Aug. 25, 1959 J. F. GILMORE 2,901,653

FLUORESCENT LAMP

Filed April 22, 1957

FIG. 1.

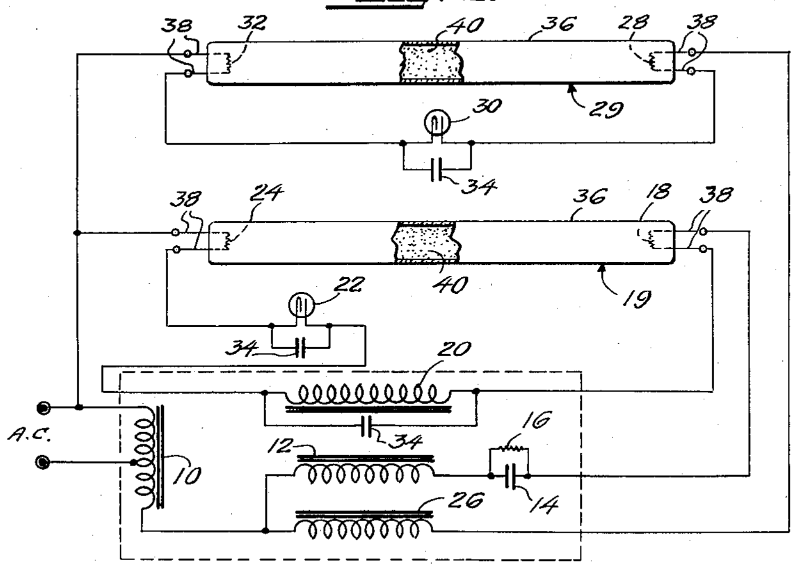
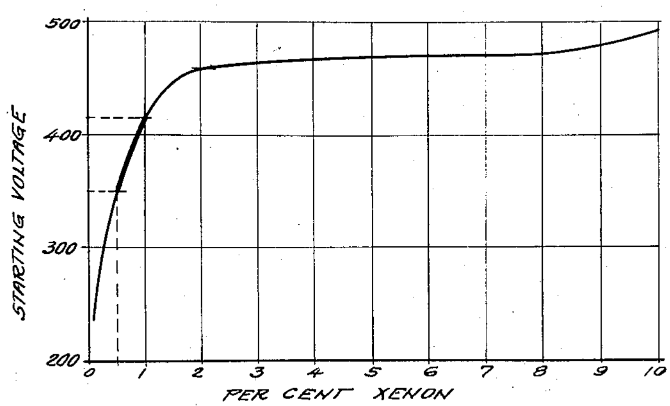


FIG. 2.



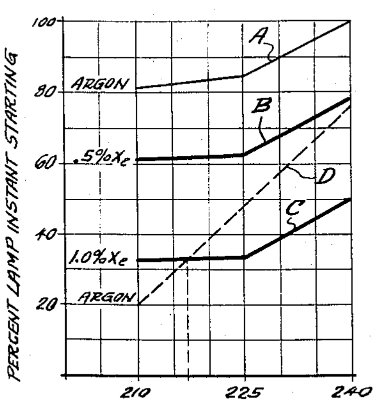


FIG. 3.

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United States Patent Office

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FLUORESCENT LAMP

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2 Claims. (Cl. 313—109)

This invention relates to fluorescent lamps and, more particularly, to gas fills for fluorescent lamps which are intended to be operated on lead-lag circuits.

The usual fluorescent lamp is designed to be operated so that the electrodes are heated before the full potential is applied across both electrodes, in order to prevent sputtering off of emission material. Such lamps are known as preheat lamps and may be operated on single- or multi-lamp ballasts. Uncorrected single-lamp ballasts have low power factors of about 45% to 60%. Two-lamp preheat ballasts are normally of the so-called lead-lag variety, in which each lamp has a separate reactor, with a capacitor connected in series with one of the reactors to produce a leading current in one lamp. Such a ballast has the advantage of providing high power factor (between 90 and 100%) and decreased stroboscopic effect with reduced auxiliary wattage loss and lower ballast cost per lamp. Since the currents of the two lamps are approximately 115° out of phase, the fluctuations in light output do not occur simultaneously and stroboscopic effect is considerably reduced.

The capacitor which is connected in series with one of the reactors is a fairly expensive item as is the iron in the reactors, and in order to decrease the cost of the lead-lag circuits, the lamp ballast manufacturers have raised the open-circuit voltage developed across the lead circuit. This enables a smaller capacitor to be used as well as less iron in the lead-circuit reactor to cheapen the entire ballast. This increased voltage across the lamp which is connected in the lead circuit, i.e., the lead lamp, has resulted in considerable instant starting of the lead lamp, particularly where the power supply may be subject to voltage fluctuations.

Instant starting of the lead lamp reduces its life considerably as the emission material is prematurely depleted. This problem has been realized before and is thoroughly discussed in Patent No. 2,740,861 to Lake, which patent discloses a special glow-switch construction and gas filling therefor in order to overcome this problem. In actual practice the special glow switch as disclosed in this Lake patent will perform satisfactory when the open-circuit voltage is somewhat on the low side, but when the open-circuit voltage is higher than normal, as it often is, this specially-designed glow switch does not appreciably decrease the percentage of instant starts, as shown hereinafter.

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to the prior art by the provision of a fluorescent lamp which will operate in a lead-lag circuit without appreciable instant starting.

It is a further object to provide a lead-lag circuit and fluorescent-lamp combination wherein instant starting of the fluorescent lamp in the lead circuit is inhibited.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by providing in the fluorescent lamp a gas fill of argon at a pressure of from 1.5 mm. to 6 mm. mercury and preferably at a pressure of from 2.5 to 3.5 mm. Added to this argon gas fill is an additional xenon gas fill in amount of from 0.5% to 1% by volume of the argon gas fill.

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For a better understanding of the invention, reference should be had to the accompanying drawing wherein:

Fig. 1 is a schematic diagram of a lead-lag circuit incorporating the fluorescent lamps as described herein;

Fig. 2 is a graph of lamp starting voltage vs. percent by volume of xenon additive to an argon gas fill for a fluorescent lamp as described herein;

Fig. 3 is a graph of percent lamp instant starting vs. transformer secondary open-circuit voltage, illustrating the instant starting encountered in lamps of various designs as well as the instant starting which is encountered with the improved glow switch design.

With specific reference to the form of the invention illustrated in the drawing, the lead-lag circuit which is illustrated in Fig. 1 may be substantially as described in the aforementioned patent to Lake and generally comprises an autotransformer **10** which is connected across the power source. A first reactor **12** is connected to the secondary of the autotransformer and in series with a capacitor **14**. A resistor **16** is connected across the capacitor **14** in order to minimize shock hazard. The reactor **12** and series-connected capacitor **14** are connected in series with one electrode **18** of the so-called lead lamp **19**. The other side of this lead-lamp electrode **18** is connected in series with a compensator **20**, through the lead-circuit glow switch **22**, through the other lead-lamp electrode **24** and to the other side of the autotransformer secondary. The lag-lamp reactor **26** is connected in series with one of the electrodes **28** of the lag-lamp **29**, through the lag-circuit glow switch **30**, through the other lag-lamp electrode **32** and to the other side of the autotransformer secondary. As is customary, capacitors **34** are provided across each of the glow switches **14** and **30** and across the compensator **20** in order to minimize radio interference. Such a design is generally standard and the coupling between the reactor **12** and the autotransformer **10** is normally such that the voltage developed across the reactor **12**, before the lamp starts, is slightly greater than the voltage developed across the reactor **26**, in order that a smaller capacitor **14** may be used to cheapen the ballast design, as noted hereinbefore.

The fluorescent lamps **19** and **29** as shown are of generally-standard design and each comprises a double-ended envelope **36**, which may be fabricated of glass, having operatively-disposed electrodes at either end thereof. Such electrodes may comprise alkaline-earth-oxide-coded filamentary coils, as is well known. These electrodes are electrically connected to the lead-lag circuit by lead conductors **38** which are sealed through the ends of the envelopes **36**, as is customary. As is usual, a phosphor coating **40** is provided on the inner surface of each of the envelopes **36** and a small charge of mercury is contained within the envelopes **36**. In accordance with the teachings herein, the envelopes also have provided therein a gas filling of argon at a pressure of from 1.5 mm. to 6 mm. mercury and preferably at a pressure of from 2.5 mm. to 3.5 mm. mercury and at least the lead lamp **19** has an additive xenon gas fill of from 0.5% to 1% by volume of the argon gas fill. At the lower end of the broad range of argon pressures, the life of the lamps tends to be short and at the higher end of the broad range of argon pressures, some difficulties may be encountered in starting under low-voltage conditions.

In Fig. 2 is shown the effect of the addition of xenon gas to an argon gas fill for a fluorescent lamp. Fluorescent lamp gas fills of argon and xenon are broadly known and are described in Patent No. 2,714,682 to Meister and

Heine, one of several references which broadly describe such an argo-xenon gas fill. The effect of a very small percentage of a xenon addition to an argon-gas fill for a fluorescent lamp, however, has never before been investigated or appreciated and this effect is most unusual and is quie critical with respect to the resultant starting voltage of the fluorescent lamp. Referring to Fig. 2, the starting voltage for the fluorescent lamp which incorporates an argon fill rises very sharply with the addition of very small amounts of xenon. At a xenon addition of one percent by volume of the argon gas fill, the curve breaks somewhat and at a xenon addition of about two percent by volume of the argon gas fill, the curve almost levels off. It should be noted that the curves shown in Fig. 2 were taken for the well-known 40 w. T12 type of lamp. Substantially all lead-lag circuits, where instant starting of the lead lamp constitutes a problem, are designed to operate with this type of lamp.

In order to realize an appreciable improvement in inhibiting instant starting of the lead lamp, it has been found that the instant-starting voltage of the lamp should be at least 350 volts and should not exceed 415 volts or difficulties will be encountered in starting the lamp under low-voltage conditions of operation. To achieve such starting votlages, the percent by volume of xenon additive to the fluorescent lamp argon fill should be from 0.5% to 1%, as shown in Fig. 2.

In Fig. 3 are shown test data wherein percent instant starting is plotted vs. the autotransformer secondary open-circuit voltage. The upper curve designated "A" represents fluorescent lamps operated in the lead circuit and having an argon gas fill only. Curve "B" represents fluorescent lamps operated in a lead circuit and having an argon gas fill within the prescribed ranges and an additional xenon gas fill of 0.5% by volume of the argon. The curve designated "C" represents lamps operated in the lead circuit, which lamps have an argon gas fill within the prescribed ranges and a xenon additive of 1% by volume of the argon. The curve designated "D" represents lamps operated in a lead circuit, which lamps have an argon gas fill with no xenon additive and wherein the lead circuit is provided with the improved-type glow switch as described in the aforementioned patent to Lake. As shown in these curves, the improved glow switch as described in this Lake patent causes the lead lamp to operate with a relatively small percentage of instant starts when the open circuit voltage is low, but when the open circuit voltage is somewhat on the high side, a very large percentage of instant starts is encountered. Under high-voltage operating conditions, lamps operated in the lead circuit of a lead-lag ballast, and containing an additive of 0.5% by volume of xenon to the argon fill, have about the same performance as argon-filled lamps operated in a lead circuit which is provided with improved glow switch of Lake. As the percent by volume of xenon additive is increased, the performance of such lamps when operated in a lead circuit under high-voltage conditions is better than the performance of argon-filled lamps which are operated with the improved glow switch described in the aforementioned Lake patent, see curves "C" and "D." As shown, the curves cross at a secondary open-circuit voltage of about 217 volts, which represents a supply voltage of about 108 volts.

While decreased instant starting of the lead lamp will be realized with such an additive xenon gas fill in the lead lamp only, it may be desirable from the practical standpoint to provide an additive xenon gas fill in both lead and lag lamps so that the lamps cannot be confused on installation. It should be noted that it is often simpler to provide an additive xenon gas fill in the lead lamp than to modify the glow switches in a manner as described in the aforementioned patent to Lake.

It will be recognized that the objects of the invention have been achieved by providing a fluorescent lamp which can be operated in a lead circuit with a considerably-reduced percentage of instant starts.

While in accordance with the patent statutes, one best-known embodiment of the invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

I claim:

1. A fluorescent lamp comprising, a phosphor-coated, double-ended and radiation-transmitting envelope, operatively-disposed electrodes positioned at the ends of said envelope, lead conductors sealed through the ends of said envelope and electrically connected to said electrodes, a small charge of mercury within said envelope, an argon gas fill at a pressure of from 1.5 mm. to 6 mm. within said envelope, and said envelope also having an additive xenon gas fill of from 0.5% to 1% by volume of said argon.

2. A fluorescent lamp comprising, a phosphor-coated, double-ended and radiation-transmitting envelope, operatively-disposed electrodes positioned at the ends of said envelope, lead conductors sealed through the ends of said envelope and electrically connected to said electrodes, a small charge of mercury within said envelope, an argon gas fill at a pressure of from 2.5 mm. to 3.5 mm. within said envelope, and said envelope also having an additive xenon gas fill of from 0.5% to 1% by volume of said argon.

References Cited in the file of this patent

UNITED STATES PATENTS

2,714,681	Meister et al.	Aug. 2, 1955
2,740,681	Lake	Apr. 3, 1956