Oct. 31, 1939. W. ELENBAAS 2,177,694

GAS OR VAPOR DISCHARGE DEVICE

Filed Dec. 29, 1936

Fig. 1.

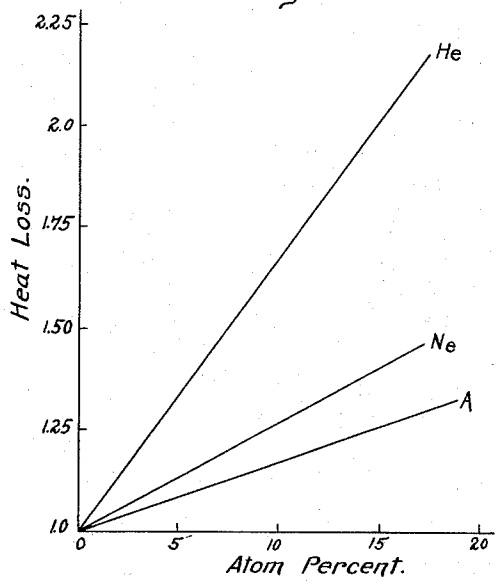
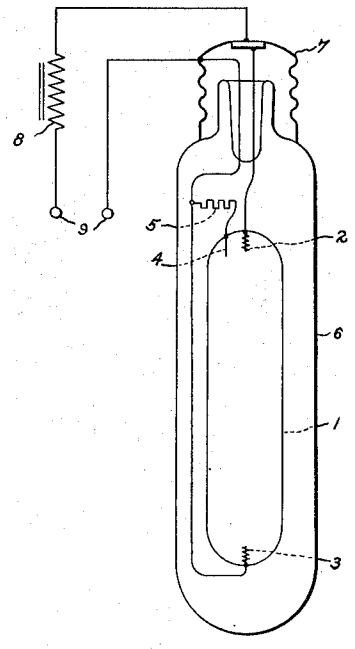


Fig. 2.



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2,177,694

GAS OR VAPOR DISCHARGE DEVICE

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In the Netherlands January 24, 1936

1 Claim. (Cl. 176—124)

This invention relates to gas or vapor discharge devices, and more particularly to such devices as are adapted to operate with an electrically constricted arc discharge. It is an object of the invention to reduce the starting potential of such a discharge device by the addition of a starting medium which does not seriously increase the loss of heat from the discharge arc to the enclosing envelope.

It is known to improve the starting of a vapor lamp, such as a mercury lamp, by the addition of a gas, for example, argon, to the mercury vapor. If one substance of such a mixture has a first excitation or "resonance" potential above the ionizing potential of the other substance, starting may occur at a lower voltage than would be possible with either substance employed alone. (It may be noted that the resonance potential of a medium is a measure of the electron energy required to raise atoms of the medium to a so-called "excited" condition from which they may return to the normal state with an accompanying release of energy.) The phenomenon of low voltage starting, which is described by F. M. Penning in Zeitschrift fur Physik, vol. 46, pages 335 et seq., is believed to be attributable to the ionization of the substance of lower ionizing potential by energy derived from excited atoms of the other substance.

It has been observed in connection with mercury vapor lamps using a single starting gas that at low temperatures, the pressure of the mercury vapor may be so slight that the desired reduction of starting potential does not occur. Consequently, I prefer in connection with the present invention to use with the mercury a mixture of two fixed gases whose excitation and ionization potentials are in the desired relation to one another.

In using a starting gas with vapor lamps adapted to operate with an internal pressure above atmospheric and, particularly, in the range between one and about ten atmospheres an unexpected difficulty is encountered in that the addition of such a gas tends to decrease the efficiency of the discharge. This is explainable by the fact that at the pressures specified the normal discharge occurs as an intense arc constricted in cross-section by the prevailing electrical conditions. The luminosity of such an arc depends largely upon its temperature, which in turn is governed by the rate of heat transfer to the walls of the enclosing envelope. It is this latter factor which is adversely affected by the addition of other gaseous media to the discharge space.

In accordance with the present invention effective reduction in starting potential is accomplished without seriously increasing the heat loss by employing particular gases under optimum pressure conditions. In particular a preferred combination for use with mercury comprises a mixture of neon with a small quantity, say 0.2 per cent of argon. The total quantity of the fixed gases should be less than 6 and, preferably, less than 4 atom per cent of the quantity of mercury vapor present in the device during operation, and the fixed gas pressure at room temperature should be less than 18 millimeters and, preferably, less than 10 millimeters. The quantity "atom per cent" may be defined as

$$100 \times \frac{N_2}{N_1}$$

in which N_1 is the number of mercury vapor atoms present during the operation of the device and N_2 is the number of fixed or starting gas atoms.

Some of the advantages realized by the use of this preferred mixture are indicated in Fig. 1 of the drawing, which shows the heat conduction from the arc discharge to the wall of the enclosing envelope as a function of the atom per cent of various starting gases. The thermal conduction in the absence of a starting gas is assumed to be equal to 1. From the ordinates it can be determined in a simple manner to what extent the different gases increase the heat conduction to the boundary of the discharge space. For instance, a helium filling of 10 atom per cent causes an extra heat loss of approximately 67 per cent while an argon filling of 10 atom per cent causes an extra heat loss of only approximately 18 per cent.

It is apparent from Fig. 1 that the heat loss may be maintained below about 15 per cent, a permissible value, by using up to about 6 atom per cent of neon. I have further determined that in so-called high pressure mercury discharge devices the addition of somewhat less than this amount of neon together with a fraction of a per cent of argon materially decreases the ignition or starting voltage of the discharge device. The permissible atom per cent is somewhat variable with the operating pressure of the mercury, but the gas pressure at room temperature should be chosen below 18 millimeters and preferably below 10 millimeters in order to maintain the heat loss within proper limits.

A particular application of the invention is shown in Fig. 2 which illustrates schematically a discharge device primarily intended as a light

source. This device consists of an envelope 1 in which the discharge takes place, cooperating electrodes 2 and 3 adapted to receive the discharge and an auxiliary electrode 4 useful in initially starting the device. It will be noted that the auxiliary electrode 4 is connected to the current supply wire of the electrode 3 through a resistance 5. The envelope 1 is placed in an evacuated enclosure 6 which is provided with a base 7 having contacts to which the two discharge electrodes are connected. During operation these base contacts are connected to a current source 9 through a series impedance 8.

The envelope 1 preferably contains about 7 milligrams of mercury per centimeter of envelope length. During operation all of the mercury is evaporated so that unsaturated mercury vapor at a pressure of about 1 atmosphere is present in the envelope. In addition, the envelope contains a quantity of neon to which about 0.2 per cent of argon has been added, the pressure of these combined gases at room temperature being about 3 millimeters. The spacing between the electrodes 2 and 3 is 150 millimeters while the inside diameter of the envelope 1 is 28 millimeters. The current, which can be regulated by means of the voltage of the current source 9 and impedance 8, is 3.5 amperes while the voltage between the electrodes is 130 volts. From these data it can be shown that the quantity of starting gas is about 3 atoms present of the quantity of mercury vapor per cent in the envelope during operation.

While I have described the invention in connection with a particular discharge device, it is also applicable to devices in which an excess of mercury is present and can be applied in connection with devices involving very high mercury pressures, for example, pressures higher than 10 atmospheres. I therefore aim in the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

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

An electric gaseous discharge device comprising a sealed tubular envelope having a pair of main operating electrodes sealed into opposite ends thereof, an auxiliary electrode sealed into said envelope adjacent one of said main electrodes, said auxiliary electrode being connected through a resistance to the other of said main electrodes, mercury within said envelope in an amount sufficient to produce a pressure of substantially one atmosphere when wholly vaporized, and a gaseous filling within said envelope of neon intermixed with 0.2% of argon at a pressure of the order or 3 mm., in combination with means to supply sufficient electrical energy to said device to wholly vaporize said mercury.

WILLEM ELENBAAS.