

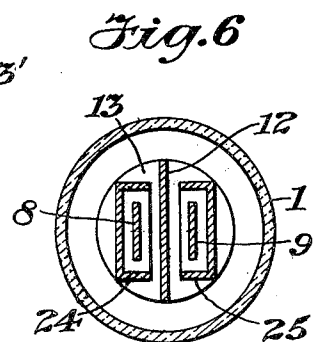
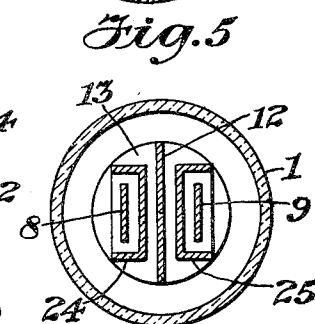
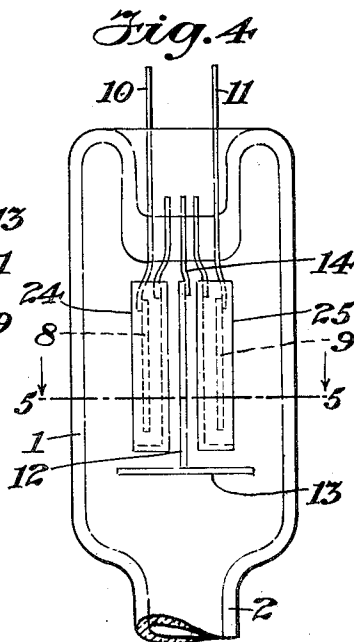
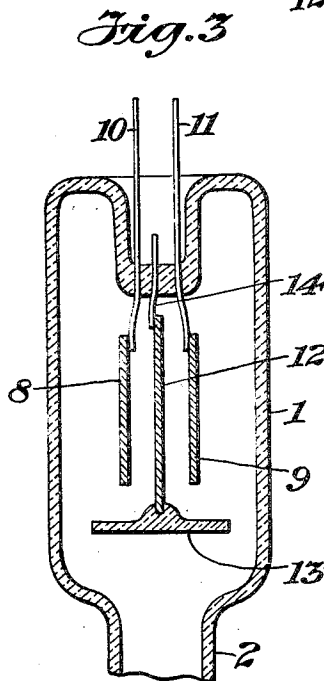
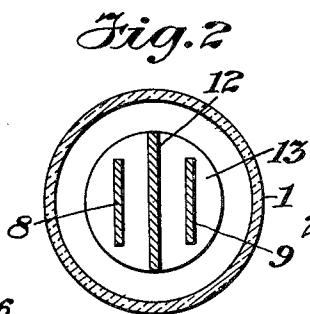
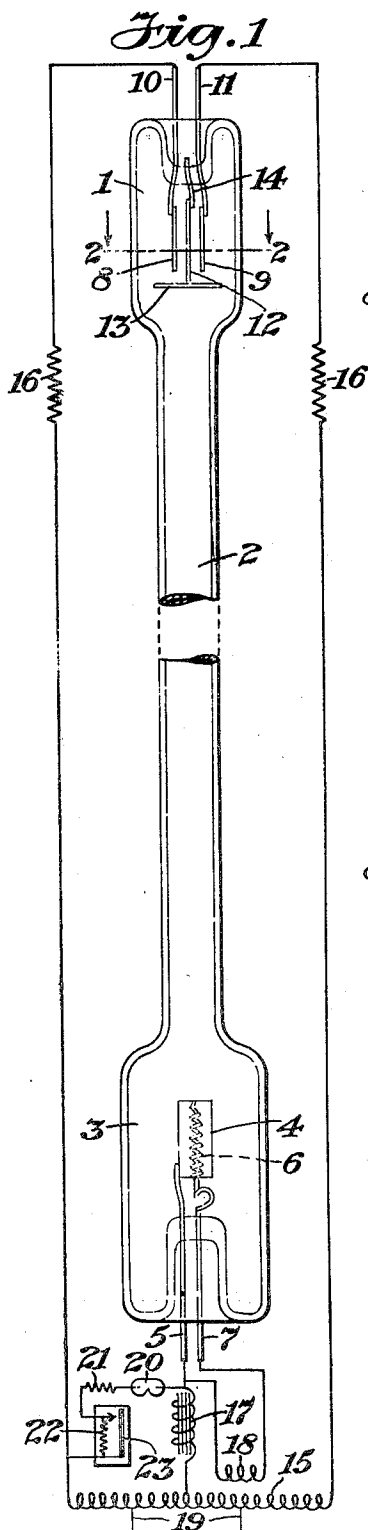
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C. E. KENTY

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ELECTRIC GASEOUS DISCHARGE DEVICE

Filed March 25, 1930



INVENTOR
Carl E. Kenty
 BY *John D. Brown*
 HIS ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRIC GASEOUS DISCHARGE DEVICE

Carl E. Kenty, Jersey City, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J., a corporation of New Jersey

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2 Claims. (Cl. 176-126)

The present invention relates to electric gaseous discharge devices, and particularly to discharge devices of the self-rectifying type in which two or more anodes of different potential are employed.

A particular object of the invention is to reduce the current flowing from one anode to another. Another object of the invention is to provide means whereby the anodes may be located in proximity to each other. Another object is to provide means whereby relatively high potential differences may be safely maintained between said anodes. Still another object of the invention is to increase the useful life of the discharge device. Other objects and advantages of the invention will appear from the following detailed specification, or from an inspection of the accompanying drawing.

The invention comprises a discharge device having the several new and novel features and combinations of parts hereinafter set forth and claimed.

Electric gaseous discharge devices which have unidirectional current carrying characteristics, such as the well known mercury arc lamps and rectifiers, the more recent devices having a single hot cathode, and the like, have been commonly adapted for use on alternating current by using a plurality of anodes, so connected that at least one of said anodes is always positive with respect to the cathode. The relatively high potential between anodes, of the order of 100-150% greater than the discharge maintaining potential, which is inherent with such a connection produces a current between the anodes, commonly called a "cross-current", which tends to build up into a destructive arc. This cross-current likewise causes destruction of the anodes by sputtering, the sputtered material in turn aiding in the undesired clean-up of any gases in the device. To reduce these currents it has been customary to put each anode into a side tube as far away from the main discharge path as was consistent with the maintenance of the discharge, and it has also been found necessary to keep the discharge maintaining potential below definite limits, which varied of course, according to the gaseous content of the device and the nature of the electrode material.

I have discovered that this current between anodes may be greatly reduced by the use of a suitable shield interposed between each of the anodes and the main discharge, a device so constructed having a far longer useful life than those constructed according to the prior art. It has also been found that when the anodes are so

shielded they no longer need to be placed in side tubes, and that the discharge potential may be increased considerably beyond prior safety limits.

The explanation of the above phenomenon is believed to be as follows. The cross-currents in these devices are undoubtedly due primarily to the ejection of electrons from the inactive, or negative, anodes by metastable atoms, with the photo-electric effect on the anodes of ultra-violet rays from the discharge forming a secondary source. The presence of metastable atoms in the vicinity of the electrodes may result either from the diffusion of such atoms from the discharge column; the diffusion of ions and electrons from the discharge column, with a subsequent recombination thereof forming a certain percentage of metastable atoms; or from the formation of metastable atoms in situ as a result of the penetration of a certain amount of resonance radiation.

While the last mentioned source of metastable atoms is believed to be the predominating one, the other sources are of considerable importance in certain cases. The shield which is employed according to the present invention is effective, however, in reducing the concentration of metastable atoms due to any of these sources, since it not only cuts off resonance radiations from the space near the anodes, but also intercepts the diffusing metastable atoms and ions toward the inactive negatively charged anodes, the shield being especially effective with respect to the ions as a result of the static charge which it soon accumulates. The shield likewise intercepts and eliminates the photo-electric effect on the anodes. A shield constructed of glass or the like has a further advantage since it not only cuts off the resonance radiations, but also passes any visible radiations, some of which are known to destroy metastable atoms, with the result that the cross-currents are even further reduced.

For the purpose of illustrating my invention I have shown several embodiments thereof in the accompanying drawing, in which

Fig. 1 is an elevational view of a gaseous discharge device having a hot cathode and adapted for use on single phase alternating current, together with a schematic diagram of the operating circuit therefor,

Fig. 2 is a sectional view taken on the line 2-2 of Fig. 1,

Fig. 3 is a longitudinal section of the anode chamber of a modification of the device of Fig. 1,

Fig. 4 is an elevation of the anode chamber of another modification of the device of Fig. 1, in

which the anodes are more extensively shielded,

Fig. 5 is a section on the line 5—5 of Fig. 4 and Fig. 6 is a section similar to that of Fig. 5 showing a modification of the structure of Figs. 4 and 5.

5 In the drawing, with reference to Figs. 1 and 2, there is shown a gaseous discharge device having the anode chamber 1, the discharge tube 2 and the cathode chamber 3, all formed of suitable vitreous material, such as glass, fused silica, or
10 the like. Within the cathode chamber 3 there is a cylindrical cathode 4, preferably formed of nickel and coated with an alkali or alkaline earth compound, such as barium oxide, said cathode being supported by the sealed-in lead 5. A filamentary
15 heater 6, one end of which is attached to the cathode 4, while the other end connects with the sealed-in lead 7, is adapted to heat said cathode 4 to a temperature at which it freely emits electrons. Within the anode chamber 1 there are two
20 plate anodes 8 and 9, of sheet iron, nickel, carbon, tungsten, molybdenum, and the like, and supported by the sealed-in leads 10 and 11, respectively. Said anodes 8 and 9 are separated by a baffle 12 of sheet iron, nickel or the like, to the
25 lower edge of which is attached a circular shield 13 of similar material, and of sufficient diameter to completely screen the anodes 8 and 9 from direct radiations from the discharge tube 2. Said baffle 12 is insulated from the anodes 8 and 9, being
30 conveniently supported by the wire 14 which is fused into the same pinch seal as the leads 10 and 11. Within the sealed envelope of this device there is an attenuated atmosphere of neon, helium, argon, mercury vapor, or other suitable gases or
35 vapors or mixtures thereof. For example, where a red light is desired a filling of either pure neon or 70% neon and 30% helium at a pressure of say 1 to 4 m.m. of mercury is employed.

As shown in Fig. 1, the leads 10 and 11 are connected to opposite ends of an auto-transformer
40 15, a suitable ballast resistance 16 being connected in series with each lead. A mid-point of said auto-transformer 15 is connected through the inductance 17 to the lead 5, while said lead 5 is
45 likewise connected to one side of a low voltage secondary coil 18, the other side of said secondary being connected to the lead 7. Said auto-transformer 15 is connected to a suitable source of
50 alternating current by means of the leads 19. For starting purposes a connection is made from lead 5 through a mercury switch 20, of the shifter type, resistance 21 and resistance 22 to one of the anode
55 leads. A bimetallic element 23 in thermal relation to said resistance 22 is adapted to short circuit said resistance after a predetermined time. Said shifter 20, which is normally in a circuit closing position, is actuated to an open position in a
conventional manner when inductance 17 is energized.

60 The structure shown in Fig. 3 is identical with that of Figs. 1 and 2, save that the shield 13' is in this case constructed of transparent or translucent material, such as quartz, glass, or the like.

In the structure shown in Figs. 4 and 5 the
65 anodes 8 and 9 are separated from each other by a baffle 12 and from the discharge tube 2 by the shield 13, as in Figs. 1 and 2. In addition the anodes 8 and 9 are partially surrounded by the
70 shallow box-like shields 24 and 25, respectively, of iron, nickel or the like, said shields being conveniently supported by wires fused into the same pinch seal as the leads 10 and 11. Said shields 24 and 25, which are electrically isolated, are each
75 open on the side away from the baffle 12 in order to give access to the anode for the discharge which

flows thereto every other half cycle, while the end of each shield which is adjacent to the pinch seal is also open to give access to the anode leads 10 and 11, respectively. In case an even greater shielding of the anodes 8 and 9 is desired said shields 24 and 25 may each be reversed, so that the open side thereof is toward the baffle 12, as shown in Fig. 6.

In the use and operation of the device of Fig. 1, upon the application of a suitable alternating
10 current potential to the leads 19 a potential in excess of that required for normal operation is applied between said anodes 8 and 9 and the cathode 4. This potential is, however, insufficient to initiate a discharge. A current flows from
15 secondary 18 through lead 7, filamentary heater 6, cathode 4 and lead 5 back to said secondary 18, said heater 6 thereby raising said cathode 4 to an electron emitting temperature. At the same time a current flows from the midpoint of auto-trans-
20 former 15 through the inductance 17, shifter 20, resistance 21 and resistance 22 back to one end of said auto-transformer 15, said current being so limited by the resistance 22 that the inductance 17 is not sufficiently magnetized to actuate the
25 shifter 20 to an open circuit position. The bimetallic element 23 is gradually warped by the heat generated by said current in the resistance 22 until after a predetermined time interval, which is made to equal the time required for said cathode
30 4 to reach operating temperature, said element 23 short circuits said resistance 22. The increased current which thereupon flows through the inductance 17 causes the actuation of the shifter 20, opening the circuit through said in-
35 ductance. The collapsing magnetic field thereupon creates a voltage surge of sufficient potential to ionize the gaseous atmosphere within the discharge tube 1, resulting in a discharge there-
40 through which is maintained by the potential differences existing between the anodes 8 and 9 and said cathode 4. This discharge flows during alternate half cycles from the anodes 8 and 9 as each in turn becomes positive with respect to the
45 cathode 4, inductance 17 then functioning to maintain the discharge during the change over period, and likewise to maintain the shifter 20 in an open circuit position.

During the half cycle in which current flows from anode 8 the anode 9 is completely shielded
50 by the baffle 12 and shield 13 from the discharge. This shielding is very effective in reducing the electron emission from the anode 9, with the result that the cross-current flowing from the anode 8 to the anode 9 during this half cycle is
55 markedly reduced.

This reduction in the number of electrons emitted from the anode 9 is believed to be due to the reduction in the number of metastable atoms which can collide with the anode 9, with an ensuing ejection of electrons, and to the prevention of the photo-electric emission of electrons under the influence of ultraviolet radiations. The latter effect logically follows from the cutting off
60 of the ultraviolet radiations by the baffle 12 and shield 13, but the reduction in the number of metastable atoms is due to a number of different effects of said baffle and shield. The main cause of this reduction is the cutting off by said baffle and shield of resonance radiations from the dis-
65 charge by which metastable atoms could be formed in the vicinity of the anode 9. Another cause is that the baffle 12 and shield 13 tend to prevent the diffusion of metastable atoms toward said anode 9 from the discharge, many of said
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atoms which come into contact therewith being destroyed. The baffle 12 and shield 13 are likewise effective in reducing the formation of metastable atoms adjacent to the anode 9 by the recombination of ions and electrons which have diffused from the main discharge, since said baffle and shield tend to prevent diffusion of ions and electrons toward said anode. The effectiveness of said shield and baffle in this respect is largely due to the fact that they become charged negatively by the electrons so that positive ions are attracted thereto, recombination of the ions and electrons being promoted thereby. These effects all contribute to the reduction in electron emissions from said anode 9 which is observed when the anodes are so shielded. During the next half cycle the main discharge is maintained from said anode 9, the baffle 12 and shield 13 then being effective in the same manner to reduce the electron emission from the anode 8.

The shield 13' in the structure of Fig. 3 is effective in reducing the emission of electrons from the negative anode in the same manner as the shield 13 of the structure of Figs. 1 and 2, but in addition it passes the visible characteristic radiations of the discharge, some of which are known to be very effective in the destruction of metastable atoms, so that the number of metastable atoms adjacent to said anode is still further reduced, with a corresponding reduction in the cross-current.

The box-like shields 24 and 25 of the structure shown in Figs. 4 and 5 function in the same manner as the shield 13 and baffle 12, the increase in electrically isolated bodies in the vicinity of the anodes, and the more devious path thereto, serving to increase the possibility of the destruction of metastable atoms, and to decrease the drift to said anodes of ions, electrons and metastable atoms. The arrangement of the shields 24 and 25 in Fig. 6 is even more effective for this purpose, and furthermore prevents metal sputtered from the anodes reaching the vitreous envelope.

From the marked decrease in cross-currents resulting from this new structure many advantages are derived. It is no longer necessary, for example, to put the anodes in side tubes, or "horns" as has heretofore been the case. Furthermore the limitation on operating potential,

which has heretofore served to limit the maximum length of the discharge for a given diameter tube, twenty inches having been considered the maximum limit with a one inch tube where neon was employed as the gaseous atmosphere, is now removed since considerably greater voltages may now be employed without the danger of destructive arcing between the anodes. The sputtering of the anode material by the metastable atoms and positive ions is also greatly reduced, resulting in a discharge device having a longer life due to the longer anode life, to the decreased blackening of the envelope, and to the reduced cleaning-up effect on the gaseous atmosphere.

While my invention has been illustrated and described with reference to certain structures adapted for use on single phase alternating current, and employing hot cathodes, it is obvious that it is not so limited. It is further to be understood that various changes, substitutions and omissions, within the scope of the appended claims, may be made without departing from the spirit of my invention.

What is claimed is,

1. In an electric gaseous discharge device having a plurality of anodes maintained at different potentials with respect to each other, the method of reducing the cross current between anodes of different potential which comprises reducing the metastable atom concentration adjacent to said anodes by irradiating the gas contiguous to each anode while inactive with radiations destructive of metastable atoms and at the same time shielding said contiguous gas from the resonance radiations of said gas.

2. In combination in an electric gaseous discharge device, a sealed envelope, a gaseous atmosphere therein, at least three electrodes within said envelope, one of said electrodes being adapted to serve continuously as a cathode while the others are adapted to serve alternately as anodes, and a shield between each of said anodes and the path of a discharge to said cathode from any other anode, at least a portion of said shield being formed of material which is opaque to radiations which promote electron emission from said anode and transparent to radiations destructive of metastable atoms.

CARL E. KENTY.