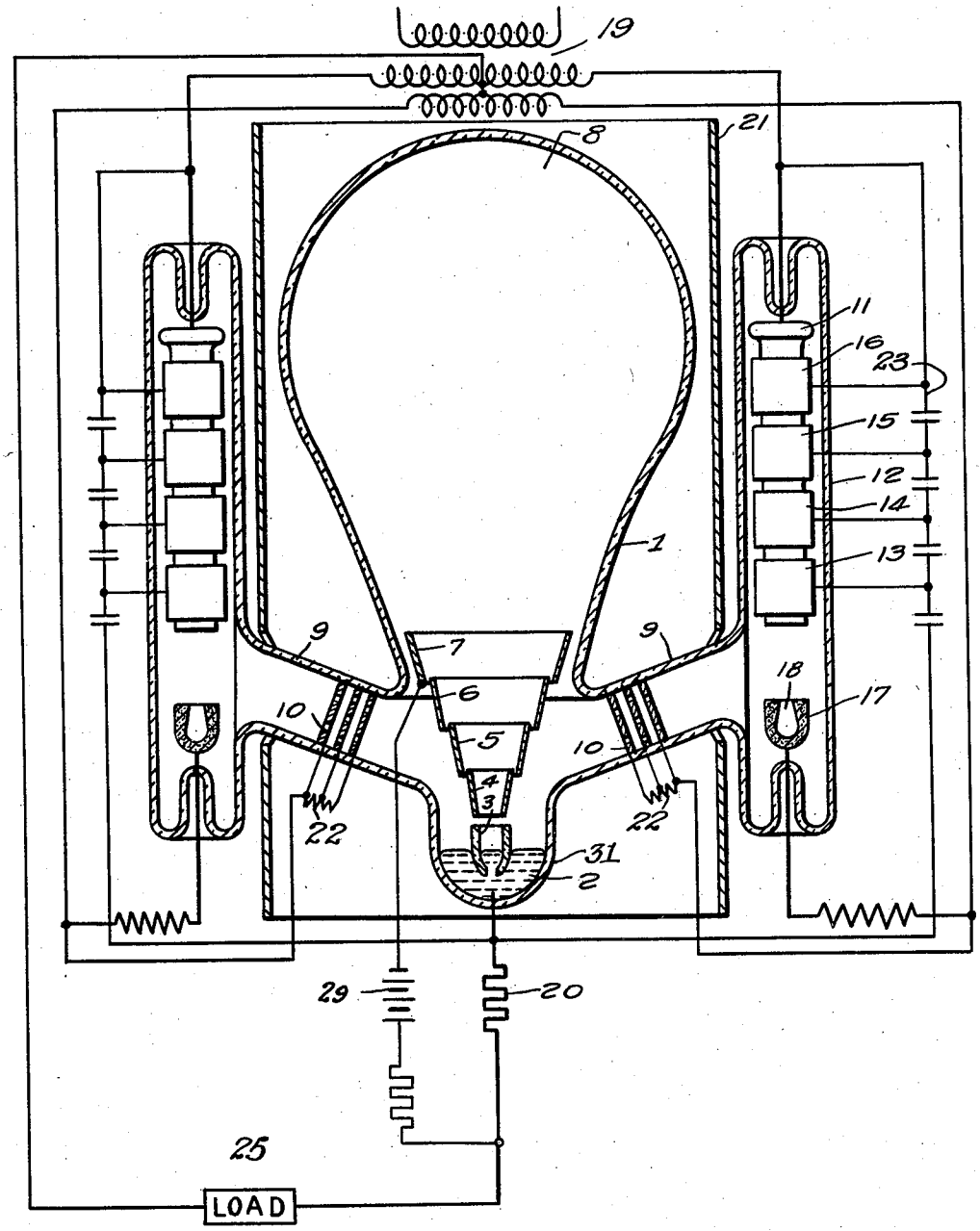
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ELECTRIC DISCHARGE DEVICE FOR HIGH OPERATING VOLTAGES

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ELECTRIC DISCHARGE DEVICE FOR HIGH OPERATING VOLTAGES

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This invention relates to an electric discharge device for high operating voltages having a metallic vapor filling and liquid cathode and employed for rectifying, controlling or converting high-voltage alternating currents of one frequency to alternating currents of another frequency. In such discharge devices troubles are in most cases caused by backfires and these troubles are the more liable to occur, the greater the vapor pressure will be in the anode arm which contains on the one hand the anode and on the other hand under circumstances the intermediate electrodes. In this case the intermediate electrodes may be employed to distribute the voltage in a certain manner, particularly in a uniform manner, along the anode arm; however, they may be employed at the same time or exclusively as control electrodes. In the rectifier according to the invention a nozzle system flaring in the direction towards the condensation space and consisting of a plurality of inserts separated with respect to each other by gaps is arranged between the cathode (for instance, the mercury cathode) and condensation space. The anode arms are arranged on the discharge vessel laterally of the nozzle system. Cylindrical inserts may be employed which have different diameters and are coaxially so arranged as to follow one another. In this manner cylindrical circular gaps result between the single inserts. The vapor current issuing from each insert flows into the next following insert. Also inserts in the form of truncated cones may be employed. In this manner a more rapid increase of the cross-section of the inserts is obtained than in the case of cylindrical inserts of different diameters. By the action of the vapor blast issuing from the individual inserts not only foreign gases which are contained in the parts lying laterally of the nozzle system, particularly in the anode arm, are caused to flow into the space of condensation but also the vapor pressure of the cathode metal in the anode arm is considerably reduced in the neighborhood of the nozzle system.

An embodiment of the invention is shown in the accompanying drawing for a two-anode rectifier. It is understood that the same construction may also be employed in a single-anode rectifier or in a rectifier for any number of phases. 1 is the discharge vessel and may consist as usual of glass or the like. However, also metal vessels may be employed. 25 is the current consuming device and 19 the transformer which transmits the alternating-current power to the direct-current circuit. The lower portion of the container 1 provides a cathode dish 31 which contains a body of vaporizable cathode material 2 which supports an insert 3 consisting of non-conducting material. 4, 5, 6 and 7 are inserts in the form of truncated cones and so arranged as to overlap in part one another. In this manner cylindrical circular gaps result between the single inserts. The insulating body 3 is so designed that the vapor blast issuing therefrom enters the first insert 4. The vapor current issuing from the nozzle system 4, 5, 6, 7 is condensed in the condensing space 8 of the discharge vessel and the condensate flows back into the cathode pool 2. Under the influence of the vapor blast issuing from the nozzles a pumping action as above mentioned is brought about by which gases and also the vapor of the cathode material are removed from the surrounding of the nozzle system as well as from the anode arm 9 arranged laterally of the nozzle system. In this manner the formation of undesirable discharges is practically suppressed. The holding arc issuing from the cathode may pass to a particular auxiliary anode; however also one or more inserts adjacent to the space of condensation, for instance, the insert 7 may be employed as an anode for the holding arc.

Since the vapor blast issuing from the cathode is not only dependent upon the current intensity of the holding arc but also upon the load current the pumping action of the nozzle system is not constant so that in periods of small current intensities a portion of gases or vapors might flow back from the condensation space 8 into the anode arms. To prevent this it is preferable to arrange in the anode arms, i. e., in the neighborhood of the nozzle system baffles preventing the gases or metallic vapors from flowing back into the anode arms. Thus, for instance, various perforated sheets may be arranged in the anode arm whose perforations are so displaced with respect to one another that metallic parts lie opposite to the perforations. A baffle consisting of three sheets is denoted in the drawing by the numeral 10. In order that the flowing back of gases or vapors is considerably retarded by the baffle it is necessary to arrange the single parts of the baffle, for instance, the individual sheets as shown in the embodiment so close to each other that the distance between the sheets is equal to or smaller than the average free path length of the gases or vapors in the neighborhood of the baffle 10. Since on the other hand the baffle should not substantially impair the discharge after the ignition of the same the perforations and the distances between the single parts of the resistance

must be so dimensioned that the layer of the space charge produced about these parts is considerably smaller than the perforations and distances. The metallic parts of the baffle may be employed to initiate or at least to support the discharge towards the anode 11 of the rectifier. For instance, the conducting parts of the baffle may be impressed with a positive voltage in the conducting period of the rectifier or at the moment of the ignition. In the case of various metallic parts of the baffle lying in series it is preferable to cause the voltage with which these parts are impressed to increase in the direction towards the anode. This may, for instance, be effected in the manner that electric resistors 22 are inserted between the individual conducting parts of the above-mentioned baffle 10 and that the positive pole of a power source is connected to the metallic part of the baffle away from the cathode. The discharge passing to the metallic parts of the resistance then causes a voltage drop in the electric resistor 22 lying between the conducting parts of the metallic baffle 10, by which voltage drop a grading of the voltage is brought about in the manner above mentioned. The metallic parts of the baffle 10 may also be employed to prevent in the non-conducting period negatively or positively charged particles from entering the anode arm. To this end, for instance, the part adjacent to the cathode may be impressed with a negative voltage and the following conducting part with a positive. The following conducting parts of the metallic baffle 10 may then be rendered alternately positive and negative. The above-mentioned electric resistors 22 may also be located in the discharge vessel 1 itself, for instance, in the manner that a suitable wire is spirally arranged around the baffle 10 and that the metallic parts of the baffle 10 are connected to single points of said wire.

As shown in the drawing besides the anode 11 intermediate electrodes 13, 14, 15, 16 are arranged in the vertical part 12 of the anode arm. These intermediate electrodes may, for instance, be impressed with a voltage lying between the anode and cathode voltage with the aid of a capacitive potentiometer 23. The intermediate electrodes are preferably so designed that the electric lines of force running between the same deviate any positively or negatively charged particles towards metallic parts, thus rendering them innoxious. In this manner the centrally traveling positively or negatively charged particles remain uninfluenced and in the non-conducting period negatively charged particles and in the conducting direction with unignited anode positively charged particles pass from the anode through the intermediate electrodes 13 to 16 and impinge upon the anode arm. They may cause on the one hand discharges in the anode arm and on the other hand they may unduly heat the walls of the vessel. To prevent this it is preferable to arrange in the path of the positively or negatively charged particles an auxiliary electrode 17 which is preferably provided with a bulb-shaped recess 18. Should particles enter the hollow space 18 of the electrode 17 secondary electrons are released there but these electrons are hardly accelerated, since the hollow space 18 is practically free of an electric field. They cannot therefore cause an initiation of a discharge. The electrode 17 may be employed to initiate the discharge in the conducting direction of the discharge device by impressing it at a given time with a positive potential. It acts then as an exciting anode.

As already above mentioned the vapor current issuing from the cathode is not constant but depends upon the load current. The greater the number of phases, the more constant the vapor current will be. In the case of a small number of phases or in the case of controlled rectifiers which in certain operating cases conduct current only for a relatively short time it might be convenient to maintain the vapor current substantially constant with the aid of special means. To this end, for instance, the holding arc may be made conditional upon the load current in the manner that the current intensity of the holding arc increases with decreasing load current. The current issuing from the cathode (sum of the holding arc current and load current) may be caused to remain practically constant, thus ensuring a uniform evaporation of cathode material. To make the current in the holding arc conditional upon the load current the anode of the holding arc (for instance, the insert 7) may be connected by the insertion of a power source 29 feeding the holding arc to a resistor 20 traversed by the load current. Since the voltage drop across the resistor 20 is in opposition to the voltage of the power source 29 the voltage feeding the holding arc decreases with increasing load current. In this manner the above-mentioned balance is brought about. In a similar manner an additional voltage may be applied to the circuit of the holding arc also by the inductive method.

Another means for rendering uniform the evaporation of cathode material consists in the fact that the part of the cathode where the discharge initiates is kept to a relatively high temperature so that also in periods of a small current intensity cathode material is evaporated under the influence of the heat stored up. As shown in the drawing the part of the electrode where the arc starts may be, for instance, separated from the remaining portion of the cathode material by a poor heat conducting insert 3 (for instance of quartz).

Since it is important in the rectifier according to the invention to keep the anode arms during the non-conducting periods as free as possible from gases or vapors it is preferable to maintain a difference in pressure between the anode arm and the space of condensation in order that no metallic vapor precipitates in the anode arm. This difference in pressure may be attained in most cases by sufficiently cooling the space of condensation. This space may under circumstances be enclosed with respect to the anode arm by a shield 21 and a current of gas may flow within this shield along the discharge vessel. The temperature in the anode arm may also be increased to a further extent by an additional heating of the anode arms, for instance, by radiation.

It has hitherto been assumed that the discharge device is provided with a mercury cathode. However, also cathodes of other materials, for instance, of alloys of mercury and alkali metals or alkaline earth metals or of alkali metals and alkaline earth metals may be employed. To support the first ignition the discharge vessel may also be filled up with an inert gas. A particular ignition device is not shown for the sake of simplicity. The same is naturally only necessary if the discharge device is not filled with an inert gas.

What is claimed is:

1. A vapor electric device comprising an envelope including a cathode dish and a condensing chamber, a mercury cathode in said cathode dish, anode arms extending from said envelope, a nozzle system composed of a plurality of separate partially overlapping nozzle sections extending from the cathode into the condensing chamber, said anode arms opening into said envelope laterally of said nozzle system.

2. A discharge device as set forth in claim 1, characterized in that the individual sections of the nozzle system have the shape of truncated cones and overlap one another in such a manner that an approximately cylindrical circular gap results between adjacent inserts.

3. A vapor electric device comprising an envelope including a cathode dish and a condensing chamber, a mercury cathode in said cathode dish, anode arms extending from said envelope, a nozzle system composed of a plurality of separate partially overlapping nozzle sections extending from the cathode into the condensing chamber, said anode arms opening into said envelope laterally of said nozzle system, and a quartz ring inserted in said cathode for guiding the vapor blast into the nozzle system.

4. A vapor electric device comprising an evacuated envelope, a cathode dish in said envelope, a vaporizable cathode in said dish, a condensing chamber in said envelope, a nozzle system extending from said cathode to said condensing chamber, said nozzle system including a plurality of separate nozzle sections spaced from each other the successive sections being increasingly larger in diameter and arranged in partially overlapping relation, a plurality of anode arms extending from said envelope at a position laterally of said nozzle system and vapor baffles in said anode arms.

5. A vapor electric device comprising an evacuated envelope, a cathode dish in said envelope, a vaporizable cathode in said dish, a condensing chamber in said envelope, a nozzle system extending from said cathode to said condensing chamber, said nozzle system including a plurality of separate nozzle sections spaced from each other the successive sections being increasingly larger in diameter and arranged in partially overlapping relation, a plurality of anode arms extending from said envelope at a position laterally of said nozzle system and vapor baffles in said anode arms, said vapor baffles comprising a plurality of perforated plates spaced from each other a distance smaller than the length of the mean free path of the cathode vapor in the vicinity of the baffles.

6. A vapor electric device comprising an evacuated envelope, a cathode dish in said envelope, a vaporizable cathode in said dish, a condensing chamber in said envelope, a nozzle system extending from said cathode to said condensing chamber, said nozzle system including a plurality of separate nozzle sections spaced from each other the successive sections being increasingly larger in diameter and arranged in partially overlapping relation, a plurality of anode arms extending from said envelope at a position laterally of said nozzle system and vapor baffles in said anode arms, an anode in each of said anode arms, an auxiliary electrode in each of said anode arms, said auxiliary electrode having a recess opposite to said anode and connections for impressing potential on said auxiliary electrode for collecting charged particles traveling from the anode.

7. A vapor electric device comprising an envelope including a cathode dish and a condensing chamber, a mercury cathode in said cathode dish, anode arms extending from said envelope, a nozzle system composed of a plurality of separate partially overlapping nozzle sections extending from the cathode into the condensing chamber, said anode arms opening into said envelope laterally of said nozzle system, means for cooling the condensing chamber and means for maintaining the anode arms at a higher temperature than the condensing chamber.

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