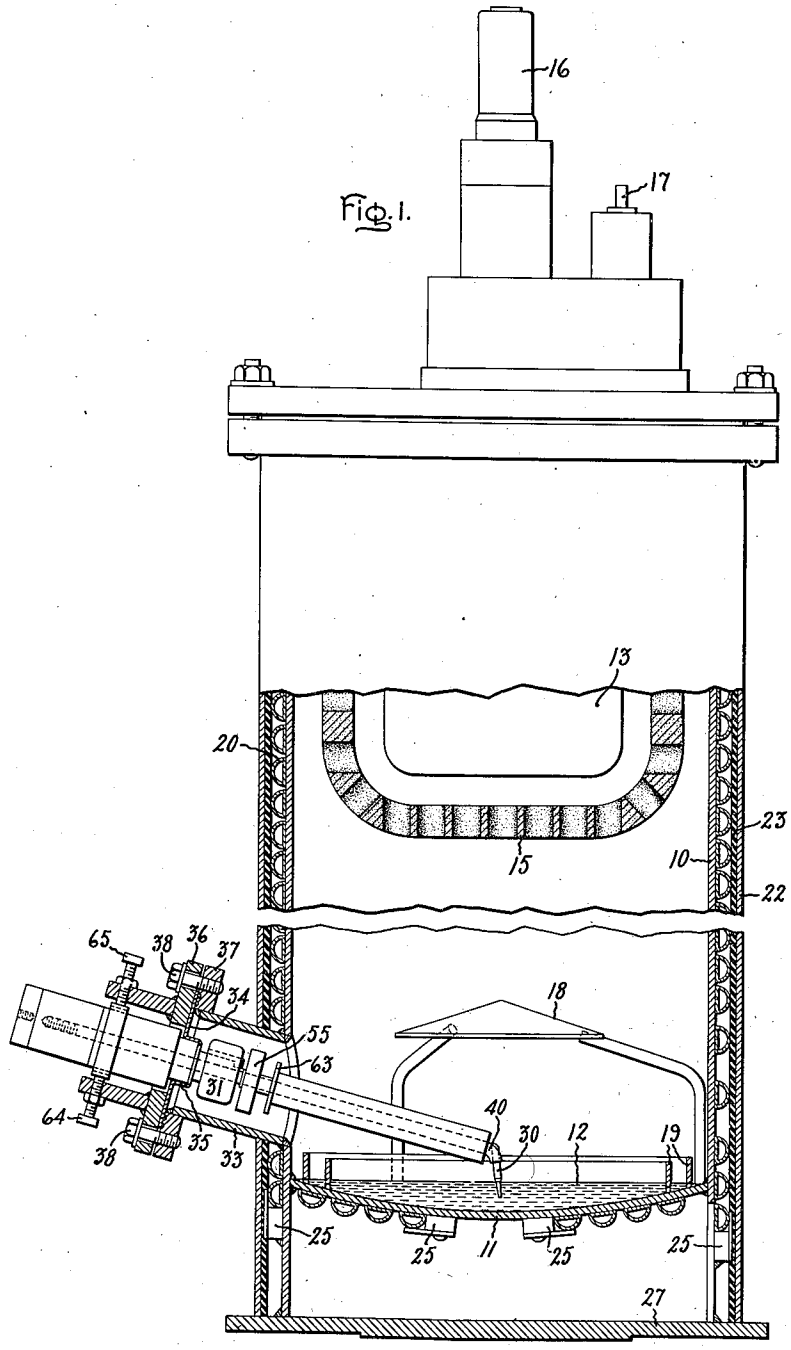
March 10, 1942. C. C. HERSKIND 2,275,852

ELECTRODE ASSEMBLY

Filed July 2, 1940 2 Sheets-Sheet 1

Fig. 1.



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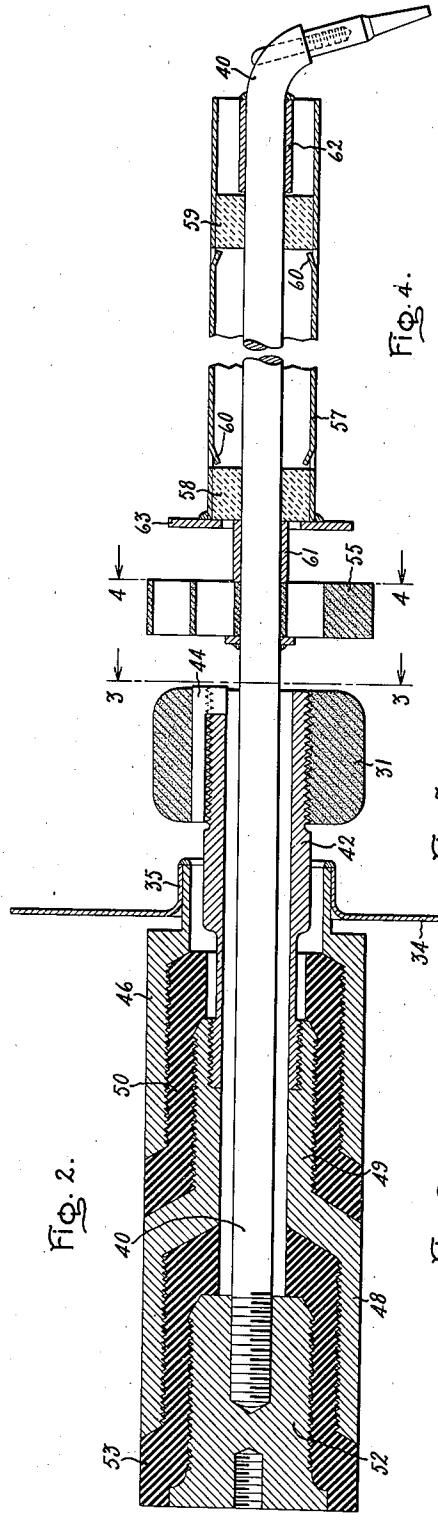


Fig. 2.

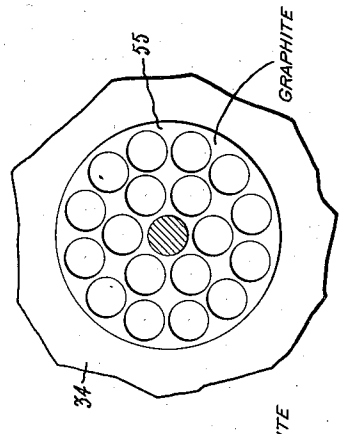


Fig. 4.

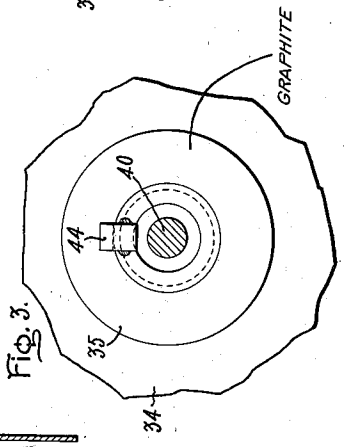


Fig. 3.

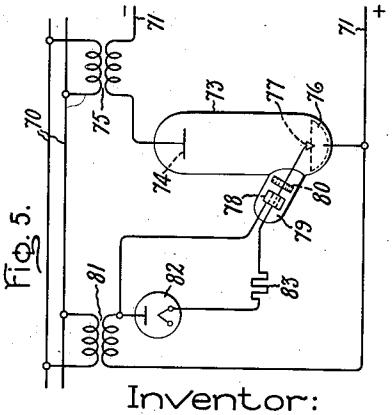


Fig. 5.

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UNITED STATES PATENT OFFICE

2,275,852

ELECTRODE ASSEMBLY

Carl C. Herskind, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application July 2, 1940, Serial No. 343,532

6 Claims. (Cl. 250—27.5)

The present invention relates to an improved electrode arrangement for a mercury-pool discharge device of the type which employs an immersion-ignitor electrode for the purpose of initiating the main discharge at controlled intervals.

In devices of the character above specified it frequently proves desirable to employ, in addition to the main discharge electrodes and the immersion ignitor electrode, an auxiliary anode which serves to augment the basic discharge-controlling means. One typical use of such an auxiliary anode is to lessen the current loading of the ignitor electrode in the period following the performance of the latter's discharge-initiating function. Another use is as a terminal for a cyclically renewed holding-arc which serves to assure the maintenance of the principal discharge under circumstances tending to cause the undesired extinguishment of the latter.

It is a particular object of the present invention to provide an improved electrode assembly in which an immersion-ignitor electrode and an auxiliary anode are combined in a unitarily mounted arrangement which not only possesses the manufacturing advantages of compactness and simplicity but which also assures that both electrodes shall function effectively in their intended manner.

An important feature of the invention consists in an arrangement whereby the ignitor electrode and the auxiliary anode are supported by a common mounting means.

A further important feature, ancillary to the above, includes the use as part of the electrode mounting means of a hollow tubular housing which extends outwardly from a lateral wall of the discharge envelope and within which the auxiliary anode is positioned. As will be more fully explained hereinafter, this construction is beneficial not only from a mechanical standpoint but also in respect to the protection against ion bombardment which it affords to the auxiliary anode.

The aspects of the invention which I consider to be novel are pointed out with particularity in the appended claims. The invention itself, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which Fig. 1 is a view in partial section of a discharge device suitably embodying the invention; Fig. 2 is an enlarged sectional view of a portion of the structure represented in Fig. 1; Fig. 3 and 4 are respectively cross-sectional views taken on lines 3—3 and 4—4 of Fig. 2; and Fig. 5 is a diagrammatic circuit representation illustrating a typical mode of use of the invention.

Referring particularly to Fig. 1, there is shown a discharge device having as an envelope an elongated metal cylinder 10 which is closed at top and bottom by appropriate transverse wall portions, the lower wall portion being illustrated at 11. Within the envelope and at the lower end thereof there is provided a cathode 12 in the form of a pool of mercury which is in direct contact with the floor of the envelope. This cooperates with an anode which is shown in part at 13, and which may be suitably constituted of graphite. A graphite baffle or shield 15, also usable under some circumstances as a control grid, surrounds the anode 13 and serves in the use of the device to protect the anode from excessive ion bombardment. The anode 13 and the baffle 15 are respectively connected with externally accessible current supply conductors of which the externally visible parts are indicated at 16 and 17.

A further baffle 18 of imperforate character is supported over the central portion of the cathode and acts to prevent mercury sprayed from the cathode from being projected on the anode where it might lead to inverse breakdown of the device. Mercury which condenses on and flows down the walls of the envelope 10 is enabled to return to the central or active portion of the cathode by passing under the lower edges of a pair of metal rings 19. These rings provide a trap for solid impurities, which, after being washed down the envelope walls, float to the mercury surface and are caught in the areas outside the rings.

In operation, the discharge chamber is maintained at a fixed operating temperature by means of a cooling coil 20 provided in direct contact with the walls of the discharge envelope, a suitable cooling fluid such as tap water being circulated through the coil to carry away the excess heat generated by the discharge. In order to prevent condensation of moisture on the surfaces of the cooling coil 20, the coil is covered with an external casing which includes an outer metal sheath 22 and a layer of thermally insulating material 23, for example, asbestos paper, which is interposed between the inner surface of the sheath 22 and the coil 20. A number of brackets, indicated at 25, are provided for the purpose of supporting the coil 20 in proper relation to the discharge envelope. A floor plate 27 which is secured to the lower extremity of the metal cylinder 10 serves to complete the enclosure

of the discharge envelope and to protect it from accumulation of dirt and moisture. This plate also provides a mounting surface for the apparatus as a whole and forms an externally accessible point at which current supply conductors (not shown) for the cathode 12 may be connected.

In addition to the elements so far described, the apparatus of Fig. 1 includes as a sub-assembly thereof, the combination of an immersion ignitor 30 and an auxiliary anode 31. The ignitor electrode 30 is in contact with the surface of the mercury and consists of a material having a high specific resistivity in comparison with mercury. It may suitably comprise silicon carbide or boron carbide or a combination of these substances with other materials. It is a known property of an electrode of this character that when impressed with a positive potential, it acts to establish a cathode spot on the mercury surface and thus facilitates the initiation of the principal discharge. The auxiliary anode 31 suitably consists of an annular body of graphite and is adapted to cooperate with the ignitor electrode 30 either in relieving the same of excessive current loading during the period immediately following initiation of a discharge or, in some cases, of facilitating the maintenance of the discharge once it is initiated.

The mounting structure which supports the electrodes 30 and 31 includes a tubular metal housing 33 which extends outwardly from the lateral wall of the discharge envelope and which is integrally joined to the envelope as by being peripherally welded thereto. Extending axially through the tubular housing 33 there is provided a rigid current supply conductor 40 (see Fig. 2) which connects at its inner extremity with the ignitor electrode 30 so as to support the latter in contact with the cathode 12. The auxiliary anode 31 surrounds this conductor and is supported in insulatingly spaced relation thereto by a second conductor in the form of a metal tube 42 which also extends outwardly through the end of the housing 33. As appears most clearly in Figs. 2 and 3, the anode is screw-threaded on one end of the conductor 42 and is maintained in fixed relation thereon by means of a suitable key 44.

The outer extremity of the housing 33 is sealed by a closure member in the form of an annular metal diaphragm 34 which supports the auxiliary anode 31 and the ignitor-electrode 30 in a manner shortly to be described. This diaphragm is peripherally clamped between an annular plate 36 and a flange 37 which extends outwardly from the housing 33 at its outer extremity. The parts 36 and 37 are forced into engagement with the diaphragm 34 by means of bolts 38 or by other suitable joining means. If desired, a deformable gasket arrangement (not shown) may be employed to improve the seal existing between the surface of the diaphragm 34 and the opposing surface of the flange part 37.

The diaphragm 34 is provided at its inner periphery with a flange or lip 35 which engages and is hermetically joined to a cylindrical metal part 46 extending outwardly from the extremity of the housing 33. Another cylindrical metal part having a first portion 48 which is of the same diameter as the part 46 and a second portion 49 of reduced diameter is positioned in partially telescoped relation with respect to the part 46. A quantity of vitreous insulating material 50, preferably of the composition known as Micalex (i. e., a mixture of mica and lead borate), is interposed between the parts 46 and 49 to establish a hermetic seal between them and to maintain them in rigid assembly. Through a screw threaded connection with this assembly the conductor 42 and the auxiliary anode 31 are supported from the diaphragm 34. The conductor 40 is also supported indirectly from the diaphragm by being connected to a metal plug 52 which interfits with and is rigidly sealed into the part 48, the seal consisting of a body of Micalex 53.

In forming the electrode-mounting structure described in the preceding paragraph the metal part 46, after being heated to a high temperature, is placed in a cylindrical mold, and a measured quantity of fused Micalex is then poured into the mold. This is followed by the part 48—49, also at high temperature. A second measured quantity of fused Micalex is then placed in the mold, and the part 53 is finally introduced. The contents of the mold are then subjected to pressure in order to force them into sealing engagement. After cooling, the seal assembly is removed from the mold and machined to the form shown in Fig. 2. If desired in order to assure the better adherence of the metal parts to the Micalex, their surfaces may be preliminarily serrated as shown. The metal parts are preferably constituted of an iron alloy containing about 25% chromium so as to provide at least an approximate match to the expansion characteristics of the Micalex.

By virtue of the fact that the auxiliary anode 31 is within the confines of the tubular housing 33 it is at least partially shielded from the possibility of bombardment due to ionization within the discharge envelope. In the use of the anode either as a relieving electrode for protecting the ignitor element 30 from the effects of excessive current conduction or as a terminal for a cyclically renewed holding arc assisting the maintenance of the main discharge this is an important factor in view of the necessity of permitting the anode 31 to attain a negative potential at some part of the discharge cycle. Excessive ion bombardment at such a time has a tendency to establish a cathode spot on the surface of the anode, thus rendering it electron-emissive and occasionally leading to an inverse discharge of harmful character. With the preferred structure illustrated this possibility is additionally guarded against by the provision of a current permeable baffle in the form of a perforated graphite disk 55 which is supported on the conductor 40 at a point between the surface of the auxiliary anode 31 and the interior of the discharge envelope. By this arrangement, ions proceeding toward the auxiliary anode are in large measure intercepted by the intervening surfaces of the baffle.

Exposure of the conductor 40 to the discharge space is found to lead to disintegration of the conductor material, and it is consequently advantageous to enclose the conductor within a metal shield 57. This shield is supported in spaced relation to the conductor by means of insulating washers 58 and 59 which are suitably constituted of lava. The washers are maintained in position by the cooperative action of studs or barbs 60 punched out of the surfaces of the shield 57 and a pair of metal sleeves 61 and 62 which are welded or otherwise secured to the conductor 40. A flange 63 which is secured to the end of the shield 57 nearest the baffle 55 serves addi-

tionally to lessen the exposure of the auxiliary anode 31 to the main discharge space.

In addition to the advantages which the invention possesses from an electrical standpoint, it has the important mechanical advantage of providing a single mounting and lead-in structure for both the ignitor-electrode and the auxiliary anode. With the arrangement described, only a single port need be provided in the wall of the discharge envelope, this being a feature which has important advantages from the standpoint of manufacturing simplicity and economy.

If desired, the construction above described may be readily adapted to permit adjustment of the position of the ignitor-electrode by means wholly external of the discharge envelope. Such means may comprise, for example, a pair of oppositely directed thrust screws 64 and 65 (Fig. 1) which are appropriately supported from the annular plate 36 and which act to cause tilting action of the electrode-supporting structure about the diaphragm 34 as a fulcrum. The diaphragm may readily be made sufficiently flexible to permit enough motion to occur to enable the degree of immersion of the ignitor 30 to be adjusted to the point which gives best operation.

The mode of use of the invention may best be understood by reference to Fig. 5 which illustrates the application of the invention in a circuit of a type which is fully described and claimed in application S. N. 326,924, filed March 30, 1940, in the name of C. C. Herskind. It is the function of the circuit to convert alternating current derived from a source 70 into direct or pulsating unidirectional current at terminals 71. For the purpose of accomplishing this conversion there is provided a discharge device 73 which, although shown diagrammatically, is assumed to be of the structural character of the device illustrated in Fig. 1. It includes an anode 74, a cathode 76, an immersion ignitor 77 and an auxiliary anode 78 which is supported in a laterally extending housing 79 and which is shielded by baffle 80.

The anode 74 is connected to one terminal of a transformer 75 excited from the source 70, and the cathode 76 is connected directly to the positive terminal of the direct current part of the system.

For initiating a discharge through the device 73 at cyclically recurrent intervals there is provided as a source of control impulses a so-called peaking transformer 81. One terminal of the secondary of this transformer is connected to the cathode 76 and the other terminal is connected to the immersion ignitor electrode 79. The connection to the ignitor is made through a thermionic rectifier 82 which permits only unidirectional current flow to the ignitor electrode, and a resistance 83 connected in series with the electrode 79 serves to limit the current flow thereto.

Assuming that the electrodes 74 and 77 attain positive potentials at concurrent instants, a cathode spot will be initiated by the electrode 77, and conduction through the tube will take place. However, as soon as an appreciable amount of ionization is established in the discharge space, an auxiliary discharge to the anode 78 will occur, and, because of the low impedance of the circuit connecting with this anode as compared with the circuit by which the ignitor is supplied, the current to the ignitor will immediately fall to a low value. In this way the ignitor will be relieved of current flow during the major portion of the operating cycle and its life will be consequently prolonged.

Upon the reversal of the potential supplied by the main source 70 the tube 73 will be rendered non-conducting, and the entire cycle will be repeated at recurrent intervals.

A further use for the invention is in a circuit which utilizes the auxiliary anode as a terminal for a cyclically renewed holding-arc rather than as a means for relieving the ignitor electrode, such a circuit being described, for example, in application S. N. 343,966 filed July 5, 1940, as a joint application of M. Edwards and O. W. Livingston.

In both the uses above referred to, the auxiliary anode necessarily attains a negative potential at some part of the operating cycle and is susceptible to bombardment by positive ions originating in the discharge space. The structural arrangement specified herein assures the protection of the auxiliary anode from direct exposure to such ions and thus minimizes the danger of arc-back arising from this cause.

While the invention has been described by reference to a particular embodiment thereof, it will be understood that numerous modifications therein may be made by those skilled in the art without actually departing from the invention. I, therefore, aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of the foregoing disclosure.

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

1. In a discharge device which comprises a main anode, a mercury pool cathode and an envelope enclosing said anode and cathode, the combination which includes an immersion-ignitor electrode in contact with the mercury cathode, a hollow housing projecting outwardly from a lateral wall of the envelope and hermetically joined thereto, a rigid current supply conductor extending from said ignitor electrode outwardly through said housing and serving to support said ignitor, an auxiliary anode comprising a body of conductive material which surrounds the said conductor at a point within the confines of said housing, whereby said auxiliary anode is at least partially shielded from the possibility of bombardment due to ionization within the envelope, said auxiliary anode being insulatingly spaced from said conductor, and a second conductor extending within said housing for supplying current to the auxiliary anode.

2. In a discharge device which comprises a main anode, a mercury pool cathode and an envelope enclosing said anode and cathode, the combination which includes an immersion ignitor electrode in contact with the mercury cathode, a tubular housing extending outwardly from a lateral wall of said envelope, a rigid current supply conductor extending from said ignitor electrode outwardly through said tubular housing and serving to support the ignitor electrode, an auxiliary anode comprising a body of conductive material which surrounds said conductor at a point within the confines of said housing, a tubular conductor coaxial with said first named conductor and extending outwardly from said auxiliary anode through the end of said tubular housing for supplying current to the auxiliary anode, a closure member for sealing the extremity of said housing and means mechanically supporting said ignitor-electrode and said auxiliary anode from said closure member through the said current supply conductors.

3. In a discharge device which comprises a main anode, a mercury pool cathode and an envelope enclosing said anode and cathode, the combination which includes an immersion-ignitor electrode in contact with the mercury cathode, a tubular housing extending outwardly from a lateral wall of the envelope, a rigid current supply conductor extending from said ignitor electrode outwardly through said housing and serving to support the ignitor electrode, an auxiliary electrode comprising a body of conductive material which surrounds the said conductor at a point within the confines of said housing, whereby the auxiliary anode is at least partially shielded from the possibility of bombardment due to ionization within the envelope, said auxiliary anode being insulated from the said lead-in conductor, means for supplying current to said auxiliary anode, and a current permeable baffle also within the confines of the housing and interposed between the auxiliary anode and the interior of the envelope for additionally shielding the anode.

4. In a discharge device which comprises a main anode, a mercury pool cathode and an envelope enclosing said anode and cathode, the combination which includes an immersion-ignitor electrode in contact with the mercury cathode, a hollow housing projecting outwardly from the lateral wall of the envelope and hermetically joined thereto, a conductor extending from said ignitor electrode outwardly through said housing and serving to supply current to the electrode, an auxiliary anode comprising a body of conductive material which surrounds the said conductor at a point within the confines of said housing, whereby said auxiliary anode is at least partially shielded from the possibility of bombardment due to ionization within the envelope, said auxiliary anode being insulatingly spaced from said conductor, and a second conductor extending within the said housing for supplying current to the auxiliary anode.

5. In a discharge device which comprises a main anode, a mercury pool cathode and an envelope enclosing said anode and cathode, the combination which includes an immersion ignitor electrode in contact with the mercury cathode, a tubular housing extending outwardly from a lateral wall of said envelope, a rigid current supply conductor extending from said ignitor electrode outwardly through said tubular housing and serving to support the ignitor electrode, an auxiliary anode comprising a body of conductive material which surrounds said conductor at a point within the confines of said housing, a second conductor extending from said auxiliary anode outwardly through the end of said tubular housing for supplying current to the auxiliary anode, a closure member for sealing the extremity of said housing and means mechanically supporting said ignitor and said auxiliary anode from said closure member through the said current supply conductors.

6. In a discharge device which comprises a main anode, a mercury pool cathode and an envelope enclosing said anode and cathode, the combination which includes an immersion ignitor electrode in contact with the mercury anode, a tubular housing extending outwardly from a wall of said envelope, a rigid current supply conductor extending from said ignitor electrode outwardly through said tubular housing and serving to support the ignitor electrode, an auxiliary anode comprising a body of conductive material which surrounds said conductor at a point within the confines of said housing, a second conductor extending from said auxiliary anode outwardly through the end of said tubular housing for supplying current to the auxiliary anode, a deformable closure member for sealing the extremity of said housing, means mechanically supporting said ignitor electrode and said auxiliary anode from said closure member through the said current supply conductors and means for controllably deforming said closure member to adjust the degree of contact of the ignitor electrode with the mercury cathode.

CARL C. HERSKIND.