

March 14, 1950

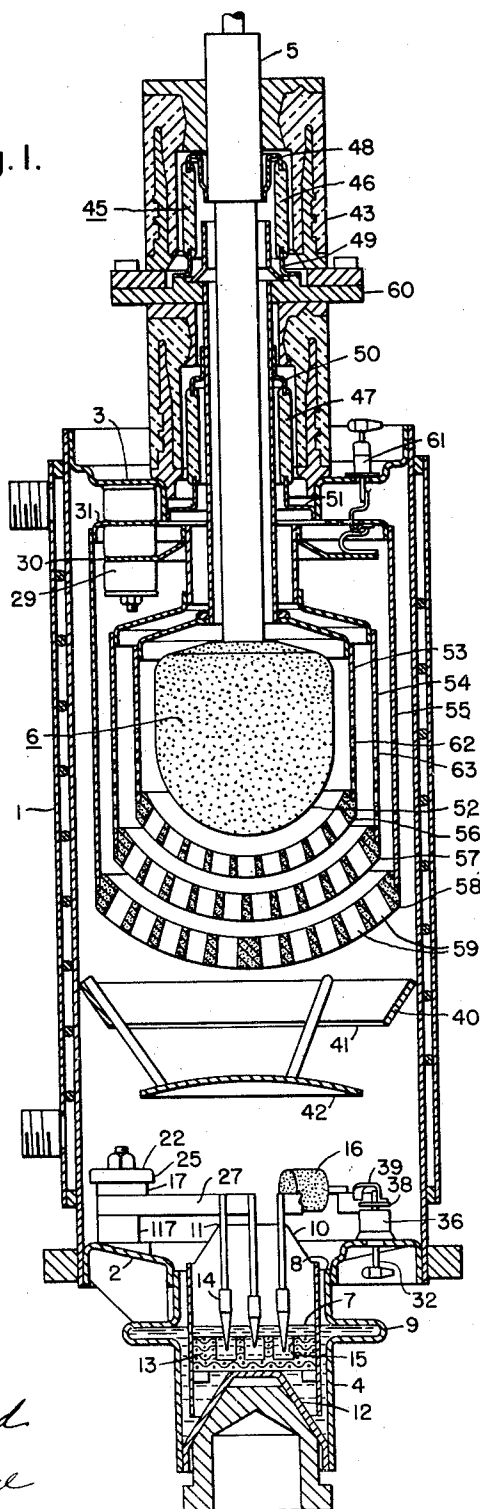
S. M. CORK ET AL
TILTING CATHODE FOR IGNITRON

2,500,153

Filed March 26, 1949

2 Sheets-Sheet 1

Fig. 1.



WITNESSES:

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2 Sheets-Sheet 2

Fig. 2.

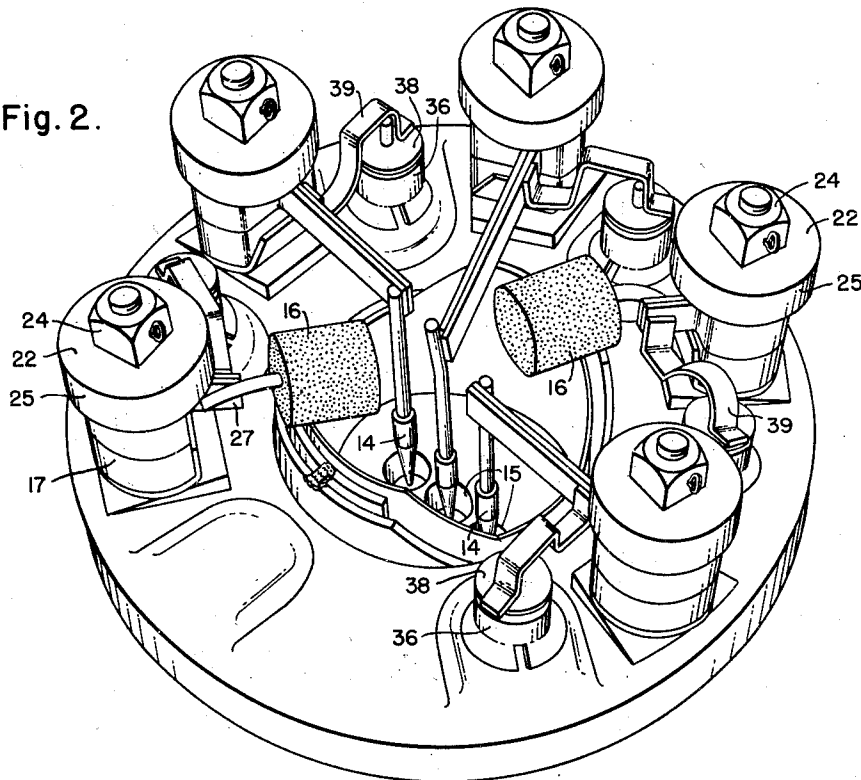
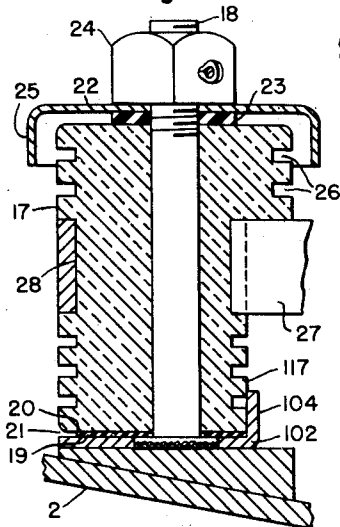


Fig. 3.



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Fig. 4.

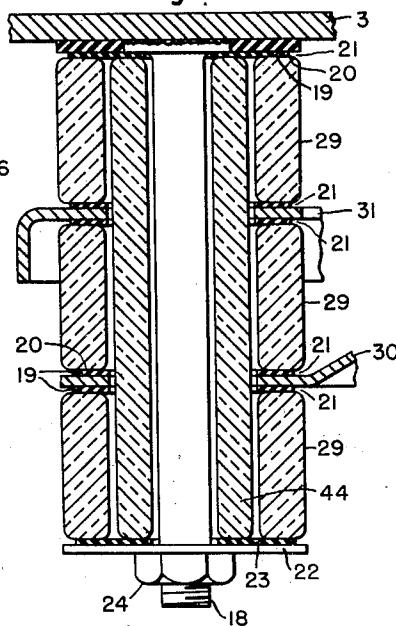
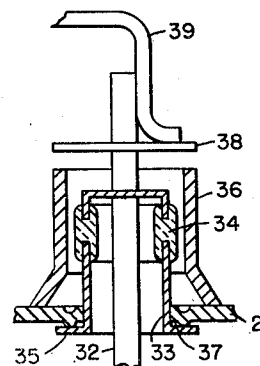


Fig. 5.



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TILTING CATHODE FOR IGNITRON

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10 Claims. (Cl. 250—27.5)

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Our invention relates to a vapor-electric device and particularly to a substantially shock-proof electric valve to be utilized on moving vehicles such as ships, locomotives and the like.

Vapor-electric devices, such as the ignitron, have been developed to a point where, in relatively stationary mountings, they are delivering very reliable service over long periods of time. However, when an attempt is made to utilize these devices on moving platforms, such as vehicles, the shock and vibration produced by the motion of the vehicles has produced serious inconveniences and unreliability in the operation of the devices.

According to our invention, we have constructed a vapor-electric device in which the inconveniences resulting from shock and vibration are substantially eliminated and in which the various component parts operate with substantially the same reliability as has heretofore been obtained in stationary devices. Not only does the shock tend to hurl portions of the liquid cathode material about the container with great violence but also the component parts such as the electrodes, the various seals and insulators are also shaken about and frequently damaged either by the mechanical stresses set up by the motion or by electrical stresses presumably intensified because of the presence of liquid cathode material at unexpected portions in the container or because of the mechanical movements of the various parts.

The various exciting electrodes utilized to establish and maintain a cathode spot on the cathode material have heretofore been directly mounted on the lead-ins for such electrodes. However, in a moving device, the weight of the electrodes will either bend the lead-in stems or crack the insulating bushings or otherwise seriously interfere with the normal operation of the device. To counteract this, we have provided separate insulating supports for the electrodes coupled with separate lead-in bushings of relatively low inertia.

Also, it has been found that in this type of service cathode spots occur at the junction of insulating and conducting materials and while the exact reason for such appearance is not known, we believe that the accumulation of dirt and possibly small particles of cathode material at the junction of the insulating and metallic portions have tended to the accumulation of electric charges which break down and establish a cathode spot substantially in the same manner as the ignitors establish a cathode spot on the

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liquid electrodes. However, regardless of the method of formation of these undesirable or parasitic cathode spots, we have found that by shading the junction of the metal and insulating material, these unwanted cathode spots are substantially eliminated.

Considerable difficulty has also been encountered because of the suspended mass of the major electrodes, such as the anode and the anode shields. It has accordingly been found necessary to use a method of supporting the anode so that it is mechanically supported by reinforcements of the vacuum seals between the container and the anode stem and to make these vacuum seals of a relatively thin material having relatively small mass. Also, we have provided a method of mounting the anode shields so that they are substantially rigid regardless of the motion of the container.

We have further found that by shaping the anode shields they can be made to substantially withstand even heavy masses of cathode material which might be hurled against them without damage or material transmission of the cathode liquid to the anode surfaces. Also, we have found that by making the active shield surfaces as a segment of a sphere, they not only have great mechanical strength but present a maximum of opening for the passage of the current-carrying arc itself.

Because of the relatively great movement of portions of the cathode material, there is a tendency to carry into the cathode a substantial amount of foreign material such as material eroded off the anodes, the shields or other portions of the devices so that in time the cathode becomes polluted and the reliability is materially affected.

Accordingly, we have provided a collecting shield so that the cathode material returns to the cathode between the edge of the cathode cup and the shield which extends from, or above the upper edge of the cathode cup to a point substantially at the bottom of the cup whereby foreign material is trapped between the dirt shield and the edge of the cup, and the cup itself, together with the shield, is contoured so that as the cathode material is inclined in various directions, it will not overrun the edge of the cup or of the dirt-collecting shield.

In order to prevent portions of the cathode material from being thrown out of the cup by violent motion transmitted to the container, we have filled the cathode pool substantially to the normal working level with a mass of metallic

mesh material and anchored the same firmly to the inside of the cup. Preferably, the mesh material is provided with relatively small openings so that the cathode material will freely flow therethrough at a relatively low speed, but will be impeded when it moves at high speed, so that there is little tendency for the cathode material to be thrown off because of violent motion imparted to the container.

In order to prevent cathode material from random motion from the cathode in the direction of the anode, we have provided a cathode shield directly above the cathode cup and firmly anchored to the container so that any mass of material striking the shield will be deflected towards the bottom portion of the container. To prevent loose cathode material from ascending along the wall of the container, a baffle plate having annular shape is rigidly secured to the side of the container so that any cathode material running along the side of the container will be intercepted and returned to the vicinity of the cathode.

It is accordingly an object of our invention to provide a substantially shockproof vapor-electric device.

It is a further object of our invention to provide an improved cathode assembly for a vapor-electric device.

It is a further object of our invention to provide an improved mounting for the electrodes of a vapor-electric device.

It is a further object of our invention to provide mountings which will rigidly hold the various elements in position.

It is a further object of our invention to provide insulating mountings which are protected against unwanted cathode spot formations.

Other objects and advantages of our invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a sectional elevation of a vapor-electric valve according to our invention;

Fig. 2 is a perspective view of a cathode assembly according to our invention;

Fig. 3 is a sectional elevation through an insulating support according to our invention;

Fig. 4 is a modification of the insulating support as shown in Fig. 3; and

Fig. 5 is a shielded lead-in connection according to our invention.

According to the exemplary embodiment of our invention, the vapor-electric device comprises an evacuated metallic container having a substantially tubular body portion 1 closed by the bottom or cathode header 2 and a top or anode header 3. A cathode cup 4 of relatively small diameter is set into the cathode header 2 and an anode stem 5 is attached to and extends through the anode header 3 and supports an anode 6 for cooperation with the cathode 7.

The cathode assembly comprises the substantially flat header 2 secured into the body portion 1 of the container usually by welding and has in the center thereof the cathode cup 4 of relatively small diameter compared to the diameter of the container and having the top edge 8 contoured or established at different levels so that the container may be inclined various amounts in various directions without spilling the cathode material 7 over the edge 8 of the cup 4. The lowermost point or points at the contoured rim 8 is made flush with the header 2 so that any cathode material on the header will drain into the cup 4. At a position intermediate the ends of the cup 4 and

adjacent the normal operating level of the cathode material 7, an enlargement or reservoir-like device 9 is supplied to supply sufficient cathode vapor for normal operation of the device without materially lowering the surface of a cathode material 7 in the cup 4.

In order to prevent foreign material from contaminating the surface of the mercury 7 in the cup, a dirt guard or shield 10 is provided in the form of a substantially tubular member rigidly supported inside the cathode cup 4 but spaced inwardly from the edge 8 thereof. The top edge 11 of the dirt barrier 10 corresponds in shape to the contoured edge or top 8 of the cathode cup 4. The bottom portion 12 of the cathode cup 4 is re-entrant to provide a minimum of cathode material 7 with the necessary ignitor immersion over various degrees of inclination of the valve or the cathode material 7 therein.

In order to prevent rapid movement of the cathode material 7 because of violent motion imparted to the container, a mass of mesh-like material 13 is firmly anchored in the cathode cup 4 and fills the same to just below the normal working surface of the cathode material 7. Mesh material 13 is relatively fine so that while the cathode material 7 such as mercury, gallium, cesium, rubidium, indium, potassium or sodium, may readily flow at relatively slow speeds therethrough, it will be substantially impeded when violent motion is imparted to the material.

In order to allow the starting electrodes to properly cooperate with the cathode material 7 to maintain excitation under the various operating conditions, a plurality of make-alive electrodes 14 are utilized and extend into holes or openings 15 which may be drilled or otherwise provided in the mesh-like material 13. Regardless of the motion of the cathode material, at least one or more of the openings 15 in the mesh 13 will almost certainly be provided with sufficient cathode liquid to establish contact with one or more of the make-alive electrodes 14 so that a cathode spot will be established with maximum certainty when an impulse is applied to the make-alive electrodes 14. In order to maintain the cathode spot until such an interval as the main anode 6 may pick up, we prefer to provide one or more keep-alive type electrodes 16 in the immediate proximity to the cathode surface.

In order to prevent displacement of the auxiliary electrodes 14 and 16 or the breaking of the seals, we have provided a special mounting for the electrodes 14 and 16. This mounting preferably takes the form of an insulating body or bushing 17 mounted on a pin or bolt 18 which is rigidly secured to the header 2 or other portion of the container usually by means of welding. In order to prevent direct contact of the edge of the insulator 17 with the metal of the header 2, a washer or bushing 19 is provided between the metal of the header 2 and the insulating body 17 so that the junction 20 between the metal and the insulating material 17 is shaded by a relatively deep crevice-like passage 21 to prevent formation of a cathode spot because of the accumulation of a charge for any reason adjacent the edges of the insulator 17. The top end of the insulator 17 is provided with a cap 22 which extends across the surface of the insulator 17 and is likewise protected from contact with the insulator by means of an undercut or undersized washer or bushing 23. The whole is securely attached and rigidly connected, preferably by means of a screw connection between the bolt 18 and a nut 24

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which is then pinned or otherwise rigidly secured in position after it is tightened in place. As the vibration sometimes tends to rotate the bushing 17 on the stem 18 an interlock is frequently applied. A satisfactory interlock comprises a flat surface 117 on the insulator 17 and a washer 102 having a portion 104 deformed into contact with the portion 117.

In those locations where liquid mercury or other cathode material might tend to flow on the top of the insulator 17, it is sometimes desirable to provide a skirt-like portion 25 on the cap 22 extending part way down over the surface of the insulator 17 in spaced relation thereto. It is also sometimes desirable to increase the creepage distance across the surface of the insulator 17 by providing grooves 16 or ridges on the surface of the insulating material.

In operation a conducting layer is gradually formed on the surface of the insulator in the positions exposed to the action of the arc stream. The use of the shading grooves 21 and 26 or the skirts 25 materially retards the formation of these conducting layers and greatly prolongs the useful life of the device.

The electrode support 27 is connected intermediate the ends of the insulating body 17 and rigidly connected thereto by pulling the same firmly in contact with the material and securing in that position, preferably by welding. It is desirable in most cases to provide a groove-like receptacle 28 for securing and rigidly holding the support 27 in position. As shown in Fig. 3, this may be done by providing a groove around the exterior of a substantially unitary or solid bushing 17 or, as shown in Fig. 4, this may be accomplished by providing a bushing in a plurality of sections including an inner portion 44 and a plurality of outer portions 29 which clamp the electrode supports 10 and 31 firmly between.

The lead-in connections for the auxiliary electrodes are made completely independent of the electrode supports and are constructed of as small mass as possible and securely shielded to prevent improper contact by the lead-in with the loose cathode material, and deterioration from heat or coating of the insulator by conducting matter. We prefer to construct these lead-ins as relatively small lead-in wires 32 extending in insulative relation to a relatively light thimble or eyelet 33 and sealed thereto by means of a vitreous seal 34. The eyelet 33 is then extended through a suitable opening 35 in the heater 2 or other portion of the container and secured thereto, preferably by projection welding. A sleeve-like guard or shield 36 is placed around the eyelet 33 and its insulating portion 34, preferably substantially concentric therewith and secured usually by welding to the inner surface of the header 2.

Usually, it is desired to provide an opening 37 at the bottom of the shield 36 so that any mercury or material which should be condensed or otherwise be formed inside this sleeve or shield 36 will readily drain therefrom. The shield is completed by a relative disk-like cap 38 secured to the lead-in wire 32 or stem. Preferably, the disk 38 extends over the end of the tubular shield 36 and in spaced relation thereto. A connection from the lead-in 32 to its associated auxiliary electrode 14 or 16 is provided by means of a resilient connection of low mass, preferably in the form of a laminated or multiple layer of strap-like material 39 which is secured by welding or other suitable means both to the lead-in stem

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32 and the support 27 of the electrode, preferably this strap-like connection 39 is of substantially S-shaped formation to take up any shock which might be transmitted to it.

Since in normal operation of the device, the cathode material 7 will be constantly being condensed and returned to the cathode cup 4 over the cathode header 2, it is usual that condensed cathode material or free cathode material will be found on the header 2. In the event of shock being transmitted to the container, this material has a tendency to flow up alongside of the container and could possibly be projected into contact with the electrodes at the top or anode end of the container. To prevent this, we have provided an annular baffle 40 rigidly connected to the external wall of the container and having a central opening 41 for the passage of the arc. Preferably, this annular baffle 40 is substantially cone-shaped with the little end extending in the direction of the cathode so that any cathode material coming in contact with the baffle 40 will be returned to the cathode end of the device. To further impede the flow of loose cathode material, a substantially disk-like baffle 42, preferably concave in the direction of the cathode, is rigidly mounted above the cathode cup 4 and between the anode and cathode so that any material flowing from the vicinity of the cathode will be impeded in its motion toward the anode 6.

The anode stem or anode lead-in is mechanically supported in an insulating bushing 43 which is rigidly attached to the anode header 3 and can be composed of any suitable material, although we have found that a solution of glass and mica with suitable metal supports provides a desirable rigid mounting support with great resistance to damage by impact by motion of the device. Since these rigid mechanical supports 43 offer poor vacuum seals, we have provided a vitreous metal seal 45 of small mass in parallel with and substantially independent from the supporting insulator 43. Preferably, this independent seal 45 is composed of a plurality of vitreous sleeves 46—47 having sealing bushings 48—49—50—51 sealed into the vitreous sleeves 46 or 47 and welded to various portions of the anode stem 5 or header 3. The anode 6 itself is supported at the lower end of the anode stem 5 and the working face comprises a spherical sector 52 to provide a maximum of working face for a given diameter. In insulations having severe shock the anode 6 may be mounted on the insulating supports and the anode lead-in may be only strong enough to properly carry its own weight. The anode shields 53—54 and 55 are constructed as substantially concentric cylinders rigidly mounted in various portions of the container and having the working faces concentric and closely spaced to each other or to the anode so that the working faces of the anode shields 53, 54, 55 are likewise spherical segments 56, 57 and 58 which are provided with a plurality of passages 59 for the major current carrying arc in the device. This spherical shape not only gives great mechanical strength from shock or from contact with flying portions of cathode material but also provides a maximum of passage opening for the diameter of the anode shield. As the concentric anode shields approach the anode 6 the spherical faces are of smaller area. In order to increase the effective arc area we provide lateral passages 62 in the inner shield 53 and lateral passages 63 in the intermediate shield 54. The lateral passages 62 and 63 are sufficient in num-

ber to produce approximately the same arc concentration in the passages at each shield. The shields 53 and 54 are usually constructed of refractory metal to prevent burning.

The innermost shield 53 conforms substantially to the shape of the anode 6 and its anode stem 5 so that the shield 53 is effective throughout substantially the full length of the anode 6 and its lead-in stem 5. It is preferably anchored intermediate the insulating support 43 for the anode stem 5 and if desired may be supplied with control potential at its mounting point 60. The anode shields 54 and 55 are preferably mounted on the anode header 3 by means of rigid insulating supports such as disclosed in Fig. 3 or 4 and hereinbefore described. If desired, lead-in connections 61 similar to the lead-in connections for the auxiliary cathode electrodes 14 or 16 may be supplied for the various anode shields. We prefer to utilize insulator supports of the type shown in Fig. 3 for the cathode electrodes and to utilize the type shown in Fig. 4 for the anode electrodes or shields, but obviously either type may be used at either position.

While for purposes of illustration, we have shown an exemplary embodiment of our invention and described our invention to the best of our present ability, we desire it to be understood that further changes and modifications can be made therein without departing from the true spirit of our invention or the scope of the appended claims.

We claim as our invention:

1. In a vapor-electric device having a metal container, an electrode support comprising an insulating bushing, a metal fastening member securing said bushing to a portion of said container, an interlock to prevent relative movement of said bushing with respect to said container, a metallic shield attached to the fastening member and covering the end of the bushing remote from the portion of the container, a skirt on said shield extending in spaced relation to a portion of the sides of said bushing and an electrode support secured intermediate the ends of said bushing.

2. In a vapor-electric device having a metal container, an electrode assembly comprising an insulating bushing, a metal fastening member securing said bushing to a portion of said container, an interlock to prevent relative movement of said bushing with respect to said container, a metallic shield attached to the fastening member and covering the end of the bushing remote from the portion of the container, a skirt on said shield extending in spaced relation to a portion of the sides of said bushing and an electrode support secured intermediate the ends of said bushing, a lead-in extending through a portion of the container, an insulating seal between said lead-in and said container, a sleeve surrounding said lead-in in spaced relation thereto, said sleeve being secured to said container, a disk-like shield secured to the lead-in and extending in spaced relation to the end of the sleeve and a resilient conductor attached to said lead-in and said electrode support.

3. In a shock resistant vapor-electric device, a cathode assembly comprising a metal header, a deep cathode cup secured to said header, the top of said cup being contoured and having the lowermost portion of the edge flush with the header, a dirt screen in said cup, said screen conforming in shape to the contour of the cup and extending in spaced relation to the side of the cup to a

point adjacent the bottom of the cup, a quantity of liquid cathode material in said cup, a mass of wire mesh firmly secured in said cup and extending substantially to the normal operating surface position of the cathode liquid, a shield firmly anchored above the cathode cup, a plurality of exciting electrodes cooperating with said cathode, each of said exciting electrodes being firmly mounted on said cathode header by means of an insulating bushing, a metal fastening member securing said bushing to a portion of said container, an interlock to prevent relative movement of said bushing with respect to said container, a metallic shield attached to the fastening member and covering the end of the bushing remote from the portion of the container, a skirt on said shield extending in spaced relation to a portion of the sides of said bushing and an electrode support secured intermediate the ends of said bushing, a lead-in extending through a portion of the container, an insulating seal between said lead-in and said container, a sleeve surrounding said lead-in in spaced relation thereto, said sleeve being secured to said container, a disk-like shield secured to the lead-in and extending in spaced relation to the end of the sleeve and a metallic strap conductor attached to said lead-in and said electrode support.

4. In an electric discharge device having a metallic header, an insulating support on the inner side of said header, an electrode rigidly mounted on said insulator, a lead-in independent of said support and a resilient connection between said lead-in and said electrode.

5. In an electric discharge device having an evacuated container, a metal header, a cathode cup secured in said header, an insulating bushing secured on the inner side of said header, a metal cap secured at the top of said bushing, skirts on said cap extended in spaced relation to a portion of the sides of said bushing, an electrode support rigidly secured to said bushing intermediate the ends thereof, an electrode attached to said support, a lead-in extending in insulated relation through said header and a resilient connection between said lead-in and said electrode.

6. An entrance bushing for an electric discharge device having a metal container, there being an opening in said container, a lead-in extending through said opening, an insulating seal between said lead-in and said container, a substantially tubular shield surrounding said lead-in, said tubular shield being secured to the container, a cap-like shield secured to the lead-in and extending in spaced relation to the end of the tubular shield.

7. In an arc discharge device having a metal container, an electrode assembly comprising an insulating body rigidly attached to the interior of the container, an electrode support firmly attached intermediate the ends of said bushing, spacer means providing a narrow shading space at the junction of the insulating member and the container, an electrode mounted on said support, a lead-in extending through said container, an insulating seal between said lead-in and said container, a shield around said seal and a resilient connection between said lead-in and said electrode support.

8. An insulating mounting for an electrode of a vapor-electric device having a metal container comprising a bolt rigidly connected to the container, an insulating body around said bolt, a spacer between said insulating body and said container, a cap on said insulating body, a spacer

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between said cap and said insulating body, fastening means for securing said parts in assembled relation and means for mounting an electrode support intermediate the ends of said insulating body.

9. A shock resistant vapor-electric device comprising an evacuated metal container, said container having a substantially tubular body with end headers, a cathode assembly on the bottom header including a relatively narrow cathode cup united to said header, a pool of cathode liquid in said cup, means secured in said cup tending to prevent displacement of said cathode material, a plurality of exciting electrodes extending into proximity with the cathode, an insulating support for each of said electrodes, means for shading the point of contact between the container and the insulating support, a lead-in for each of said exciting electrodes, an insulating seal for each lead-in, a shield surrounding each of said seals, a re-

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silient connection between each of the lead-ins and its associated electrode.

10. A vapor-electric device comprising an evacuated container, a cathode header at one end of the container, an anode header at the opposite end of the container, a cathode cup set into said cathode header, a plurality of exciting electrodes mounted on said cathode header, a lead-in for each of said exciting electrodes independent of the mounting, an anode, an insulating support for said anode, an insulating vacuum seal independent of said mounting, a plurality of anode shields surrounding said anode, insulating mountings for said anode shields, said shields having substantially spherical arc passage faces.

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No references cited.