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GASEOUS ELECTRIC DISCHARGE DEVICE

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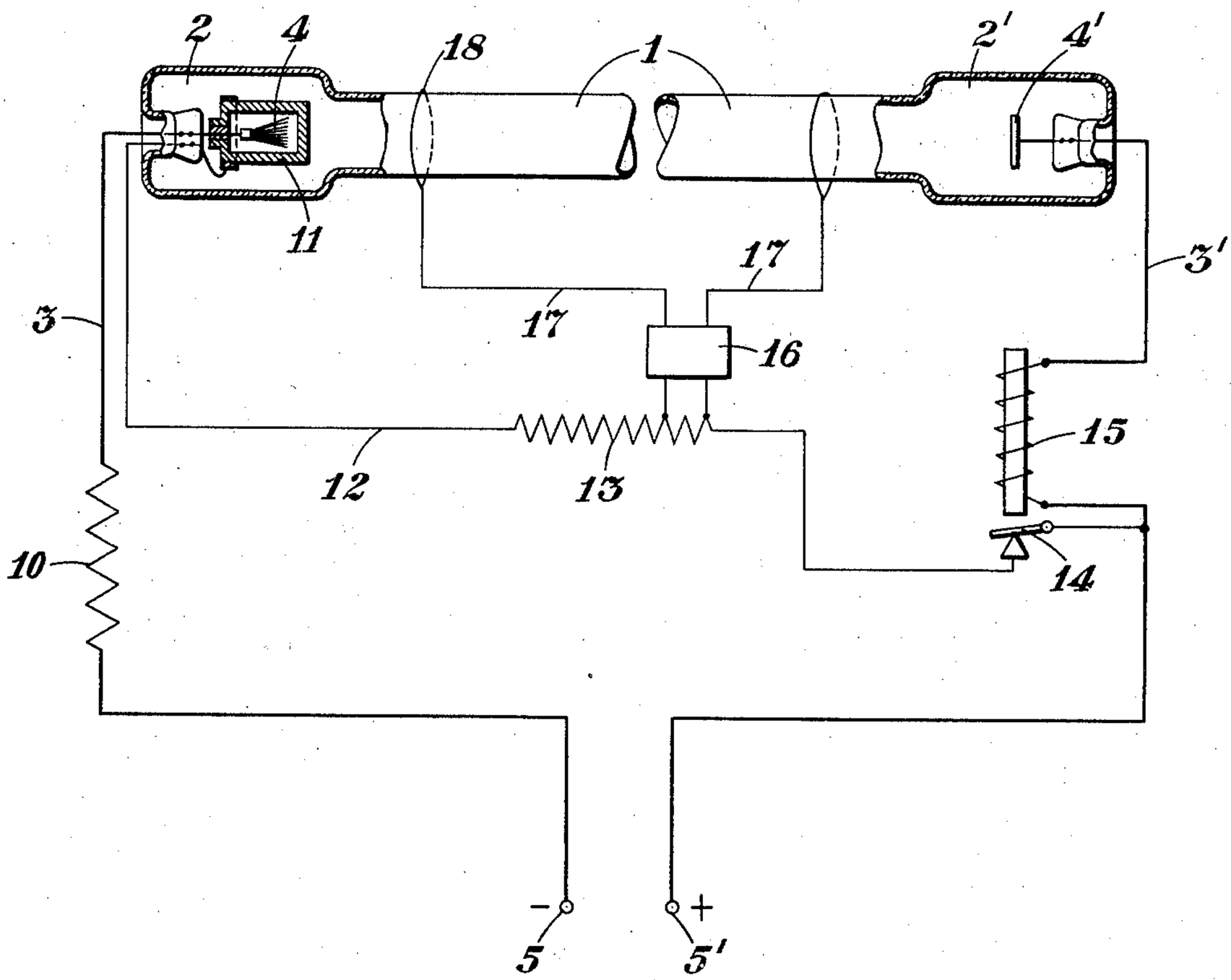

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GASEOUS ELECTRIC DISCHARGE DEVICE

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3 Claims. (Cl. 176—126)

The present invention relates to gaseous electric discharge devices generally and more particularly the invention relates to means for starting and improving the operating efficiency of hot cathode positive column discharge devices of the arc and of the glow types similar to those disclosed in co-pending application, Serial Number 377,044, filed July 9, 1929, being the invention of Marcello Pirani and Hans Ewest.

In German application 21f2 P 369—30, filed in Germany July 25, 1930 and being the invention of Georg Gaidies and Hans Straehler, is described a gaseous electric discharge device having metal shells surrounding the main thermionic electrodes said shells being connected through a resistance to the lead of the electrode opposite the one each surrounds and being adapted to decrease the radiation of heat from said thermionic electrodes to improve the starting and the operating efficiency of the device. It has been found necessary to connect into the circuit a heating means for the cathode of such devices when operating on direct current as the cathode potential drop is generally too weak to maintain the cathode at the desired high temperature to support the gaseous discharge during the operation of the device. This is not necessary when the device is operating on alternating current since, as is well known in the art, the electrodes operate both as anode and as cathode and are sufficiently heated by the strong anode potential drop as well as the cathode potential drop.

The object of this invention is to provide a gaseous electric discharge device of the above type requiring no special heating means connected into the circuit for the thermionic cathode when operating on direct current. A further object of the invention is to provide such a device in which starting takes place quickly. 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 an inspection of the accompanying drawing and from the following detailed description.

In accordance with these objects the invention comprises an electrode, used exclusively as an auxiliary anode only during the starting of the device to rapidly raise the thermionic cathode to its operating temperature, which completely encloses the thermionic cathode and which is coated or impregnated with electron emitting material. Said auxiliary electrode, since it completely encloses said cathode, operates also as a cathode after the gaseous electric discharge device has been started into operation so that two gaseous discharges are present in the device during the operation thereof, one between the cathode and the interior surface of the auxiliary electrode which acts as an anode with respect to said cathode and the other between the anode and the exterior surface of the auxiliary electrode which acts as a cathode with respect to said anode after the device has been started into operation.

Due to this new and novel arrangement of the electrodes the auxiliary electrode is intensely heated during the operation of the device since it operates both as anode and cathode to take the full current on the device and not, as in prior direct current devices, only part of the current. The cathode enclosed by the auxiliary electrode is strongly heated by radiation from the interior of the auxiliary electrode during the operation of the device so that no special, connected into the circuit, heating means is required to maintain said cathode at a sufficient temperature to support the gaseous discharge during the operation of the device. After the device has been started into operation by a high frequency apparatus suitably connected the auxiliary electrode may be cut out of circuit, or not as desired though it is advantageous to cut out of circuit said auxiliary electrode during the operation of the device since the device operates more efficiently due to the saving of the by-pass currents.

In the drawing accompanying and forming part of this specification an embodiment of the invention is shown in side elevation partly in section the circuit therefore being shown schematically, but as such illustration is primarily for purposes of disclosure it will be understood, of course that numerous substitutions, modifications and changes in the form and details of the device and in its use and operation may be made by those skilled in the art without departure from the broad spirit and scope of the invention.

Referring to the drawing the new and novel gaseous electric discharge device comprises a container 1 having a suitable electric discharge supporting gaseous atmosphere therein and having main electrodes 4 and 4′ sealed into electrode chambers 2 and 2′ thereof respectively. Said electrodes 4 and 4′ are connected to the terminal posts 5 and 5′ respectively of a direct current source by leads 3 and 3′ respectively. The electrode 4 which operates as the cathode has a fan shape, though it may have any suitable shape, and consists of metal wires such as tungsten, coated or impregnated with electron emitting material such as barium oxide. Resistance 10 is connected into lead 3 of cathode 4 and, as is well

known in the art, acts as the ballast resistance during the operation of the device. Electrode 4' which operates as the anode consists of the usual commercial metals, such as iron, or it may consist of difficultly fusible metals, such as tungsten, or of a material such as carbon. Cathode 4 is completely enclosed by the auxiliary electrode, said auxiliary electrode being in the form of a housing 11, and said lead 3 of cathode 4 is led through and insulated from the back of said housing 11. Said housing 11 consists of a sintered mixture of difficultly fusible metals and electron emitting metals and oxides thereof, such as tungsten, and electron emitting material such as mixtures of barium and barium oxide as disclosed in co-pending applications, Serial Number 377,044, filed July 9, 1929, being the invention of Marcello Pirani and Hans Ewest, and Serial Number 447,051, filed April 24, 1930, being the invention of Georg Gaidies and Marcello Pirani, or said housing electrode 11 may consist of a sheet metal shell coated with said electron emitting material, as desired. Said housing 11 is connected to the positive terminal 5' by lead 12 connected to said lead 3' of the anode 4'. Said lead 12 has connected therein resistance 13 and a switch 14. The movements of said switch 14 are controlled by an electro-magnet 15 connected into the lead 3'. A small high frequency apparatus 16 is connected to a part of the resistance 13, said high frequency apparatus 16 consists of a vibrator, a spark-inductor, an oscillation circuit, and a high frequency transformer as is well known in the art. Two leads 17 of the high frequency apparatus are either connected to the electrodes 4 and 4', or, as illustrated, are looped around container 1 in the vicinity of the electrodes.

When current is applied to the gaseous electric discharge device a glow discharge consuming a proportionately weak current such as 20 to 50 milli-amperes takes place between said cathode 4 and the interior surface of housing 11 which is connected into the circuit as an anode. Said thermionic electrodes 4 and 11, which are coated or impregnated with electron emitting material, are rapidly raised to a suitable temperature by the glow discharge and this discharge changes to an arc discharge causing a decrease in the potential drop between electrodes 4 and 11 which increases the flow of current to approximately one ampere. This increased current flow increases the potential drop through said resistance 13. The high frequency apparatus 16, connected to a part of said resistance 13, and which remains inactive during the time of the glow discharge between electrodes 4 and 11 due to the small potential on resistance 13 is adapted to come into operation during the time of the increased potential drop through resistance 13. The gaseous atmosphere in container 1 is ionized by the high frequency discharge and a luminous positive column arc or glow discharge, is quickly established between the exterior side of housing 11, which acts as a cathode, and the anode 4'. Two series discharge paths are then present in the container 1; a short one between the cathode 4 and the inside surface of housing 11 and a long one between the outside surface of housing 11 and anode 4'.

The housing 11 which acts as an anode and a cathode simultaneously during the operation of the device receives the full current on the device and is thereby maintained at a high temperature during the operation of the device to maintain the cathode 4 enclosed therein at a suitable temperature to support the gaseous discharge in said device so that a special, connected into the circuit, heating means is not necessary for said cathode 4.

As soon as the luminous discharge between the outside surface of housing 11 and anode 4' has been established, which takes place very quickly, switch 14 is open circuited by electric magnet 15 to cut out of circuit lead 12 and therewith resistance 13 and high frequency apparatus 16. A hand switch or a thermally operated switch may be used in place of the electromagnet switch 14—15 if desired. If high frequency apparatus 16 is connected to a separate current source switch 14 is not necessary and the housing 11 may remain connected to the positive terminal 5' during the operation of the device.

It will be understood, of course, that the structure of electrodes 4 and 11 may be duplicated at the opposite end of the tube and the circuit therefor adapted for operation on alternating current, if desired, in which case the element 14 will have two pole pieces to break the circuit to the intermediate electrodes 11, 11 when desired.

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

1. An electric discharge device comprising a container, a gaseous atmosphere therein, a plurality of starting and operating electrodes therefor, one of said electrodes being an anode, one other of said electrodes being an electron emitting cathode, another of said electrodes being electron emitting and being a solid walled housing completely enclosing said electron emitting cathode and adapted to rapidly increase to and maintain said electron emitting cathode at its stable discharge supporting temperature.

2. An electric discharge device comprising a container, a gaseous atmosphere therein, a plurality of starting and operating electrodes therefor, one of said electrodes being a solid walled housing completely enclosing the main cathode and being an anode for the discharge to said main cathode and a cathode for the discharge to the main anode of said device, said intermediate electrode being heated by the anodic and cathodic current effects to quickly raise to and maintain said main cathode at its discharge supporting temperature.

3. In combination, an electric discharge device comprising a container, a gaseous atmosphere therein, a plurality of starting and operating electrodes therefor, one of said electrodes being a solid walled housing completely enclosing the main cathode and being an anode for the discharge to said main cathode and a cathode for the discharge to the main anode of said device, said intermediate electrode being heated by the anodic and cathodic current effects to quickly raise to and maintain said main cathode at its discharge supporting temperature, a current source for said device and means to disconnect said housing electrode from said current source during the operation of said device.

HANS EWEST.