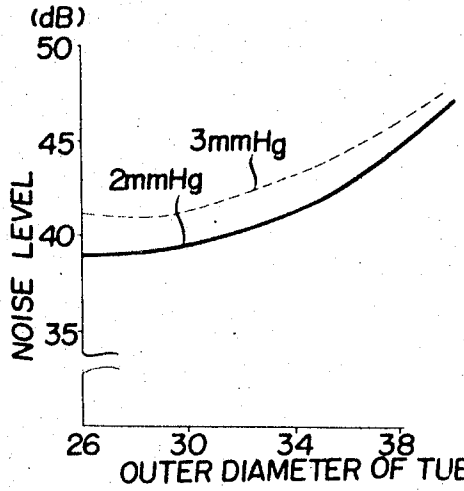


FIG. 3



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FIG. 4

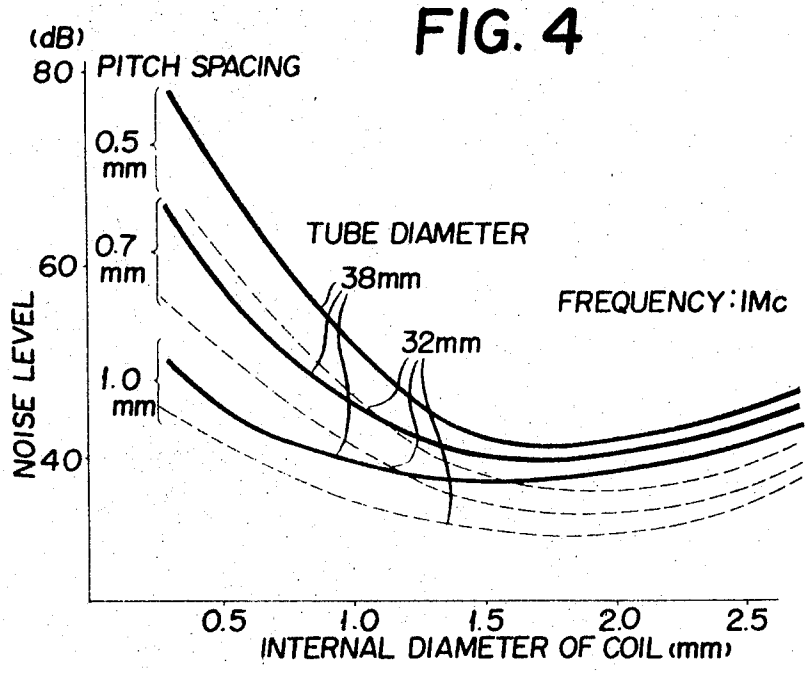
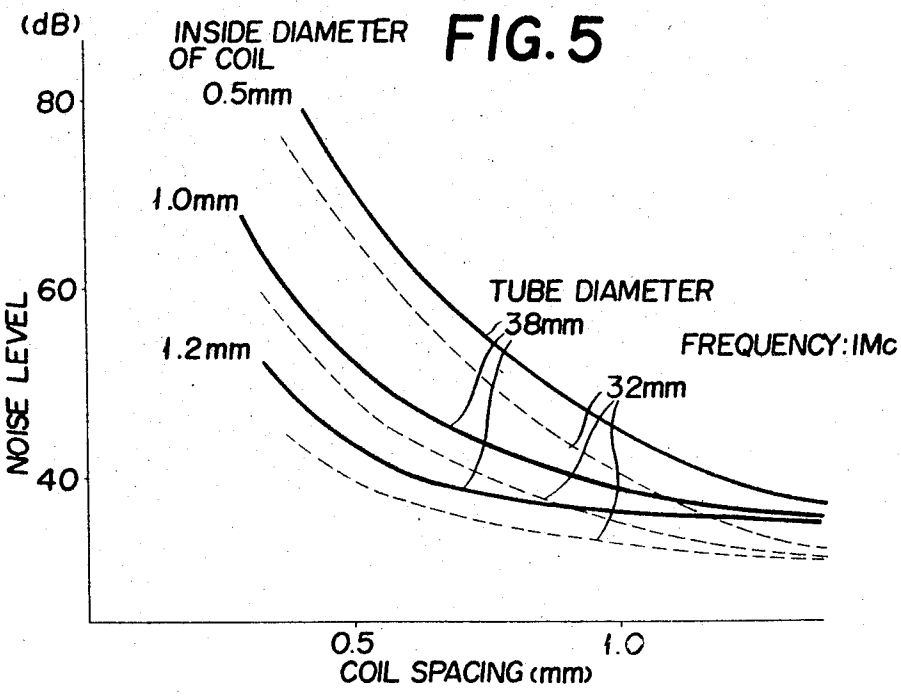

(dB)
80
60
40
NOISE LEVEL
PITCH SPACING
0.5 mm
0.7 mm
1.0 mm
TUBE DIAMETER
38mm
32mm
FREQUENCY: IMc
0.5
1.0
1.5
2.0
2.5
INTERNAL DIAMETER OF COIL (mm)

FIG. 5


(dB)
80
60
40
NOISE LEVEL
INSIDE DIAMETER OF COIL
0.5mm
1.0mm
1.2mm
TUBE DIAMETER
38mm
32mm
FREQUENCY: IMc
0.5
1.0
COIL SPACING (mm)

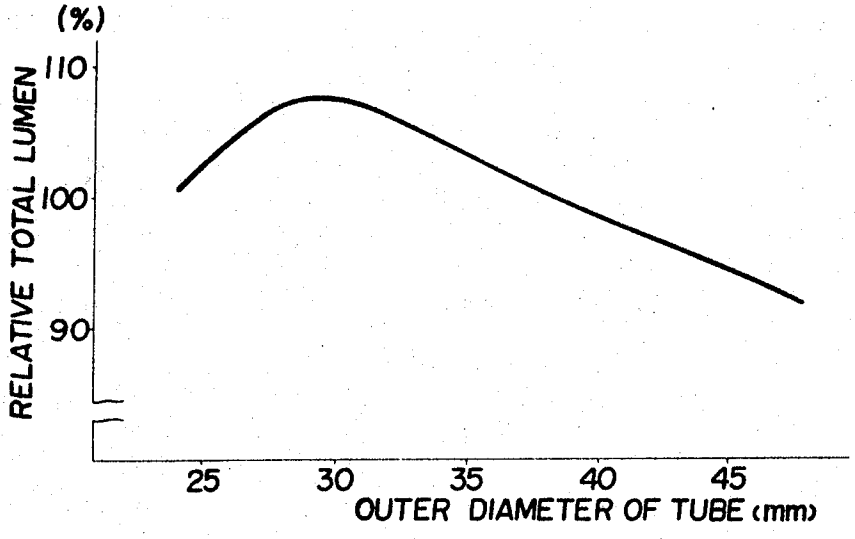

(%)
110
100
90
RELATIVE TOTAL LUMEN
25
30
35
40
45
OUTER DIAMETER OF TUBE (mm)

FIG. 6

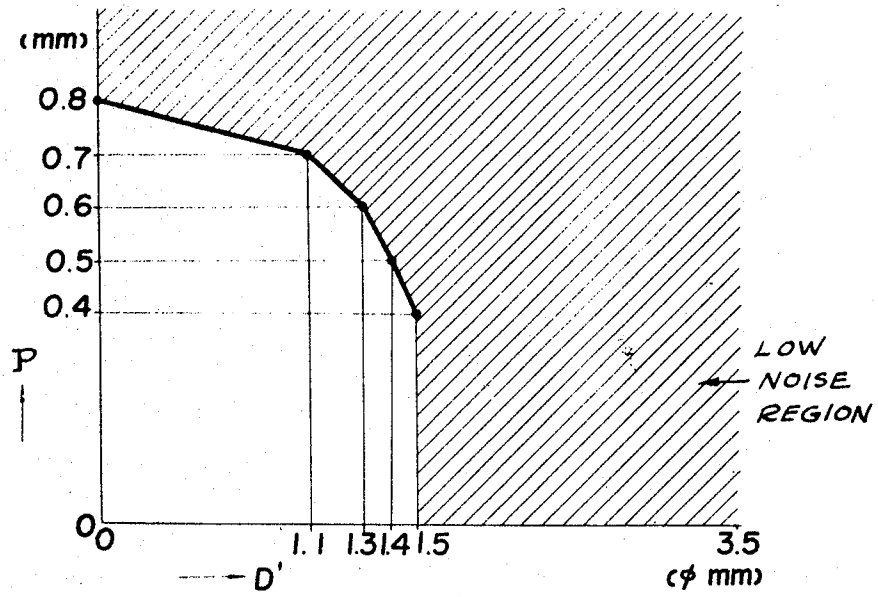

(mm)
0.8
0.7
0.6
0.5
0.4
P
0
0
1.1
1.3
1.4
1.5
3.5
D'
(φ mm)
LOW
NOISE
REGION

FIG. 7

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3,462,631

FLUORESCENT LAMPS

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U.S. Cl. 313—109 9 Claims

ABSTRACT OF THE DISCLOSURE

A fluorescent lamp which generates a reduced amount of high frequency noise when the lamp is turned on and which provides an increased light output, the fluorescent lamp having a tube length of from 400 mm. to 1200 mm., a tube current of 0.7 ampere or less, an external diameter ranging from 28 mm. to 35 mm. and coiled electrodes sealed in both ends of the tube having a coil internal diameter set at from 1.2 mm. to 3.5 mm.

This invention relates to an improvement in fluorescent lamps and more particularly to a fluorescent lamp of improved construction for reducing the amount of high-frequency noises caused when the lamp is turned on, and for increasing the light output of the lamp.

It is a well-known fact that the high-frequency oscillation induced chiefly by the cathode oscillation of the fluorescent lamp causes wireless equipment such as a radio receiver to produce noises when the lamp designed to operate on the A.C. power is turned on. A conventional method adopted in general to prevent the occurrence of such noises resides in the provision of a noise suppression capacitor of for instance 6,000 pf. (pico farad) in parallel connection with the fluorescent lamp in the lamp lighting circuit. No substantial improvement, however, is provided by this technique. Namely, the strength of noises produced by the standard fluorescent lamp in conventional use is of a high value of around 60 to 100 db (decibel) within the radio broadcasting frequency band. A wanted *S/N* (ratio of signal voltage to noise voltage) is over 20 db or so; however the previously stated parallel connection of a capacitor with the fluorescent lamp will be able to reduce noise strength to 20 to 25 db at maximum and it is understood that this method is not effective. Particularly for broadcasting, noise trouble in the weak electric field of, for example, around 40 db/m. (decibel/meter) will impose a great problem.

For the purpose of noise prevention, another method accepted in a part of the art is to reduce noises further by the employment of a special filter circuit. However, because of its complicated construction and high manufacturing costs, this method is still far from extensive acceptance.

An object of this invention is to provide a fluorescent lamp which, in the fluorescent lamps having a tube length of 400 mm. to 1200 mm. and a tube current of 0.7 a. or less, comprises a tube having an external diameter ranging from 28 mm. to 35 mm. and electrodes sealed in both ends of said tube and having a coil internal diameter set at from 1.2 mm. to 3.5 mm.

Another object of this invention is to provide a fluorescent lamp comprising, in the fluorescent lamps of 400 mm. to 120 mm. in tube length and around 0.7 a. or less of tube current, a tube having an external diameter ranging from 28 mm. to 35 mm., and electrodes sealed in both ends of said tube and having a coil spacing set at 0.6 mm. or more.

Still another object of this invention is to provide a

fluorescent lamp comprising a tube having an external diameter ranging from 28 mm. to 35 mm., and coiled electrodes sealed in both ends of said tube and having a coil internal diameter set at 1.2 mm. and a coil spacing set at 0.7 mm.

Still another object of this invention is to provide a fluorescent lamp comprising a tube having an external diameter ranging from 28 mm. to 35 mm., and coiled electrodes sealed in both ends of said tube and having a coil internal diameter set at 1.3 mm. and a coil spacing set at 0.6 mm.

The invention can be more fully understood from the following embodiments of the fluorescent lamp of our invention, taken in connection with the accompanying drawings, in which:

FIG. 1 is a partial side sectional view of one embodiment of this invention;

FIG. 2 is a fragmentary enlarged view, partly broken away, of a coating of an electrode;

FIGS. 3, 4 and 5 are curves of actually measured amount of noises;

FIG. 6 is a curve of the actually measured external diameter of the fluorescent lamp tube obtained by a test made from the point of lamp efficiency; and

FIG. 7 is a graph to explain the relation of limited scope with a spacing between adjacent turns and the inner diameter of a coil in the elimination or minimization of the noise.

In order to better understand the excellent advantages of this invention, the construction and dimension of fluorescent lamps in conventional use will be first described hereunder. The fluorescent lamp most broadly accepted in home in general is a standard straight-tube type which is 38 mm. in tube diameter, about 400 to 1200 mm. in tube length, about 0.3 to 0.7 a. in tube current, and 15 to 40 W. in capacity. This type of fluorescent lamp includes a starting gas such as argon at a pressure of about 3 mm. Hg therein, in addition to mercury in a tube of the aforementioned dimensions whose inner surface is coated with fluorescent substance, and that electrodes are sealed in both ends of said tube, said electrodes being formed by coating tungsten coils with electron emissive material. The coils stated above are double coils of such a construction that a coil made of tungsten wire is wound in a spiral on the coil of approx. ten turns. This double coil thus prepared is about 0.5 to 0.9 mm. in internal diameter, and about 0.5 mm. in coil spacing (space between turns of the inner and outer coils).

Referring to the graph shown in FIG. 4, it can be understood that the aforementioned fluorescent lamp in conventional use is of high noise strength. That is, the graph, using the outside diameter of the lamp tube and coil spacing as a parameter with the noise strength taken on the axis of the ordinate and the internal diameter (mm.) of the coil on the axis of the abscissa, shows the result of actual measurements of noise strength of fluorescent lamps provided with the aforementioned coiled electrodes having a varied internal diameter and having a coil spacing of 0.5 mm., 0.7 mm. and 1.0 mm. with respect to the tubes having an external diameter of 38 mm. and of 32 mm.

FIG. 5 is a graph showing the result of actual measurements of noise strength of fluorescent lamps of varied coil spacing (mm.), wherein the external diameter of the lamp tube and the internal diameter of the coil as a parameter, with the noise strength taken on the axis of ordinates and the coil spacing (mm.)on the axis of abscissa. In this case, it is understood that conventional fluorescent lamps are high in noise strength.

From these results of actual measurements, it can be understood that the fluorescent lamp of a comparatively small diameter is low in noise strength, that the fluorescent lamp of a comparatively large coil spacing is con-

siderably low in noise strength; and that the preferable internal diameter of the coil is 1.2 mm. or more.

Further, according to FIG. 6 showing a graph of actual measurements, with the external diameter of lamp tube taken on the axis of abscissa and the total lumen on the axis of ordinate, it can be understood that the specially effective external diameter of the fluorescent lamp ranges from 28 to 35 mm.

This invention, therefore, is to provide a fluorescent lamp obtained from the data of such actual measurements, whereby the quantity of luminous flux will never be reduced but will be increased as well as noise strength can be diminished to a considerable extent.

Additionally, this invention provides a fluorescent lamp whereby noises can be reduced fully to such a degree as will cause no trouble on radio reception simply by improving the construction of the fluorescent lamp itself; and a fluorescent lamp being effective in use in conventional fluorescent lamp apparatus, requiring no particular lighting circuit for noise prevention.

Referring to FIG. 1; in a fluorescent lamp having a tube length of 400 mm. to 1200 mm. and operated on a rated current of 0.7 a. or less, the desired reduction in noise or increased *S/N* can be obtained by keeping between 29 mm. and 35 mm. the external diameter D of the glass tube **1** whose inside wall is coated with phosphor and by setting at 1.2 mm. or more the internal diameter of coil **2** of the electrodes sealed on each end of the glass tube. In practice, combination of spaced electrodes **2** and above reduced tube diameter could lower the noise level by 20 to 30 db as shown in FIG. 4. The coil **2** of FIGURE 1 is of conventional construction except for the particular parameters indicated herein and is shown in an enlarged view in FIG. 2. The coil **2** consists of a double or triple coil of tungsten coated with a thermionic radioactive substance **4** as is well known in the art. Referring to FIG. 2, D′ represents the internal diameter of the coil **2** and *p* represents the spacing between adjacent coils of coil **2**.

In FIG. 3, the noise strength varies to a large extent depending upon the difference of the external diameter of the tube, and yet even if the external diameter of the tube is the same, the noise strength varies dependent upon the variation in pressure of mercury or the starting gas. Thus, in the manufacture of the fluorescent lamp, varying the external diameter of the tube or setting the pressure of the starting gas within the range of from 1.0 mm. Hg and 3.0 mm. Hg promotes the effect of additionally decreasing noise.

In view of the fact that in the fluorescent lamps of the same diameter the noise level varies with the pressure of rare gas other than mercury gas, further reduction in noise is effected by fixing the pressure of such a rare gas with the range of 1.0 mm. Hg to 3.0 mm. Hg in manufacturing the fluorescent lamp as shown in FIG. 3.

In this case, both the lowered noise level and increased flux of light are observed simultaneously either by reducing the tube diameter from the conventional value of 38 mm. or by making the gas pressure lower than 3 mm. Hg. However, reduction in tube diameter will increase the voltage across the tube to make difficult the starting of the lamp and will also decrease the tube current accompanying reduction of the light output. Therefore, the minimum external diameter of the tube must be maintained at 28 mm. If the external diameter is made greater than 35 mm. it is impossible to achieve sufficient noise reduction while maintaining the power of the tube sufficiently high. On the other hand, reduction in gas pressure will be followed by decrease in tube voltage with an increased hazard of overheating the ballast by increase in tube current. It is therefore necessary to maintain the minimum gas pressure at 1.0 mm. Hg. These lower limits of tube diameter and gas pressure not only prevent excessive voltage and current in the tubes but also provide lower noise level and increased flux of light.

Even in case the internal diameter of the electrode coil is not restricted to 1.2 mm. or more, the tube diameter and gas pressure thus restricted can lower the noise level to 5 to 10 db, which is a considerable decrease over the conventional value. However, reduction in noise to the above level is not considered to be sufficient for obtaining the *S/N* ratio desirable for the weak electric field. This is met by limiting to 1.2 mm. the internal diameter of electrode coil; and in practice the noise level of the lamp is further lowered by 20 to 30 db as shown in FIG. 4.

It is further experimentally known that more effective reduction in noise is possible by keeping coil spacing B at 0.7 mm. with the inside diameter of electrode coil maintained at 1.2 mm. or more.

The extent in which low noise effects have been found to be remarkable in accordance with this invention corresponds to the hatched portion of the graph shown in FIG. 7 where the ordinate represents the pitch spacing p and the abscissa represents the internal diameter D′ of a coil.

In the following are given several examples of the present invention. The noise levels referred to the description are all in the frequency band used in radio broadcasting.

Example 1

In 20W lamps having a tube diameter of 32 mm., filled with argon gas at 2 mm. Hg, and provided with electrode coils having 1.6 mm. internal diameter and pitched at 1 mm., noise level was about 41 db while the flux of light was about 1200 lm.

Example 2

In 30W lamps having a tube diameter of 33.5 mm., argon gas filled to 2.3 mm. Hg, and electrode coils formed to 16 mm. internal diameter and with 1 mm. pitch, the noise level was about 41 db and the flux of light about 1880 lm.

Example 3

The 40W lamps having a tube diameter of 32 mm., argon gas filled at 2 mm. Hg and electrode coils provided with 1.85 mm. internal diameter and spaced at 1 mm. were observed to have noise level of about 40 db and the flux of light of about 3100 lm.

Each of the above examples exhibited very low noise levels and when the lamp was used with the equipment having conventional noise suppression capacitor, it was indicated that an improvement of *S/N* of 20 db or more could be obtained even in the above weak electric field by combined use of a capacitor's noise suppression effect and this invention. Also, the flux of light was increased by 5 to 12% as compared with that of the conventional standard lamps of the same rated capacity, the service life and other properties were equal to those of the conventional lamps and power consumption and tube current tended to decrease.

What is claimed is:

1. In fluorescent lamps having a tube of a length of about 400 mm. to 1200 mm. and a lamp current of about 0.7 a. or less, the improvement comprising:

said tube having an external diameter ranging from 28 mm. to 35 mm.; and

coiled electrodes sealed in both ends of said tube, said electrodes having a coil internal diameter set at from 1.2 mm. to 3.5 mm.

2. In fluorescent lamps having a tube of a length of about 400 mm. to 1200 mm. and a lamp current of about 0.7 a. or less, the improvement comprising the tube having an external diameter ranging from 28 mm. to 35 mm.; and

coiled electrodes sealed in both ends of said tube, said electrodes having a coil spacing set at a minimum of 0.6 mm.

3. The fluorescent lamp according to claim **1** wherein said electrodes have a coil spacing set at a minimum of 0.6 mm.

4. The fluorescent lamp according to claim **1** wherein

said tube is filled with starting gases at a pressure of 1.0 to 3.0 mm. Hg, and mercury.

5. The fluorescent lamp according to claim 2 wherein said tube is filled with starting gases at a pressure of 1.0 to 3.0 mm. Hg, and mercury.

6. The fluorescent lamp according to claim 3 wherein said tube is filled with starting gases at a pressure of 1.0 to 3.0 mm. Hg, and mercury.

7. In fluorescent lamps having a tube length of about 400 mm. to 1200 mm. and a lamp current of about 0.7 a. or less, the improvement comprising:

said tube having an external diameter ranging from 28 mm. to 35 mm.; and

coiled electrodes sealed in both ends of said tube, said electrodes having a coil internal diameter set at 1.2 mm. and a coil spacing set at 0.7 mm.

8. In fluorescent lamps having a tube of a length of about 400 mm. to 1200 mm. and a lamp current of about 0.7 a. or less, the improvement comprising:

said tube having an external diameter ranging from 28 mm. to 35 mm.; and

coiled electrodes sealed in both ends of said tube, said electrodes having a coil internal diameter set at 1.3 mm. and a coil spacing set at 0.6 mm.

9. In fluorescent lamps having a tube of a length of about 400 mm. to 1200 mm. and a lamp current of about 0.7 a. or less, the improvement comprising:

said tube having an external diameter ranging from 28 mm. to 35 mm.; and

coiled electrodes sealed in both ends of said tube with the dimensions of pitch spacing (p) and internal diameter (D') chosen to provide a ratio which falls within the cross-hatched area of FIG. 7.

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U.S. Cl. X.R.

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