

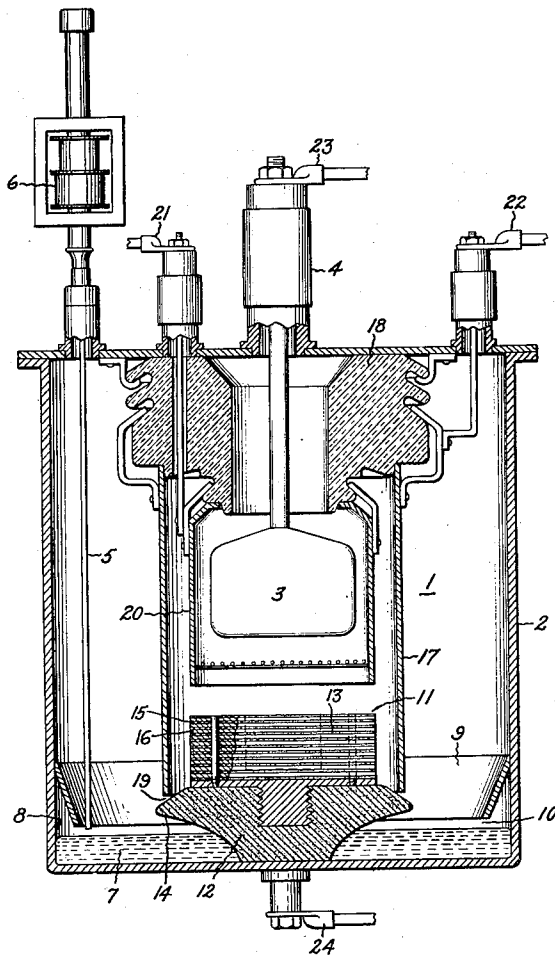
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VAPOR ELECTRIC DEVICE

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VAPOR ELECTRIC DEVICE

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Our invention relates to vapor electric devices, particularly to vapor electric devices of the solid heated cathode type, and its principal object is to provide a vapor electric device combining the advantages of the solid heated cathode type and the liquid cathode or mercury pool type.

In the use of vapor electric devices of the mercury pool type such as the mercury arc rectifier difficulties are at times encountered due to relatively large drop in voltage in the arc between anode and mercury cathode. Further, it has been necessary usually to provide water cooling for the mercury pool cathode and to provide a relatively large rectifier casing or tank to ensure efficient condensation of the mercury vapor given off from the cathode pool. It has also been usual practice to insulate the cathode pool from the metal tank thus necessitating the provision of relatively costly vacuum-tight sealing and insulating means for the cathode.

The use on the other hand of vapor electric devices of the solid heated cathode type has been attended by the disadvantage that the starting of the device is not instantaneous, as is substantially the case with the mercury pool type, but is delayed due to the necessity of preliminary heating of the cathode to a predetermined temperature.

In accordance with our invention these disadvantages, encountered in certain cases in the operation of vapor electric devices of the mercury pool type and of the solid heated cathode type, are avoided and the advantages of both types retained, by the provision of a vapor electric device including a solid cathode and a mercury pool cathode.

In carrying our invention into effect we so arrange the vapor electric apparatus that the arc in the vapor electric device is first struck between the mercury pool and the anode. The arc is made to pass by, and impart its heat to, the solid cathode, and thereafter, when the solid cathode has attained the proper temperature, the normal operating arc is established between the solid cathode and the anode.

Our invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, the single figure thereof is a sectional view of a vapor electric apparatus embodying our invention.

In the figure, the invention is illustrated as embodied in a vapor electric device 1 compris-

ing an evacuated metal container or tank 2 on the cover of which an anode 3 is mounted as by means of a suitable insulating seal 4, and an ignition electrode 5 provided with the usual starting solenoid 6.

To provide the mercury cathode, between which cathode and anode 3 the arc is first struck, a mercury pool 7 is provided which preferably rests directly on the bottom of the tank 2 and in electrical contact with the metal of the tank. In order to prevent cathode spots formed between the upper surface of the mercury and the metal of the tank, as at a point 8, from jumping to points on the metal above the mercury, a shield 9 is provided so arranged that the arc resulting from the formation of such a cathode spot passes through a narrow opening 10 between the mercury and the lower edge of the shield 9 and "skims" the surface of the mercury, thereby transferring the arc back to the mercury.

To provide the solid cathode to which the arc in the device is eventually transferred for normal operation after being struck initially between mercury pool 7 and anode 3, a cathode body 11 is mounted within the tank and in electrical contact with the bottom or lower wall thereof.

The cathode body 11 comprises a lower or base portion 12 and an upper or active portion as 13 forming the solid heated cathode proper. The lower or base portion 12 is formed of conductive material of high melting point such as graphite, having a lip portion 14 curved over the mercury surface. As long as the active portion 13 of solid cathode body 11 is cold the arc discharge takes place between the anode 3 and the cathode spot formed in the surface of the mercury pool. In case the cathode spot tends to travel from the pool to the base portion 12 of the solid cathode 11, then by reason of the close proximity of the under surface of lip portion 14 to the upper surface of the pool 7, the spot is instantly transferred back to the pool surface, the arc preferring to strike to the mercury surface rather than to a spot on the solid surface of element 14 in such close proximity to the pool. This lip portion 14, therefore, prevents the cathode spot from traveling from the mercury surface and upwardly over the graphite base portion 12 to the upper active portion of the solid heated cathode before this latter active cathode element has attained the proper temperature, the lip portion 14 thus preventing the cathode spot from causing sputtering of the solid heated cathode due to cold cathode conditions.

The upper active portion or solid heated cath-

ode proper may assume various forms and may comprise various electronemissive materials. For example this portion may be formed of a mixture of a conductive powder, characterized by a high melting point, and an oxide of a rare earth element such as barium or the like. This electronemissive or active portion of the solid cathode may also be formed of graphite soaked with a rare earth oxide.

The upper active portion or solid heated cathode portion 13, however, preferably comprises a laminated structure built up of conductive plates or washers 15, formed of graphite or other suitable conductive material of high melting point, between which are disposed layers 16 of barium carbonate mixed with a suitable binder, or layers of other suitable electronemissive substance may be employed. This preferred cathode structure prevents the loss of electronemissive material, contained in the layers 16, and minimizes the amount evaporated of such material, since only a very small surface of the active material is exposed between the graphite layers 15. In spite of the small surface exposed, the emissive material necessary to impart emissivity to the surface of the solid heated cathode works out between these graphite layers in just sufficient amount to cause an atom-thick active layer to spread over the entire surface. Thus the stock of barium carbonate in the structure becomes an inexhaustible source of electronemission.

In order to facilitate the heating of the solid heated cathode portion 13 and the transfer of the arc thereto from the mercury pool cathode 7 a preferably cylindrical shield member 17 is mounted, preferably insulatingly as by an insulator 18, on the cover of the container and extends downwardly to a point relatively close to the surface of mercury pool 7, the solid cathode body being preferably of rounded or cylindrical form to provide a relatively narrow opening 19 between the solid cathode and the lower edge of the shield 17, and thus cause the arc to produce a large amount of heat due to this constriction and impart the heat to the upper active element or solid heated cathode proper 13.

To assist in controlling the current in the device 1 or for other purposes, a grid member 20 may be mounted in proximity to the anode, as by suspension from the insulator 18, and provided with an external terminal 21 adapted to be connected to a source of potential. The shield member 17 may, likewise, be provided with an external terminal 22 for the purpose of impressing a potential on the shield. Anode 3 is provided with an external terminal 23 for connection to external circuits, and connection between such circuits and the cathode members 7 and 11 may be made through a terminal 24 which may be connected directly to the metal wall of tank 2. As the circuits to which the vapor electric device 1 may be connected form no part of the present invention they are not illustrated or further described herein.

In operation of the vapor electric apparatus illustrated in the drawing, a voltage may be impressed from a suitable source on the anode 3 and the arc is then first struck, in the manner usual in the operation of mercury arc rectifiers, by energizing solenoid 6 momentarily, thereby plunging ignition anode 5 into the mercury pool, and immediately withdrawing this anode. A cathode spot is thus formed on the mercury from which an arc is picked up by main or power anode 3 as in the usual mercury arc rectifier.

The large rounded or cylindrically shaped and relatively wide-based cathode body 11, formed of heat resistant material and mounted close to the lower edge of the downwardly depending shield 17, cooperates with this shield to prevent the cathode spot and the vapor blast from entering the anode chamber within shield 17. At the same time the arc discharge traverses the path between mercury pool 7 and anode 3 through the narrow opening 19 between the lower edge of shield 17 and the base of the lower portion 12 of cathode body 11.

The arc thus traversing the path between the mercury pool 7 and the anode 3 heats the upper active portion or solid heated cathode proper 13 of solid cathode body 11. As soon as this upper active portion 13 is raised to the proper temperature for the emission of electrons from the rare earth material of which it is in part composed, the arc is transferred from the mercury pool 7 to the solid heated cathode 11. The arc thus established between the solid heated cathode 11 and the anode 3 is the normal operating arc in the device.

It will be seen, however, that an operating arc, initially the arc between mercury pool 7 and anode 3, is established in the device practically simultaneously with the striking of the ignition arc by ignition anode 5, and that the starting into operation of the vapor electric device 1 is not delayed pending the preliminary heating of the solid cathode 11.

If for any reason the temperature of the solid cathode 11 drops below that required for the proper emission of electrons for a given current or if the current rises rapidly, operation of the device will be resumed from the cathode spot of mercury pool 7.

The periods during which the device is operated from the mercury pool 7 are of relatively short duration. Therefore it will be noted that a large condensing surface is not required for condensing the vapor rising from the mercury cathode 7. The tank 2 may be consequently of relatively small size with side walls relatively close to the operating elements within the tank. Further, water cooling for the cathode is not required, nor are the usual sealing and insulating means for cathode or cathode leads since the cathode elements 7 and 11 are both in contact with the metal wall of the tank, to which circuit connections may be made directly as through terminal 24.

It will be observed, further, that since the normal operating arc is between the solid heated cathode 11 and the anode 3 the arc voltage drop between cathode and anode has the desirably very low value which characterizes vapor electric devices of the solid heated cathode type as compared with vapor electric devices of the mercury pool type.

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

1. In combination, a vapor electric apparatus comprising an anode, a liquid cathode, a solid heated cathode, means to initiate an arc between said liquid cathode and said anode, and means to transfer the arc to said solid heated cathode.
2. In combination, a vapor electric apparatus comprising an anode, a mercury pool cathode, a solid heated cathode, means to initiate an arc between said mercury pool cathode and said anode, means including said arc to heat said solid heated cathode to the electron emission temperature, and means to transfer said arc from said mercury cathode to said solid cathode.
3. In combination, a vapor electric apparatus

comprising an anode, a mercury cathode, means to initiate an arc between said anode and said mercury cathode, a solid heated cathode including a base portion of heat-resistant material and a portion composed of material adapted to emit electrons connected thereto, means including said arc to heat said second-named portion to the electron emitting temperature, and means to transfer said arc from said mercury cathode to said solid cathode.

4. In combination, a vapor electric apparatus comprising an evacuated tank, an anode, a mercury cathode and a solid heated cathode mounted in said tank, an anode shield surrounding said anode and extending adjacent the solid heated cathode to restrict to a small amount the vapor passing from the mercury cathode to the space adjacent the anode.

5. In combination, a vapor electric apparatus comprising a mercury cathode, a solid heated cathode including a base portion of heat-resistant material and a portion composed of material adapted to emit electrons connected thereto, means to form a cathode spot on said mercury cathode and to initiate an arc between the cathode spot and the anode, said second-named portion of said solid heated cathode being heated by said arc, said base portion including a portion extending over said mercury cathode to prevent the cathode spot from travelling from the mercury cathode to the second-named portion of the solid heated cathode before said second-named portion has attained the temperature proper to electron emission.

6. In combination, a vapor electric apparatus comprising an evacuated tank, an anode, a mercury cathode, a solid heated cathode mounted in said tank and including a portion adapted to emit electrons, an anode shield surrounding said anode and extending adjacent the solid heated cathode to restrict to a small amount the vapor passing from the mercury cathode to the space adjacent the anode and to constrict the arc between the anode and the mercury cathode, said solid heated cathode having a lip portion extending over the mercury cathode to prevent sputtering of said

electron emitting portion of the solid heated cathode.

7. In a vapor electric apparatus comprising an anode, a liquid cathode, and a solid heated cathode, the method of operation which includes initiating an arc between the liquid cathode and the anode, and transferring the arc to the solid heated cathode.

8. In a vapor electric apparatus comprising an anode, a mercury pool cathode, and a solid heated cathode, the method of operation which includes initiating an arc between the mercury pool cathode and the anode, heating the solid cathode to the electron emission temperature by said arc, and transferring the arc from the mercury pool cathode to the solid cathode.

9. In a vapor electric apparatus comprising an anode, a mercury pool cathode, a solid heated cathode, and an ignition anode, the method of starting and operating which includes striking an arc between the mercury pool cathode and the ignition anode to form a cathode spot, picking up an arc between said cathode spot and the anode, heating the solid cathode to the electron emission temperature by said arc, and transferring said arc to the solid heated cathode.

10. In combination, a vapor electric apparatus comprising an anode, a liquid cathode, a solid cathode adapted to emit electrons when heated, means to initiate an arc between said liquid cathode and said anode, and means to transfer said arc to said heated cathode as soon after said initiation of the arc between the liquid cathode and the anode as said solid cathode is sufficiently heated to maintain said arc.

11. In a vapor electric apparatus comprising an anode, a liquid cathode, and a solid cathode adapted to emit electrons when heated, the method of operation which includes initiating an arc between the liquid cathode and the anode, and transferring the arc to the solid cathode as soon after said initiation of the arc between the liquid cathode and the anode as said solid cathode is sufficiently heated to maintain said arc.

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