

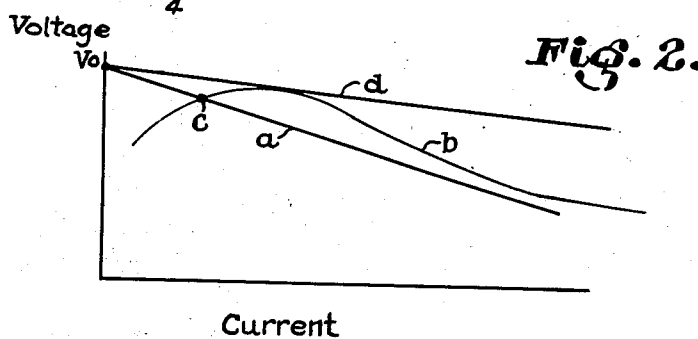
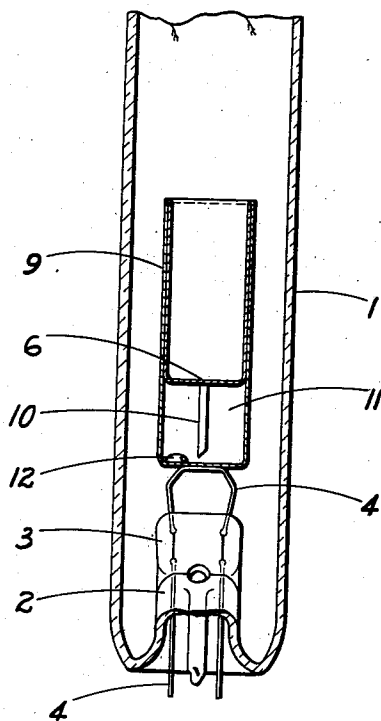
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GASEOUS ELECTRIC DISCHARGE DEVICE

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Fig. 1.



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GASEOUS ELECTRIC DISCHARGE DEVICE

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6 Claims. (Cl. 176—124)

The present invention relates to gaseous electric discharge devices of the positive column discharge type.

The starting potential of gaseous electric discharge devices of the positive column type having a filling of neon is considerably reduced by the addition of about 5% to less than 1% of argon to the gaseous filling.

Argon is also useful in positive column discharge devices containing mercury vapor and neon to assure the emission of light characteristic of the mercury vapor from the device when operated in low ambient temperatures. An addition of 5 to 25% of argon to the neon is effective for this purpose.

The object of the present invention is to provide a mercury vapor discharge device of the low pressure, positive column discharge type having a mixture of neon and argon therein and which operates at high efficiency and has a positive volt-ampere characteristic. Still further objects and advantages attaching to the device and to its use and operation will be apparent to those skilled in the art from the following particular description.

We have discovered that when the total pressure of the fixed gas in a mercury vapor discharge device of the above type is from 4 mm. to 8 mm. and when the argon is from 0.2% to 2% of the fixed gas atmosphere the discharge device has a positive volt-ampere characteristic over a current range of between a few milliamperes to the order of 50 to 100 milliamperes. This characteristic persists even when the current is slightly greater than 100 milliamperes. At higher currents the volt-ampere characteristic of the device gradually changes from positive to negative.

Such a device, of course, starts on a lower potential than a similar device containing only neon so that even when no mercury vapor is present in the device, due to an extremely low ambient temperature, a comparatively small series resistance is sufficient to absorb the small difference between the starting and the operating voltage and no other means is required for limiting the current flow in the device. Thus a discharge device embodying the present invention is a highly efficient one since the energy dissipated in the ballasting devices of prior discharge devices is eliminated.

The device of the present invention has a positive volt-ampere characteristic over a wide ambient temperature range from an extremely low ambient temperature up to room temperature and higher. While mercury discharge devices

embodying the present invention emit light characteristic of the neon at a higher ambient temperature than prior devices containing a higher percentage of argon this can be avoided by using means to generate mercury vapor in the lamp. For example, one or both of the electrodes in the device are provided with hollow chambers containing mercury and having a capillary opening to permit the mercury vapor to enter the discharge path. The vaporization of the mercury is caused by the heating of the electrodes by the discharge incident thereat.

It is essential that the total gas pressure and the percentage of the argon be kept within the limits specified above in order to obtain the advantages of the invention. We have observed that when the argon is in smaller amounts or when the total gas pressure is less than that specified the argon is absorbed after the device has been operating in a low ambient temperature for a few hours. When the amount of argon is higher or when the total gas pressure is greater than that specified the positive volt-ampere characteristic of the device is not obtained when the device is operated in a low ambient temperature. The total gas pressure and the percentage of argon specified are thus critical to success in the present invention.

We prefer to use cold sheet metal electrodes in the device since we have discovered further that the voltage drop thereat increases with current when the device contains the gas mixture of the present invention. Thermionic electrodes are used, when desired, but since the voltage drop thereat decreases with an increase in the discharge current an extremely long discharge with a positive volt-ampere characteristic is required if the device is to have a positive volt-ampere characteristic. Such devices are cumbersome and are difficult to mount and ship. Devices of this type having one thermionic electrode and one cold electrode have the desired positive volt-ampere characteristic in lengths which make such devices practical commercially. Such tubes can be operated on direct or alternating current. When operating these devices on direct current, however, care must be exercised that the various constituents of the gaseous atmosphere are not separated by electro-phoresis which would change the volt-ampere characteristic from a positive one to a negative one.

The volt-ampere characteristic of the device is positive over a current range of from a few milliamperes to about 100 milliamperes, as pointed out above. When the current is increased beyond

100 milliamperes the volt-ampere characteristic gradually changes from a positive one to a negative one in which the voltage decreases very gradually with increasing current. In order to avoid such a change, which would be disastrous to the device, the supply voltage and the series resistance are preferably such that, as shown in Fig. 2, a straight line *a* drawn through a point *V₀* representing the voltage of the current source on the ordinate axis of a graph whereon a curve *b* representing the relation between voltage and current of the lamp is plotted and a point *c* representing the operating current and voltage of the lamp device on the rising part of said curve is steeper than a line *d* drawn through the point on the ordinate axis representing the voltage of the current source and tangent to the aforesaid curve on the descending part thereof. (See Rudolph Seeliger "Physik der Gasentladungen" 2nd edition, 1934, starting at page 128.) This undesired change from a positive to a negative volt-ampere characteristic is avoided when the voltage supplied to the device is lower than the maximum voltage at which the device still has a positive volt-ampere characteristic.

In the drawing accompanying and forming part of this specification an embodiment of the invention is shown in Fig. 1 in a front elevational, partly sectional view, and

Fig. 2 is a graph showing the electrical characteristics of the circuit.

Referring to the drawing the gaseous electric discharge device comprises an elongated, tubular container 1 (one end thereof being shown for clarity of illustration) having cold sheet iron electrodes sealed therein at each end thereof. Each of the electrodes is of the type which generates mercury vapor during the operation of the device, when desired, or only one of said electrodes is of this type, when desired.

The electrode illustrated in the drawing is of the mercury vapor generating type and consists of a tubular member 9 closed at one end and having an inner tubular member 6 inserted therein so as to form a chamber 11. The member 6 has a tube 10 extending into the chamber 11 and said tube 10 has a capillary opening therein. A quantity of mercury 12 is located in said chamber 11 and when the electrode is heated by the discharge incident thereat the mercury vapor from the source 12 passes through the capillary opening in the tube 10 and into the discharge path. The electrode 9 is supported in said container 1 by a pair of current leads 4 fused into the press 3 of the stem 2 of said container 1. The discharge device has a gaseous atmosphere therein consisting of neon containing about 0.6% argon, the total pressure of the fixed gas being 6 mm. The container 1 has a diameter of 20 mm. and the electrodes are separated a distance of 1 meter. The electrodes are 50 mm. in length and 17 mm. in diameter. We have demonstrated that such a device starts on a potential of 800 volts even at an ambient temperature of -22° C. and operates at such temperature on a voltage of about 650 volts and a current of 40 milliamperes so that only about 1/2 of the supply voltage must be dissipated in the series resistance. The discharge device has a positive volt ampere characteristic and is capable of operation without a ballast resistance.

While we have shown and described and have pointed out in the annexed claims certain novel features of the invention, it will be understood that various omissions, substitutions and changes

in the forms and details of the device illustrated and in its use and operation may be made by those skilled in the art without departing from the broad spirit and scope of the invention, for example, when the lamp device is to be used in locations whereat the ambient temperature is not extremely low two sheet metal electrodes of the usual type which do not generate mercury vapor are used, when desired; a luminescent material which is excited to emit visible light rays under excitation by radiation from the discharge in said lamp is associated with said lamp, such as by being applied in powder form to the inner surface of the container 1, to increase the efficiency and improve the spectrum of the light emitted by the lamp, when desired, or, when desired, a luminescent glass is used for the container 1 for the same purpose, when desired, or both of these structures are used in the same lamp, when desired.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a gaseous electric discharge lamp device of the positive column type having a positive volt-ampere characteristic comprising a container, electrodes sealed therein, a fixed gaseous atmosphere therein consisting of neon and argon and a quantity of vaporizable material therein, the total pressure of the fixed gas being 4 to 8 mm., the argon being 0.2 to 2.0% of the total fixed gas atmosphere and means to supply a current of from a few milliamperes to 100 milliamperes to said device, whereby said device operates stably with a positive voltage-current characteristic.

2. In combination, a gaseous electric discharge lamp device of the positive column type having a positive volt-ampere characteristic comprising a container, electrodes sealed therein, a fixed gaseous atmosphere therein consisting of neon and argon and a quantity of vaporizable material therein, the pressure of the neon being 6 mm. and the argon being 0.5% of the neon and means to supply a current of from a few milliamperes to 100 milliamperes to said device, whereby said device operates stably with a positive voltage-current characteristic.

3. In combination, a gaseous electric discharge lamp device of the positive column type having a positive volt-ampere characteristic comprising a container, electrodes sealed therein, a fixed gaseous atmosphere therein consisting of neon and argon and a quantity of vaporizable material therein, said electrodes being cold electrodes, the total pressure of the fixed gas being 4 to 8 mm., the argon being 0.2 to 2.0% of the total fixed gas atmosphere and means to supply a current of from a few milliamperes to 100 milliamperes to said device, whereby said device operates stably with a positive voltage-current characteristic.

4. In combination, a gaseous electric discharge lamp device of the positive column type having a positive volt-ampere characteristic comprising a container, electrodes sealed therein, a fixed gaseous atmosphere therein consisting of neon and argon and a quantity of vaporizable material therein, one of said electrodes being a thermionic electrode, the other of said electrodes being a cold electrode, the total pressure of the fixed gas being 4 to 8 mm., the argon being 0.2 to 2.0% of the total fixed gas atmosphere and means to supply a current of from a few milliamperes to 100 milliamperes to said device, whereby said device operates stably with a positive voltage-current characteristic.

5. In combination, a gaseous electric discharge lamp device of the positive column type having a positive volt-ampere characteristic comprising a container, electrodes sealed therein, a fixed
5 gaseous atmosphere therein consisting of neon and argon and a quantity of vaporizable material therein, one of said electrodes being a cold electrode having a chamber therein containing said
10 vaporizable material, said chamber being pervious to the vapor of said vaporizable material, the total pressure of the fixed gas being 4 to 8 mm., the argon being 0.2 to 2.0% of the total fixed gas
15 atmosphere and means to supply a current of from a few milliamperes to 100 milliamperes to said device, whereby said device operates stably

with a positive voltage-current characteristic.

6. In combination, a gaseous electric discharge lamp device of the positive column type having a positive volt-ampere characteristic comprising
5 a container, electrodes sealed therein, a fixed gaseous atmosphere therein consisting of neon and argon and mercury therein, the total pressure of the fixed gas being 4 to 8 mm., the argon being 0.2 to 2.0% of the total fixed gas atmosphere and means to supply a current of from a
10 few milliamperes to 100 milliamperes to said device, whereby said device operates stably with a positive voltage-current characteristic.

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