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S. W. CRAM

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ELECTRIC DISCHARGE LAMP

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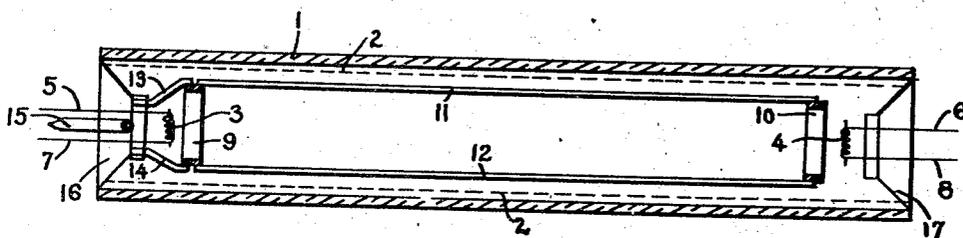


fig. 1

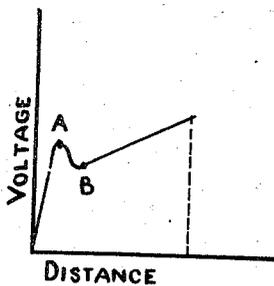


fig. 4

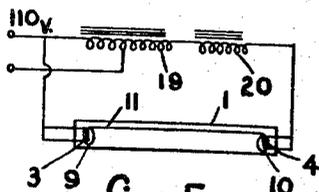


fig. 5

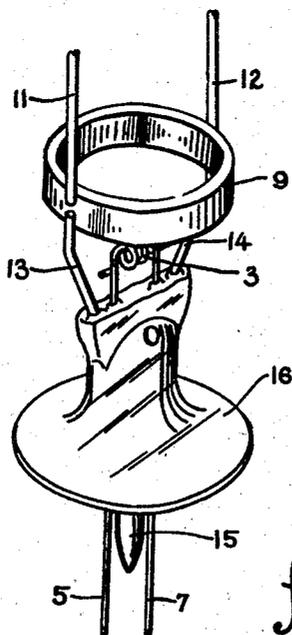


fig. 2

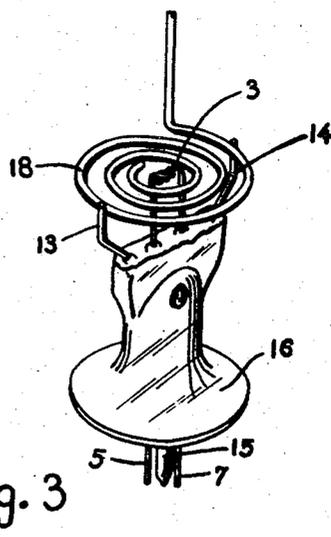


fig. 3

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ELECTRIC DISCHARGE LAMP

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2 Claims. (Cl. 176-122)

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My invention relates to electric gaseous discharge tubes, and particularly to electric gaseous discharge lamps and to an arrangement and method for starting such lamps.

Heretofore lamps of this type have been started by connecting the filaments in series through an external circuit during starting. Thus, a heating current is allowed to flow through the electrodes and after a few seconds the starting circuit is opened, thus causing a peak voltage to be pressed across the lamp to start it. In order to dispense with the time delay in starting lamps according to the above process, it has also been suggested to start the lamp with cold cathodes by impressing a sufficient voltage across the lamp to start it practically instantly. Another arrangement for providing substantially instantaneous starting without the use of a sufficiently high voltage to force an arc to strike directly between the electrodes is to employ probes and mechanisms between the electrodes to initiate a glow. It has also been suggested that the glow-producing devices be electrically connected together externally of the lamp or within the envelope when the metallic connection is otherwise insulated from the arc discharge. However, even with such glow-producing mechanism, it is still necessary to provide sufficient voltage to cause the glow arc to transfer from one end to the other.

It is, therefore, an object of my invention to provide an arrangement for starting an electric gaseous discharge lamp relatively instantaneously and without the necessity of providing sufficient voltage to force the glow arc transition to be directly initiated between the two cathodes.

A further object of my invention is to provide an electric discharge lamp which may be easily started without excess voltage under normal conditions and also under high ambient humidity conditions.

A further object of my invention is to provide a lamp which starts easily when filled with inert gas with pressure of 5 to 20 millimeters of mercury.

A further object is a lamp which utilizes a vapor in addition to the inert gas, and maintains its efficiency at such comparatively high gas pressures by operating with a mercury vapor pressure above the usual value of about 8 microns used in low pressure fluorescent and germicidal lamps. Still another object is a compact lamp of high efficiency and higher brightness than the present commercial lamps.

A feature of the invention is a metal ring or

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the like in front of each electrode but not connected to either electrode. A further feature is a conductor for connecting the rings together. Still another feature is a filling of inert gas at comparatively high pressures such as 5 to 20 millimeters, with the mercury pressure correspondingly raised from its usual value of 8 microns when 4 mm. of inert gas such as argon is used. My invention is not to be understood as limited to such high pressures; however, as certain features of it, such as the interconnected rings, are useful at low pressures also.

My invention will be more fully set forth in the following description referring to the accompanying drawing, and the features of novelty which characterize my invention will be pointed out in the claims annexed to and forming a part of this specification.

Referring to the drawing, Fig. 1 is a longitudinal sectional view of the device according to my invention; Fig. 2 is a perspective view of one end of the tube of Fig. 1; Fig. 3 illustrates a modification of the auxiliary electrode construction; Fig. 4 is a curve of the voltage drop along the lamp and will be used in a description of my invention; and Fig. 5 illustrates the circuit for starting my improved lamp.

Referring to the drawing, I have illustrated a tube 1 of glass or other light-transmitting material sealed in each end by stems 16 and 17, one of which will ordinarily contain an exhaust tube 15. A coating of fluorescent material capable of excitation by the discharge in the tube may be provided if desired to enhance the emission of light or other radiation from the tube. At each end of the tube 1, there are provided electrodes 3 and 4, preferably but not necessarily a coiled tungsten wire coated with one or more of the alkaline earth oxides, which is attached to lead-in wires 5, 6, 7, and 8, which are in turn sealed through the stems 16 and 17.

In order to facilitate starting of the lamp at relatively low voltage, I provide auxiliary electrodes, metallic members or rings 9 and 10, which are composed of any suitable conductive material which are placed in front of or adjacent to the electrodes 3 and 4. The rings may be of a diameter nearly as great as that of the tube 1, and they should be connected by a conducting wire 11, 12 or the like, for example, of metal of low resistance. This might appear to short-circuit the portion of the discharge between the two rings 9, 10, but I find that this is not the case, and the discharge passes regardless of this apparent short-circuit. One conductor, for ex-

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ample, conductor 11, is sufficient connection between the two rings 9, 10, but I have shown the additional conductor 12 to provide a firmer support for the two rings 9, 10. One or both rings 9, 10 may be supported from a stem, such as 16, by support wires 13, 14, which are sealed into the stem 16 from which they extend to attachment with ring 9. The other ring 10 may be similarly supported from stem 17, if desired, for additional rigidity particularly if the tube 1 is long. If both rings 9, 10 are supported from their respective stems 16, 17, the support wires extending from one of the stems may fit into sockets set in the corresponding ring, for ease of assembly. If both rings are rigidly mounted on their respective stems, prior to assembly of the lamp, the wire 11 connecting them may be made fine and flexible so that it will not interfere with the stems being pushed inward for assembling and sealing.

The connecting wires 11, 12 work well when fairly close to the tube wall 1, but if the lamp has a fluorescent coating, they may be spaced somewhat from the coating 1 to prevent shadows thereon. In some cases, the rings 9, 10 may be formed directly on the glass tube 1 by condensing metal thereon.

The electrodes 3, 4 will retain their emitting material longer at higher inert gas pressures, and I find that my starting rings also work somewhat better at high pressure, pressures even as high as 15 mm. are satisfactory. If a vapor such as mercury is used with the inert gas, the efficiency of radiation emission from the vapor, for example, the efficiency of radiation of the 2537 Angstrom Unit wave length of mercury is used, will not ordinarily be as great as at lower gas pressures, if the operating temperature of the lamp is not raised to increase the mercury vapor pressure correspondingly, so that the mercury atoms will be in about the same proportion to argon atoms as in the lower pressure lamps. Some increase in temperature will come from the increase in gas pressure, because of the consequent increase in lamp operating voltage, if the current is kept the same; but in some cases it may be necessary to increase the current somewhat, or even to change to a different inert gas to get a higher voltage drop across the tube. In this way, for example, a fluorescent lamp of the geometrical size now used commercially for a 20-watt lamp, may be used at 40 watts, possibly at the same current and voltage as a 40-watt lamp.

My construction is particularly suitable for germicidal and sterilizing lamps, such as those used in domestic refrigerators, where compactness and low starting voltage is essential, even under the high humidity condition of some of the compartments in the newer refrigerators.

The electrodes 9, 10 may be considered for the purposes of this application as activated electrodes, for convenience in phraseology. The rings 9, 10 should not be activated, because if they are, the discharge will go directly to them from the main electrodes, and will not pass through the gas in the path between the rings.

The rings should be placed outside the region of the so-called "dark space" near the electrodes. With the pressures used, this will mean that the ring should clear the electrode by about $\frac{1}{8}$ inch in most cases.

In the foregoing, I have generally referred to the auxiliary electrodes near the cathodes as "rings" for convenience, but other suitable forms

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of electrode may, of course, be used. For example, I have found the spiral wire electrode 18 of Figure 3 to be very satisfactory. The spiral may be in a flat plane just parallel with the end of the cathode coil. With this electrode, and a gas filling comprising in addition to mercury vapor a filling of argon mixed with some neon, in amount up to 30% of the argon, I have been able to start a 48-inch long, $\frac{1}{4}$ inch diameter, lamp at 210 volts with no preheating of the electrodes.

Under such circumstances, my device provides a localized heating of the cathode by the intense glow current, which makes the cathode capable of supporting an arc, and then the transition from glow to arc along down the tube is facilitated by the glow which occurs along the conductor connecting my spirals or rings. My device is thus most effective at gas pressures which permit the formation of such a glow along the conductor prior to the actual arcing of the lamp.

I have found that a lamp formed with spiral auxiliary electrodes such as illustrated in numeral 18 of Fig. 3 provide a very improved and efficient arrangement for starting an electric gaseous discharge lamp. The steps in starting are as follows:

1. When a voltage is impressed across the lamp, which may be connected in a simple circuit as illustrated in Fig. 5, a glow will first show between the cathode and auxiliary electrode 18.
2. The glow then increases from the auxiliary cathode area to the wire along the column.
3. The glow then spreads from both ends of the tube cascading along the wire toward the center, and just before the glows on the wire meet, the glow shifts to the gaseous column.
4. The glow then shifts to an arc, and the lamp will then run in this final condition.

As has been mentioned above, the rings or auxiliary electrodes should be placed adjacent to the cathodes but outside the "dark space." Referring to Fig. 4, I have illustrated a conventional lamp characteristic in which voltage is plotted on the ordinate axis and distance along the tube is plotted on the abscissa axis. It will be seen that the voltage rises very rapidly to a point identified as "A," and it is in this part of the voltage curve one finds the space which is commonly called the "dark space." The voltage then decreases to a point marked "B," and it will be seen that the characteristic then shows an increasing voltage until the opposite end of the tube is reached.

As has been stated the auxiliary electrodes should not be placed closer to the cathode than that point corresponding to that point marked "A" shown on the curve, and it is also preferable that the auxiliary electrode not be placed further from the cathode than a distance corresponding to that point "B" on the voltage characteristic curve. If the auxiliary electrode is placed further away from the cathode than the point correspondingly indicated by the point "B," a correspondingly higher voltage will be required in order to initiate the glow between the cathode and the auxiliary electrode.

I have found that in order that the auxiliary electrode should not shield the electrical field existing between the two cathodes that the auxiliary electrodes should be placed radially from and in the same plane as the cathodes, such a construction being illustrated in Fig. 3 of the drawing. It will also be seen from an inspection of Fig. 3 that the inner coil of the auxiliary electrode is spaced radially from the cathode, and this radial space

may be considered so far as the characteristic of Fig. 4 is concerned as a space along the tube.

I have further found that the area presented by the auxiliary cathode should be sufficiently large to cause a glow to be initiated by the cathode and the auxiliary electrode and still should not be too large so as to prevent the cascading of the glow along the wire which connects the two spiral electrodes. For example, a 40-watt lamp which I tested using 7 millimeters of an argon-neon mixture and with about 8 microns of mercury operated satisfactorily with auxiliary electrodes having three convolutions as illustrated in Fig. 3, the auxiliary electrodes and connection being formed with the wire having approximately .03 inch diameter. In this particular device which was tested, the wire was formed of nickel and the resistance of the connection between the auxiliary electrodes was less than one ohm. It is desirable to have the value of the resistance of the connection between the auxiliary electrodes as low as possible so as to facilitate the cascading effect of the glow along the wire. I further found that a 40-watt fluorescent lamp having the characteristics described above started practically instantaneously when a voltage of between 210 and 260 volts was impressed across the cathodes.

Although I have shown and described particular embodiments of my invention, I do not desire to be limited to the embodiments described, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

A discharge tube according to my invention may, of course, be used in various circuits, but I have found the circuit of Fig. 5 particularly useful. The autotransformer 19 is connected to the usual 110 volt A.C. line and through the inductance coil 20, which acts as a ballast to limit the current, to the lamp electrodes 3 and 4. The rings 9 and 10, and their connecting conductor 11 are also shown, the entire diagram of connections being merely schematic. The coil 20 may be merely the leakage reactance of the transformer 19 itself, if the leakage reactance is large enough.

What I claim is:

1. An electric discharge device comprising a tubular envelope, a filamentary electrode at each end thereof, a coating of at least one of the alkaline earth oxides on said electrodes, a plain metal ring electrode in front of each of said filamentary electrodes and of a diameter nearly as great as that of the tubular envelope, a filling of inert gas and mercury vapor in said envelope, and a pair of low resistance wires within said envelope electrically connecting said rings together and placed near and along but spaced from the wall of said envelope, said wires being directly exposed to said gas inside said envelope and out of physical contact with said filamentary electrodes.

2. The combination of claim 1 in which the inert gas pressure is above 5 millimeters and the mercury vapor pressure about 8 microns during operation, and, with the ratio of inert gas pressure to mercury vapor pressure being of the order of 500 to 1, and in which the ring electrodes are close to the respective filamentary electrodes but outside the dark space for the gases and pressure used.

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