

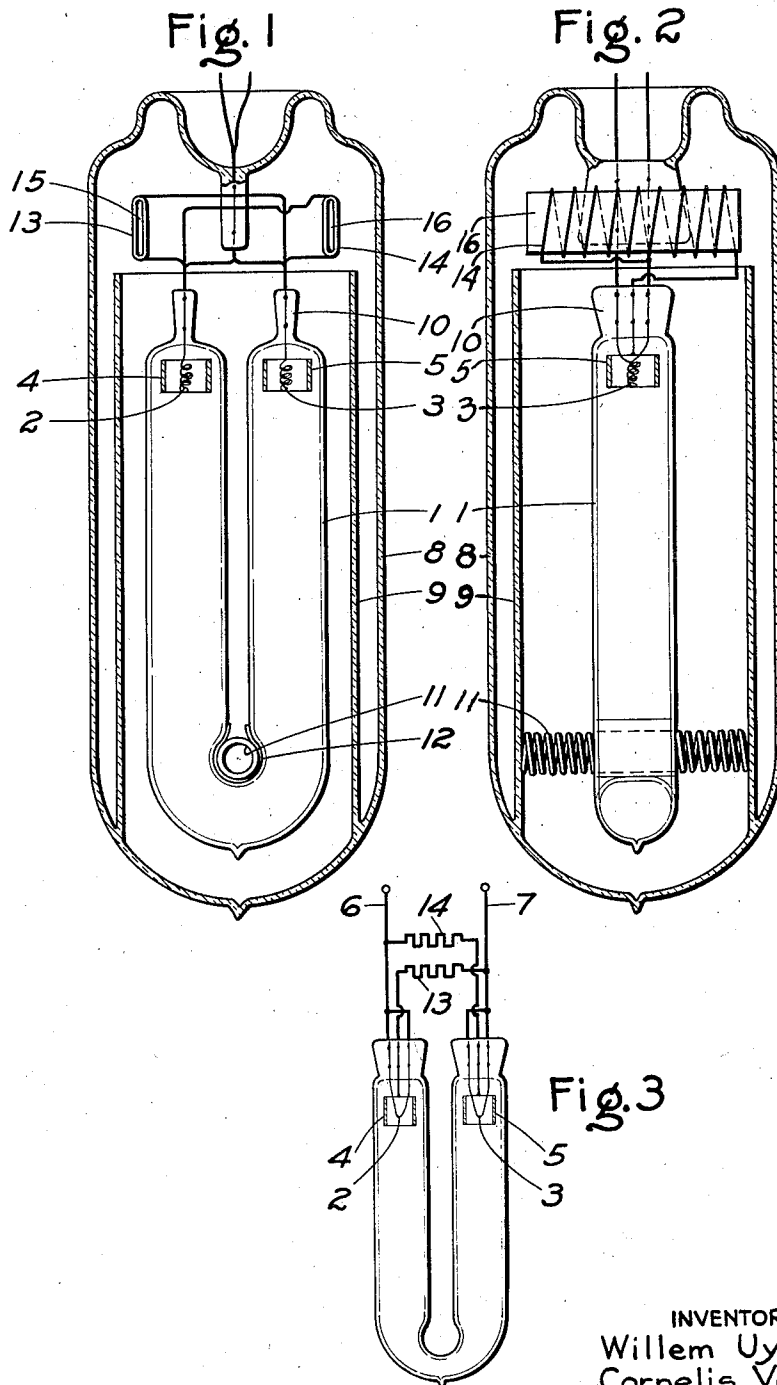
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GASEOUS ELECTRIC DISCHARGE DEVICE

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GASEOUS ELECTRIC DISCHARGE DEVICE

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The present invention relates to gaseous electric discharge devices generally and more particularly the invention relates to methods and means for starting such devices into operation.

5 The starting of gaseous electric discharge devices is facilitated by mounting an auxiliary, starting electrode adjacent a main discharge supporting electrode which is electron emitting when heated and which main electrode is heated directly by the arc current and the voltage drop thereat during the operation of the device. The auxiliary electrode is connected through a resistance to a main discharge supporting electrode other than that to which it is adjacent. The auxiliary discharge path between the starting electrode and the main electrode together with the said resistance is in parallel with the main discharge path. During the starting period current flows through the parallel circuit and an auxiliary starting discharge takes place between the starting electrode and the main electrode which heats the latter to an electron emitting, main discharge supporting temperature and, simultaneously, the gaseous atmosphere in the lamp is ionized by the auxiliary discharge. The starting of the main discharge in the lamp is thus facilitated and the starting of this discharge takes place on a lower voltage than would be the case were the starting circuit incorporating the auxiliary, starting electrode omitted.

30 The starting circuit described above may be changed in many details, for example, when the gaseous electric discharge device is provided with two main electrodes which are electron emitting when heated an auxiliary electrode is mounted adjacent each of said main electrodes and is connected through a resistance to the main electrode other than that to which it is adjacent. Both main electrodes are thus heated to an electron emitting discharge supporting temperature and two starting discharges take place in the lamp during the starting period to facilitate the starting of the main discharge between the main discharge supporting electrode. When desired, the two auxiliary electrodes are connected together electrically through a resistance to form a circuit parallel to the main discharge path. When desired, the starting of the main discharge is facilitated by mounting an electrically conducting body inside the lamp container, extending along the main discharge path between the electrodes and terminating adjacent each of said main electrodes. In this case the conductor itself acts as a resistance and an auxiliary discharge takes place between each main electrode and the end

of the conducting body adjacent thereto during the starting period to facilitate the starting of the main discharge in the lamp.

It will be noted that in all the starting circuits described above these features are common: the auxiliary starting circuit is in parallel with the main discharge path, has an auxiliary discharge path extending to one of said main discharge supporting electrodes and has a resistance to limit the flow of current through the starting circuit.

The object of the present invention is to provide an improved starting circuit of the above type for gaseous electric discharge lamp devices comprising a main discharge supporting electrode which is maintained at an electron emitting, discharge supporting temperature during the operation of the device by the arc current and the voltage drop thereat. Still further objects and advantages attaching to the device and to its use and operation may be apparent to those skilled in the art from the following particular description.

In accordance with these objects the starting circuit of the present invention comprises a resistance having a high positive thermal coefficient of electrical resistance. We have observed that the lower the resistance in the parallel starting circuit, and thus the greater the current flow in this circuit, during the starting period the lower is the starting voltage of the main discharge and the faster the starting of the main discharge. However, when a low resistance is used in the starting circuit the main discharge in the lamp during the operation thereof is frequently unstable and the light emitted by the main discharge flickers. Another disadvantage in using too low a resistance in the starting circuit is that the large current flow in this circuit during the operation of the lamp is wasteful and lowers the efficiency of the lamp device. The starting circuit of the present invention avoids these latter disadvantages while retaining the important advantage of faster starting of the main discharge on a lower starting voltage. The high positive thermal coefficient of electrical resistance of the resisting element used in the starting circuit of the present invention permits a strong current to flow in the starting circuit during the starting of the lamp and, when the lamp has attained its operating temperature, the resistance increases to decrease the current flow through said starting circuit. The advantage of the starting of the main discharge on a low starting voltage is thus retained and at the same time

the disadvantages of a loss in efficiency and of instability of the main discharge during the operation of the device are avoided.

We have discovered that the above advantages are secured and the above disadvantages are avoided when the resistance in the starting circuit, during the operation of the lamp device, is approximately 1.5 times as great as the initial resistance in said circuit during the starting period. We prefer, however, to make the resistance in the starting circuit during the operation of the lamp device approximately two, or three times that of the initial resistance in said circuit during the starting period.

When, in accordance with the present invention, the resistance has a high thermal coefficient of electrical resistance it is frequently desirable to heat this element to a higher temperature than that to which it is heated by current flow there-through during the operation of the lamp device. In these instances it is advantageous to mount the resistance in heat receiving relation to the container of the lamp device. In such an arrangement the resistance in the starting circuit increases rapidly to and is maintained at a high value during the operation of the discharge lamp so that said main discharge in the lamp is stable in operation. The starting circuit of the present invention is particularly desirable for use in connection with lamp devices which operate at container temperatures of approximately 200° C. and higher, such as mercury vapor discharge devices operating at pressures closely approaching 1 atmosphere or higher, or lamp devices in which the gaseous atmosphere comprises a vapor of a difficultly vaporizable material, such as sodium vapor. Lamp devices of this type usually comprise a heat conservator, such as an evacuated envelope or vessels in which the lamp container is mounted. In devices of this type it is advantageous to mount the resistance element of the present invention inside of the heat conservator and in close proximity to the lamp container.

In the drawing accompanying and forming part of this specification an embodiment of the invention is shown, in which

Fig. 1 is a front elevational, partly sectional view of a gaseous electric discharge lamp unit embodying the invention,

Fig. 2 is a side elevational, partly sectional view of the lamp unit shown in Fig. 1, and

Fig. 3 is a schematic view of the discharge lamp of the lamp unit shown in Figs. 1 and 2 and a diagram of a starting circuit therefor.

Like numbers denote like parts in all the figures.

Referring to the drawing the gaseous electric discharge lamp device comprises a U-shaped tubular container 1 having electrodes 2 and 3 mounted adjacent the ends thereof and auxiliary, starting electrodes 4 and 5 mounted adjacent said main electrodes 2 and 3, respectively. The main electrodes 2 and 3 are electron emitting when heated and comprise a metal filament, such as a tungsten filament, bent double and wound helically and covered with a material having high electron emissivity characteristics, such as barium oxide. Each of said electrodes 2 and 3 are mounted on two current leads sealed into the external pinch 10 at the ends of the container 1. The two current leads for each of said electrodes 2 and 3 are joined together externally to the container 1 and are connected to a single current lead 6 or 7, as shown in Figs. 2 and 3 of the draw-

ing. The main discharge supporting electrodes 2 and 3 are maintained at a discharge supporting, electron emitting temperature during the operation of the device by the arc current and the voltage drop thereat. The auxiliary electrodes 4 and 5 consist of hollow, metal cylinders surrounding said main electrodes 2 and 3, respectively. The lamp container 1 has a gaseous filling therein comprising a starting gas, such as neon, argon, xenon, or a mixture of such gases, at a pressure of approximately 1 to 10 mm. and contains a quantity of vaporizable material, such as sodium, the vapor of which is light emitting during the operation of the device. During starting of the lamp device the discharge takes place in the gas and the heat emitted by the gas discharge heats up the vaporizable material to generate sufficient vapor in the lamp so that the light emitted thereby is rich in rays characteristic of the metal vapor.

The container 1 is mounted in a sealed envelope 8 having current leads 6 and 7 sealed into the stem thereof. A cylindrical glass baffle 9 is interposed between the container 1 and the envelope 8 and is fused at one end thereof to the said envelope 8. The container 1 is supported in the envelope 8 by the current leads 6 and 7 as shown in Fig. 2 of the drawing and by the helical coiled spring 11 which is clamped between the legs of the U-shaped container 1 and presses against the cylindrical baffle 9. A small mica plate is interposed between said spring 11 and said container 1. The container 1 is thus firmly supported in said envelope 8 and maintained in spaced relation thereto.

The auxiliary electrode 4 surrounding the main electrode 2 is connected through the resistance 13 to the current lead 7 of the main electrode 3. Similarly the auxiliary electrode 5 surrounding the main electrode 3 is connected through a resistance 14 to the lead 6 of the main electrode 2 as shown in Fig. 3 of the drawing. Two auxiliary starting circuits connected in parallel with the main discharge path between the main electrodes 2 and 3 are thus formed. One auxiliary starting circuit comprises the resistance 13 and the auxiliary discharge path between the main electrode 2 and the auxiliary electrode 4, the other starting circuit comprises the resistance 14 and the auxiliary discharge path between the main electrode 3 and the auxiliary electrode 5. Each of the resistances 13 and 14 consists of a wire having a high positive thermal coefficient of electric resistance, such as an iron wire, wound around a small plate of mica 15 and 16, respectively.

The resistances 13 and 14 are mounted in said envelope 8 adjacent the end of the tubular container 1, as shown in Figs. 1 and 2, and, during the operation of the device, are heated not only by current flowing therethrough but also by the heat developed in and given off by the container 1. The device is started into operation by connecting the current leads 6 and 7 across the terminals of a main alternating current source in series with an impedance. The resistances 13 and 14 during this period are at a comparatively low temperature and offer but little resistance to the flow of current therethrough. A large current thus flows through the auxiliary starting circuit and an intense starting discharge takes place between said auxiliary electrode 4 and said main electrode 2 and between auxiliary electrode 5 and the main electrode 3, respectively. The main electrodes 2 and 3 are thus rapidly

raised to an electron emitting, discharge supporting temperature, higher than would be the case were said resistances 13 and 14 of a higher value, and the main discharge is quickly started between said main electrodes 2 and 3 and at a comparatively low potential. When the main discharge has been started the resistance wires 13 and 14 are heated to a higher temperature and their resistance to current flow therethrough increases. This increase of resistance is advantageous, as pointed out above, since the reduction of the current flow through these starting circuits increases the efficiency of the device and permits stable operation of the main discharge. The starting circuits of the present invention are simple and positive in action and eliminate complicated switching mechanisms to interrupt current flow in the starting circuit after the main discharge has been started, characteristic of prior starting circuits of this type.

We have demonstrated that when the resistances 13 and 14 in lamp units of the above type have a resistance of about 1,000 ohms in a cold condition the resistance thereof during the operation of the device is increased to about 2,500 ohms. We have demonstrated that when the elements 13 and 14 have a resistance of 2,500 ohms in a cold condition the starting potential of the main discharge is 23% higher than is the case when the elements 13 and 14 have a value of 1,000 ohms in a cold condition.

The invention is also useful in the type of discharge lamp wherein an electrically conducting body is mounted inside the lamp container and extends along the main discharge path therein to terminate adjacent the main discharge supporting electrodes. In accordance with the invention the electrically conducting body consists of a material, at least in part, having a high thermal coefficient of electrical resistance and which is protected from the discharge by an insulating material, such as a glass tube.

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, the resistance elements 13 and 14 are mounted between legs of the U-shaped container 1 when desired and consist of thin iron wire wound around a thin, enameled copper rod, when desired. In this position the resistance elements 13 and 14 are exposed fully to the heat given off by the container 1 during the operation of the device and the obstruction of the emitted light by such elements is reduced a minimum.

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

1. A gaseous electric discharge device comprising a container, electrodes sealed therein and a gaseous filling therein, one of said electrodes being a main discharge supporting electrode which is electron emitting when heated and another of said electrodes being an auxiliary starting electrode, said auxiliary electrode being mounted in operative relation to said main electrode, an auxiliary starting circuit connected in parallel with the main discharge path in said device and incorporating said auxiliary electrode, said starting circuit comprising a resistance having a large positive thermal co-efficient of electrical resistance.

2. A gaseous electric discharge device comprising a container, electrodes sealed therein and a gaseous filling therein, one of said electrodes being a main discharge supporting electrode which is electron emitting when heated and another of said electrodes being an auxiliary starting electrode, said auxiliary electrode being mounted in operative relation to said main electrode, an auxiliary starting circuit connected in parallel with the main discharge path in said device and incorporating said auxiliary electrode, said starting circuit comprising a resistance having a large positive thermal co-efficient of electrical resistance, the value of said resistance during the operation of said device being approximately 1.5 times the value thereof in a cold condition.

3. A gaseous electric discharge device comprising a container, electrodes sealed therein and a gaseous filling therein, one of said electrodes being a main discharge supporting electrode which is electron emitting when heated and another of said electrodes being an auxiliary starting electrode, said auxiliary electrode being mounted in operative relation to said main electrode, an auxiliary starting circuit connected in parallel with the main discharge path in said device and incorporating said auxiliary electrode, said starting circuit comprising a resistance having a large positive thermal co-efficient of electrical resistance, said resistance being mounted in heat receiving relation to said container.

4. A gaseous electric discharge device comprising a container, electrodes sealed therein and a gaseous filling therein, one of said electrodes being a main discharge supporting electrode which is electron emitting when heated and another of said electrodes being an auxiliary starting electrode, said auxiliary electrode being mounted in operative relation to said main electrode, an auxiliary starting circuit connected in parallel with the main discharge path in said device and incorporating said auxiliary electrode, said starting circuit comprising a resistance of iron wire.

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