Dec. 16, 1947. C. DEPEW 2,432,513

IONIC DISCHARGE DEVICE

Filed May 24, 1946 2 Sheets-Sheet 1

FIG. 1

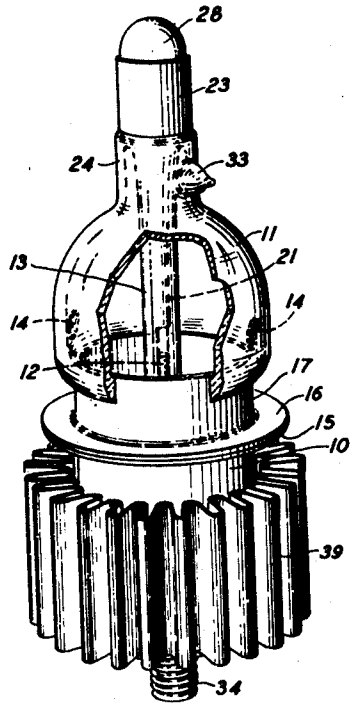


FIG. 2

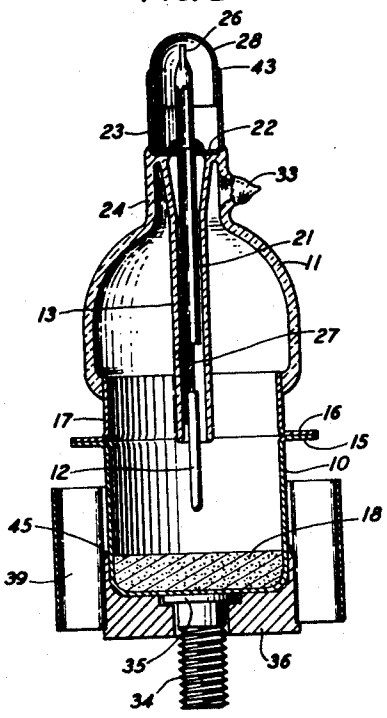


FIG. 3

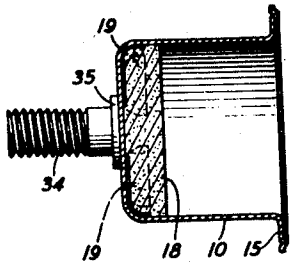
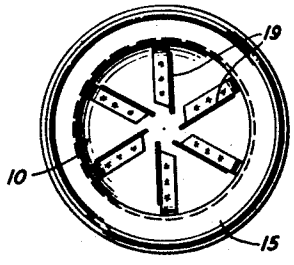


FIG. 4



INVENTOR
C. DEPEW
BY
ATTORNEY

Dec. 16, 1947. C. DEPEW 2,432,513

IONIC DISCHARGE DEVICE

Filed May 24, 1946 2 Sheets-Sheet 2

FIG. 6

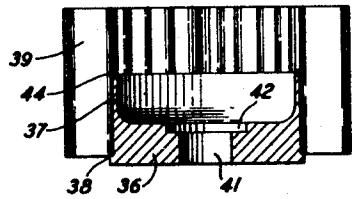


FIG. 5

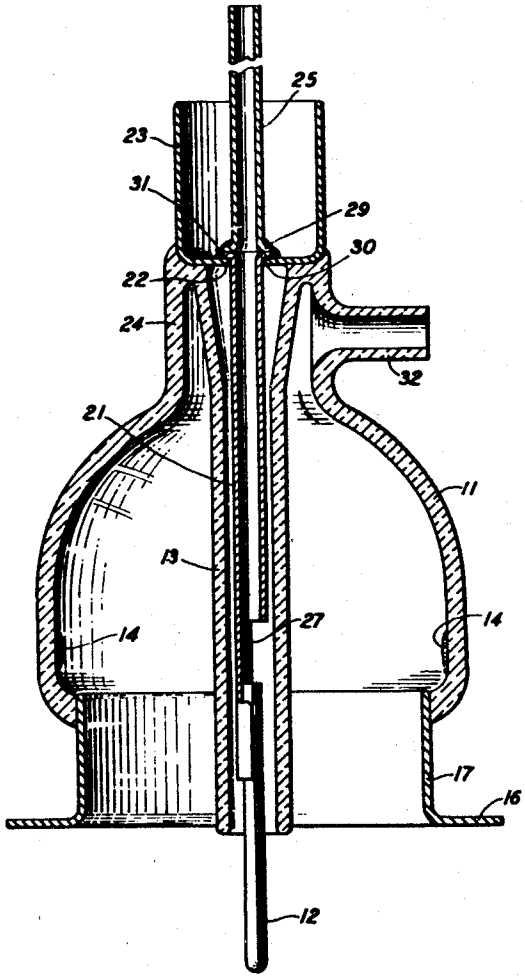


FIG. 7

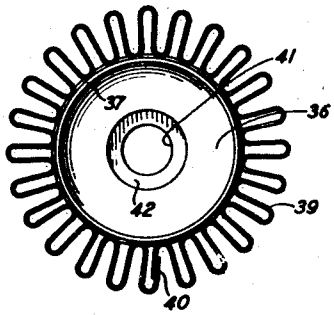
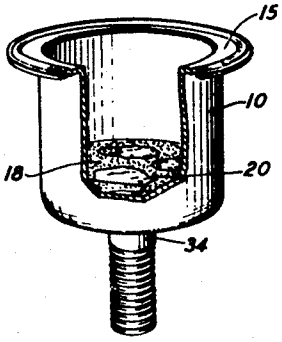


FIG. 8



INVENTOR
C. DEPEW
BY
ATTORNEY

Patented Dec. 16, 1947 2,432,513

UNITED STATES PATENT OFFICE

2,432,513

IONIC DISCHARGE DEVICE

Charles Depew, Oakland, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 24, 1946, Serial No. 672,011

15 Claims. (Cl. 250—27.5)

1

This invention relates to ionic discharge devices and more particularly to spark gap devices having a stabilized high frequency discharge of high power rating.

In high frequency pulse generating systems the intensity and pulse periodicity of the spark discharges materially shorten the duration of operating life and the stability of the discharge, due, principally, to diffusion of the cathode surface which eventually alters the space relation between the electrodes in the device and thereby deleteriously affects the operating characteristics. When attempts are made to overcome these defects by employing a non-consumable electrode surface for the cathode, such as a body of mercury, to maintain constant space relation and elimination of sputtering or diffusion of cathode material in the discharge gap, they are only of limited utility since the mercury is not held stationary if the device is mounted in operational equipment employed in a movable carrier, such as a naval vessel or airplane. In such applications, the mercury cathode device is subjected to considerable agitation thereby resulting in unstable space relation between the spark gap electrodes and consequent inefficiency in the operating characteristics of the device.

An object of this invention is to definitely insure stable equilibrium in the spark gap of ionic discharge devices.

Another object of the invention is to increase the operating life of such devices by maintaining a constant space relation between the electrodes in the device.

A further object of the invention is to efficiently dissipate heat energy in the device whereby excessive vaporization of the cathode material is eliminated.

Another object of the invention is to improve the fabrication of the assembly of the device so that a rugged construction is realized.

Another object of the invention is to facilitate the mounting of the device in operational equipment in order to insure positive connection of the electrodes to the power source.

A further object of the invention is to increase the over-all rigidity of the device so that it can withstand severe operating conditions without affecting the disposition of the electrodes in the device.

These objects are attained in accordance with this invention in a high frequency spark gap discharge device capable of operating with high efficiency and constant uniformity over a long period to supply a high power output of unvarying amplitude, by an assembly involving a cathode cup forming a portion of the enclosing vessel, which is sealed to a vitreous portion supporting an anode structure centrally mounted within the enclosing vessel and operatively spaced in relation

2

to a porous sintered metallic mass anchored in the cathode cup and saturated with mercury. This construction insures stability in the relationship of the cathode surface with respect to the anode in the gaseous discharge gap within the device and materially increases the dielectric resistance between the electrodes due to the fabrication of the anode on the opposite end of the enclosing vessel.

A feature of the assembly relates to the juncture of the vitreous portion with the cathode cup portion of the vessel. This is accomplished by forming a flange on the cathode cup and sealing a flanged ring to a vitreous dome portion, the flanges on the cup and ring being subsequently welded together to hermetically seal the enclosing vessel.

Another feature of the invention relates to the fabrication of the porous metallic mass within the cathode cup and the anchoring of the mass therein. The internal base of the cathode cup portion is provided with radial projections which are embedded in a metallic powder mass pressed into the cup and subsequently sintered to form a rigid sponge which is saturated with mercury.

A further feature of the invention relates to the radiation and dissipation of heat energy from the cathode whereby excessive vaporization of mercury in the discharge gap is prevented. The construction includes a solid cup member of high heat conduction material affixed to the base of the cathode body and a large area heat radiator in the form of a folded or corrugated sheet material of high heat conductivity rigidly attached to the solid cup member to carry away the heat generated in the spark discharge.

Another feature of this construction relates to the anchoring of the device in the operating equipment to insure rigid mounting of the assembly and to provide a positive terminal contact for supplying power energy to the cathode of the device. This construction involves attaching a screw terminal centrally through the solid radiator cup member to the cathode base to permit ready mounting of the device and to serve as the current conductor for the cathode.

A further feature of the invention relates to the assembly of the anode from the opposite end of the vessel and the combined anode standard, exhaust outlet and terminal contact hermetically sealed to the vitreous portion of the vessel for insulating the anode from the cathode in the device. This mounting comprises an inverted cup terminal sealed to a neck portion of the vitreous dome portion of the vessel, the cup being provided with an axial tubular standard or support extending into the cathode portion of the vessel and a tubular continuation extending outwardly from the cup terminal. The standard is slotted opposite the cathode and supports a rod anode of

highly refractory metal which is accurately mounted to provide the desired space relation to the plane surface of the sintered sponge mass anchored in the cathode cup. The tubular standard is protected from the discharge by an insulating sleeve which forms a part of the hermetic seal between the neck portion and the terminal cup.

Another feature of this construction relates to the evacuation and the filling of the device with a gaseous mixture and the protection of the exhaust tip within the anode terminal assembly. This arrangement utilizes the tubular standard and exhaust tubulation which forms a continuous passageway to the interior of the vessel to remove air and occluded gases from the enclosure and to attain a high vacuum in the device so that a definite pressure of pure inert gases, such as hydrogen and argon, may be injected into the device prior to sealing off the tubulation. The sealed termination of the exhaust connection is permanently protected by a dome cap enclosing the seal and fitted into the anode terminal cup.

The complete assembly insures a rugged spark gap discharge device of high efficiency, long life and freedom from diffusion of cathode material in the discharge gap. Furthermore, the saturated porous mass in the cathode facilitates the operation of the device notwithstanding the unstable equilibrium of the vehicle or carrier in which the device is located or the intense shock and continuous vibration such as may be encountered on board naval vessels and combat aircraft.

The above-noted and other features and advantages will be more fully apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view of the complete assembly of a device illustrative of this invention, a portion of the vessel being broken away to show the internal assembly;

Fig. 2 shows a cross-section view in elevation illustrating details of construction of the device shown in Fig. 1;

Fig. 3 is a side view in cross-section of the cathode portion of the device with the anchored porous mass in the base of the cathode;

Fig. 4 is a plan view of the cathode assembly showing the radial anchor members in the bottom of the cathode, these anchors being embedded in the mass, as shown in Fig. 3;

Fig. 5 is an enlarged cross-sectional view showing details of assembly of the anode portion of the device;

Fig. 6 is a cross-sectional view in elevation of the radiator assembly which is affixed to the exterior of the cathode, as shown in Fig. 2;

Fig. 7 is a plan view of the radiator assembly; and

Fig. 8 is a perspective view of the cathode portion of the device, shown partly broken away, to illustrate the excess mercury collected on the surface of the porous mass therein.

Referring to the drawings, and particularly to Figs. 1 and 2, the invention is shown, in a specific example, as a high voltage spark gap pulse generator device for high frequency pulsing systems capable of producing pulse vibrations of high periodicity and having a relatively long operating life with substantially constant characteristics. The device comprises a vacuum-tight sealed vessel or receptacle having an external metallic cup-shaped cathode portion 10 forming the lower end of the vessel and a dome-shaped vitreous insulating portion 11 forming

the top end of the vessel. The portion 11 supports a rod anode 12 axially within the cathode portion and insulated from the cathode over a long path of high resistance. In addition, the anode is shielded within the vessel by an elongated insulating sleeve 13, to insure the discharge path from the cathode being confined to the anode, which is preferably formed of a highly refractory metal, such as molybdenum, having a high melting point and a relatively low diffusion rate.

The vessel is filled with a gaseous mixture, preferably hydrogen and argon of equal proportions, at a pressure of the order of 72 centimeters of mercury or slightly below one atmosphere, to provide an ionizable conduction medium for the generation of the spark discharge between the electrodes in the device. The initiation of the discharge is aided by the presence of free electrons in the discharge space by applying spots of radium bromide 14 to the inner wall of the vitreous portion 11, this material being decomposed in the final processing of the device to provide elemental radium in the vessel.

The cathode cup portion 10 is preferably formed of a nickel-iron-cobalt alloy, which has a low thermal coefficient of expansion, and the cup is provided with a peripheral flange portion 15 at the open end which is joined to a complementary flange portion 16 on an auxiliary sealing ring 17, also formed of said alloy. The ring 17 is directly and hermetically sealed to the large diameter end of the vitreous dome portion 11 of the vessel. The latter is preferably one of the hard boro-silicate glasses, such as 7052 glass, made by the Corning Glass Company, the glass having substantially the same coefficient of expansion of the said alloy, to produce a substantially strain-free sealed joint at the juncture of the seal between these materials.

A porous sintered compact 18, of iron powder, is located in the base portion of the cathode cup 10 and is anchored therein by a plurality of angular strips 19, as shown in Fig. 4, arranged in radially distributed formation so that they are embedded in the compact 18, as shown in Fig. 3, to rigidly secure the compact in the base of the cathode. The porous metallic mass 18 is saturated with predistilled mercury 20 which forms the primary non-consumable cathode material for the generation of the spark discharge in the device.

The anode rod 12 is supported from the dome glass portion 11 by a tubular metallic standard 21 which is coaxially mounted in an apertured base 22 of a cup terminal member 23, preferably formed of said alloy, since the base portion 22 is directly sealed to a neck portion 24 of the glass dome 11 and the concentric elongated sleeve 13 to form a vacuum-tight sealed joint at the upper terminal end of the vessel. A tubular extension 25 is aligned with the standard 21 and sealed in abutting relation to the standard within the cup terminal, the extension being sealed off at 26 after the evacuation and gas-filling processes of the device are completed through the slot opening 27 in the standard. The seal 26 is protected by a nickel-plated brass cap closure 28 which is soldered in the cup terminal 23.

In the manufacture of the device, in accordance with a feature of this invention, the two portions of the enclosing vessel and the respective electrodes supported thereby are individually fabricated as separate units, as shown in Figs. 3

and 5 respectively, to eliminate contamination and oxidation of the ferrous sponge-like mass 18. A particular advantage of this construction will be realized from the fact that if the dome glass portion 11 were sealed to the cathode cup portion, the intense heating conditions for attaining the sealed joint would oxidize the surface of the sintered compact 18 and result in the porous mass being resistant to absorption of the mercury saturant necessary in the operation of the device. In other words, the oxidation of the ferrous compact would render the mass substantially immiscible to the mercury so that saturation would be prevented. If this condition occurs, the mercury will merely collect on the surface of the compact, thereby altering the critical space relation to the point of the anode which determines the operating characteristics of the device. Furthermore, the body of free mercury would be subjected to all the disadvantages which the invention is intended to overcome, since tilting of the device would vary the spark gap spacing and continued exposure of the compact to discharge breakdown would cause disruptive attacks of the iron mass and the iron particles would immediately be diffused and result in unstable operation and consequent destruction of the device for the purpose for which it is intended. However, the welded seal formed at the conjoint flanges of the ring 17 and the cathode cup 10 does not produce the prolonged heating conditions which endanger the easily oxidizable material of the compact so that this seal may be accomplished without deleterious effects on the operation of the device.

In the production of the device, in accordance with a feature of this invention, the cathode assembly is fabricated as follows: After the metal alloy cup 10 is formed with the flange 15, as shown in the drawings, it is chemically cleaned to remove grease and lubricants employed in the forming process. In addition, the formed alloy cup must be freed from occluded gases and contaminants which requires a heat treatment in a hydrogen furnace at a temperature of 1100° C. for approximately one-half hour. The cathode cup is now ready for the introduction of the porous metal compact 18 which provides the cathode surface in the discharge gap. The flanged or angular anchors 19 which are preferably formed of cold rolled steel strips are spot-welded on the flat inner surface of the cup in radial formation with the outer ends of the welded portions being bent to follow the curvature of the base of the cup and the other flange portions extending perpendicularly to the flat surface of the cup and equally spaced in fan fashion over the surface of the cup.

A quantity of fine particle iron powder, for example, 25 grams, preferably of high purity carbonyl iron particles, of a size between 5 to 8 microns, is poured into the cathode cup 10 to completely cover the anchor strips 19 and the loose powder is equally distributed to form a level mass filling the bottom of the cup. The powder mass is compacted by pressing under a load of 3,000 pounds per square inch to form a cake of compact particles having a thickness of approximately one-quarter the length of the cup. The compact 18 is then heat treated in a furnace at a temperature of 1000° C. for one hour while passing hydrogen therethrough, to thoroughly clean the iron mass and completely sinter the particles together. This treatment removes entrapped gases in the compact so that the resultant mass

is porous like a sponge and while some shrinkage is produced in the compact, nevertheless, the mass is definitely anchored by the angular strips to insure permanence of the compact in the cathode cup. After the above heat treatment is completed, the easily oxidizable iron mass is protected from the atmosphere by storing in a desiccator until ready for sealing to the anode portion of the device.

The construction of the anode portion of the device, as shown in Fig. 5, is as follows. The metallic tubular members 25 and 21 are provided with short flange portions 29 and 30 respectively, to form abutting surfaces which can be spot-welded in the base portion 22 of the terminal cup 23, to form a linear conduit leading to the slotted portion 27 in the standard 21 supporting the anode rod 12. While both tubular members may be formed of a rigid material, such as steel, it is preferable to form the standard 21 of said alloy to avoid setting up stresses in the glass seal formed on the base of the terminal cup 23. A further precaution taken to avoid leaks at the welded seam joint of the abutting flanges 29 and 30 within the cup is the braze-soldered joint formed by melting copper rings 31 which melt at a temperature of 1100° C. around the flanges to form a tight union at this point. The dome glass portion 11 of the vessel is sealed at the larger end to the alloy ring 17 and the neck portion 24 is sealed together with the sleeve 13 to the base of the terminal cup 31, the said alloy parts, namely, the standard 21, cup 23 and ring 17 being previously heat treated before assembly in the same manner as described in connection with the cathode cup 10. The neck portion 24 of the dome-shaped glass portion 11 is also provided with a side tube outlet 32, the purpose of which will presently be described. After the above sealing operations are completed, the spots of radium bromide 14 are applied to the inner surface of the dome glass portion adjacent the ring 17, although there is no restriction on the placing of these spots as long as they are somewhere in the enclosed vessel, to supply the free electrons for initiation of the discharge. The completed anode assembly, as shown in Fig. 5, is then combined with the previously completed cathode assembly, by welding the abutting flanges 16 and 15 together in a ring-welding machine, to hermetically seal the two portions of the vessel together and accurately space the rounded point of the anode 12 with respect to the plane surface of the porous compact 18 in the cathode cup 10.

The device is connected to a high vacuum pump station through the glass tubulation 32 and the tubular extension 25 connected to a receptacle containing the predistilled mercury, a supply of purified hydrogen flushing gas, and the hydrogen-argon filling gas mixture for the following procedure. After the high vacuum pump has operated to remove gases and produce a low pressure in the enclosing space in the device the glass walls are thoroughly baked to remove water vapor. At the same time the cathode cup 10 containing the sintered compact 18 is heated, preferably by high frequency induction to a temperature of 800° C. When the compact 18 is up to temperature, the interior of the enclosure is thoroughly flushed with hydrogen three or four times by injecting hydrogen through the conduit 25 and removing the hydrogen through the tubulation 32 connected to the high vacuum station. In this operation, the glass sleeve 13 serves an additional purpose by directing the flow of gas

through the tubulation 25 and slot 27 of the standard 26, so that the hydrogen is directed toward the compact 18 to thoroughly flush the iron mass and decompose any iron oxides formed on the surface. After this deoxidizing treatment a measured quantity of predistilled mercury, for example, 65 grams, is permitted to flow through the extension 25, to saturate the porous plug 18 in the bottom of the cathode cup, the tubulation 32 being sealed off at 33, as shown in Fig. 2. The quantity of mercury is sufficient to thoroughly saturate the porous compact and provide a slight excess which, although shown as a small pool 20 on the surface of the compact in Fig. 8, is actually a mirrored surface on the plane of the compact with the shrinkage space around the compact, caused by sintering, being filled with the fluid mercury. The vessel is filled with the desired hydrogen-argon mixture of inert gases to the pressure of the order of 72 centimeters of mercury, to provide the ionizing atmosphere in the discharge and after this is completed the tubulation 25 is sealed off at 26, as shown in Fig. 2, and the device is removed from the pump station. The cap 28 is soldered in the terminal cup 23 by a low melting point solder 43 composed, for example, of 45 per cent tin and 55 per cent lead which melts at a temperature of 180° C. If desired, the tubulation 32 may be eliminated and the device completely processed through the linear conduits 25 and 27 for evacuating, flushing, mercury filling and gas filling if provisions are made for handling these operations through the pumping system.

The high tension operation of the device for attaining the high power output attainable with the device necessarily creates an intense spark discharge in the gap between the anode 12 and the cathode surface 18 and vaporization of the cathode material, namely, mercury, naturally ensues in the operation of the device. However, since this material readily condenses on the cooler glass portion of the vessel, the mercury is returned to the compact reservoir and aids in protecting the compact from direct disruptive discharge which would cause diffusion of the iron with consequent variation in the critical spacing of the discharge gap between the electrodes. Accordingly, it is desirable to prevent excessive vaporization of the mercury and this is accomplished by dissipating the heat energy generated in the discharge gap so that the ambient temperature of the mercury body in the pores of the compact is held at a minimum. This is produced by enclosing the greater portion of the cathode cup in a heat radiator of large area, to dissipate the heat energy generated in the spark gap discharge device. Before applying the heat radiator to the cathode portion, a terminal screw 34 having a head 35 centrally in contact with the bottom of the cathode cup 10 is affixed thereto by welding. The terminal screw is preferably formed of steel having a nickel plating, to prevent oxidation of the terminal. The radiator assembly, as shown in Figs. 6 and 7, includes an apertured cup member 36, of large mass formed of material having a high heat conductivity, such as copper. The radiator cup is machined to fit the base of the cathode cup with the side walls 37 extending up to the surface of the compact 18 within the cathode cup 10, the outer surface of the member 36 having a ledge 38 formed on the lower rim. This ledge provides a seat for a wide ribbon corrugated radiator 39, preferably formed of copper sheet, and folded back and forth to form a large

radiating surface having the ends brought together at 40, to form an annular body fitting closely over the exterior of the cup 36. The radiator cup is also provided with a central aperture 41 and a large recess 42 coaxial therewith to clear the terminal 34 and the head 35 thereof, as shown in Fig. 2, the radiator cup also mechanically securing the terminal to the cathode. The large surface radiator 39 is rigidly secured to the radiator cup 36 by a high melting point solder 44, for example, of 65 per cent silver, 25 per cent copper and 10 per cent zinc, which has a melting point of 700° C. The radiator assembly is affixed to the cathode cup by soldering or brazing with a solder composition 45, for example, of 85 per cent tin and 15 per cent silver, which has a melting point of 220° C. The heat radiator efficiently dissipates the heat generated in the device so that efficient operation is attained over a long operating life and stable operation of the discharge is secured notwithstanding the intense energy created in the spark discharge gap between the electrodes.

While the invention has been disclosed with respect to a particular construction of the device, in accordance with this invention, it is, of course, understood that various changes may be made in the detailed assembly without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An ionic discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a sintered porous mass within said cup portion, a conducting fluid material saturating said mass, a plurality of metallic anchor members mounted on the base of said cup portion and embedded in said mass, and a rod anode supported by said dome portion and axially projecting toward said mass but spaced therefrom.

2. An ionic discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a sintered metallic powder sponge having a plane surface filling the bottom of said cathode portion, said sponge being saturated with fluid cathode material, anchor elements embedded in said sponge and secured to said cathode portion, and a rod anode supported by said dome portion and axially projecting toward said sponge.

3. An ionic discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a sintered metallic powder sponge filling the bottom of said cathode portion, a quantity of mercury saturating said sponge, the excess thereof barely covering the surface of said sponge, radial anchor elements embedded in said sponge and secured to said cathode portion, and a rod anode supported by said dome portion and axially projecting toward said sponge.

4. An ionic spark gap discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a sintered porous mass within said cup portion, a quantity of mercury saturating said mass, a plurality of angular metallic anchors projecting from the base of said cup portion and being embedded in said mass, and an anode extending from said dome portion and spaced in operative relation with respect to the surface of said mass.

5. An ionic spark gap discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a

sintered porous mass within said cup portion, a quantity of mercury saturating said mass, a plurality of metallic strips affixed to the base of said cup portion in spaced relation and having bent angular longitudinal and end curved portions projecting into and being embedded in said mass, and a rod anode supported by said dome portion and projecting toward said mass.

6. An ionic discharge device comprising a metallic cup-shaped cathode, a dome-shaped glass vessel sealed to said cathode, a metallic cup member sealed to the top of said glass vessel, a pair of linear tubular members having flanged ends in abutting engagement secured coaxially within said cup member, and an anode rod attached to one of said tubular members and extending toward said cathode.

7. An ionic discharge device comprising a metallic cup-shaped cathode, a dome-shaped glass vessel sealed to said cathode, a metallic cup member sealed to the top of said glass vessel, a pair of linear tubular members coaxially secured within said cup member, an anode rod attached to one of said tubular members and extending toward said cathode, and a threaded terminal contact centrally attached to the exterior of said cup-shaped cathode.

8. An ionic spark gap discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a porous metallic compact within said cup portion, said compact being saturated with mercury, a rod anode supported by said dome portion and projecting toward said compact, a solid metallic heat radiating base joined to said cathode cup portion over an area confined to the porous compact therein, and a plurality of heat radiating fins projecting from said base.

9. An ionic spark gap discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a sintered powder sponge filling the base of said cup portion and saturated with mercury, a rod anode supported by said dome portion and projecting toward said sponge but spaced therefrom, a solid metallic heat radiating base joined to said cup portion, and a large area folded heat radiator encircling said base, the longitudinal dimension thereof being greater than that of said base.

10. An ionic spark gap discharge device comprising an enclosing vessel having a metallic cathode cup portion and a vitreous dome portion, a sintered metallic porous mass anchored in said cup portion and saturated with mercury, a rod anode supported by said dome portion and projecting toward said mass, a solid metallic heat radiating base joined to said cathode cup portion over an area confined to the porous mass therein, and an annular folded ribbon heat radiator engaging said base and partially surrounding said cathode cup portion above the plane of said mass enclosed therein.

11. An ionic spark gap discharge device comprising an enclosing vessel having a vitreous dome portion and a metallic cup portion sealed thereto, a gaseous mixture therein at a pressure for ionizable conduction, a sintered powder mass filling the base of said cup portion, said mass being saturated with mercury, a metallic cup terminal having a base portion sealed to the top of said dome portion, a slotted tubular metallic standard extending through said cup terminal, and a rod anode supported by said standard within said vessel in axial spaced relation to the surface of said sintered mass, the opposite end of said standard being sealed within said cup terminal.

12. An ionic spark gap discharge device comprising an enclosing vessel having a vitreous dome portion and a metallic cup portion sealed thereto, a gasecus mixture therein at a pressure for ionizable conduction, a sintered powder mass filling the base of said cup portion, said mass being saturated with mercury, a metallic cup terminal having a base portion sealed to the top of said dome portion, a slotted tubular metall c standard extending through said cup terminal, a rod anode supported by said standard within said vessel, the opposite end of said standard being sealed within said cup terminal, and a protective metallic cap affixed to said terminal and covering said sealed standard.

13. An ionic spark gap discharge device comprising an enclosing vessel having a vitreous dome portion and a metallic cup portion sealed thereto, a gaseous mixture therein at a pressure suitable for ionizable conduction, a sintered powdered mass filling the base of said cup portion, said mass being saturated with mercury, a metallic cup terminal having a base portion sealed to the top of said dome portion, a tubular member having a cut-out portion at one end and a flange portion at the other end extending within said metallic cup terminal, a solid anode rod affixed to said member adjacent said cut-out portion and spaced with respect to the surface of said sintered mass, a short metallic tubulation having a flange portion within said cup terminal, the flange portions of said tubular member and tubulation being disposed in abutting relation and anchored to the base of said cup terminal, and an insulating sleeve surrounding said tubular member and sealed to said dome portion.

14. An ionic spark gap discharge device comprising an enclosing vessel having an insulating dome portion and a metallic cup po.tion, said cup portion having a bordering flange projecting outwardly therefrom, a porous mass of carbonyl iron particles secured in the base of said cup portion and saturated with mercury, an anode supported from said dome portion, and a flanged metallic ring member sealed to the rim of said dome portion and hermetically joined to said bordering flange of said cup portion.

15. An ionic spark gap discharge device comprising a metallic external cathode cup having a sealing flange on the open end, a sintered porous iron plug rigidly held in said cup, a quantity of mercury in said cup sufficient to saturate said plug and provide a slight excess over the surface thereof, a metallic ring having a flange at one end complementary to said flange on said cathode cup, said flanges being welded together, a dome-shaped glass vessel sealed to said ring and having a neck portion on the other end, an elongated insulating sleeve coaxially mounted within said glass portion, a small diameter metallic cup terminal having an apertured base hermetically sealed to said neck portion and insulating sleeve, a tubular support within said sleeve and sealed through said base of said cup terminal, said tubular support being sealed at its outer end, and a rod anode projecting from the other end of said support and spaced from the surface of said plug.

CHARLES DEPEW.