J. L. R. HAYDEN.

STATIC PROTECTOR FOR VAPOR ELECTRIC APPARATUS.

APPLICATION FILED JAN. 5, 1906.

996,582. Patented June 27, 1911.

Fig. 1.

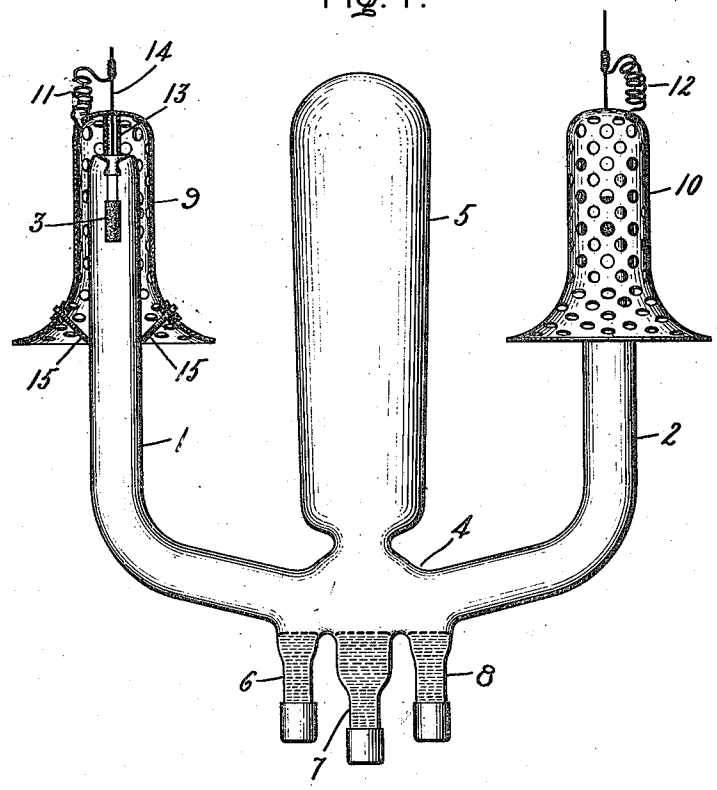


Fig. 2.

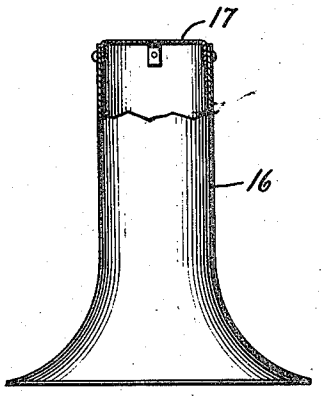
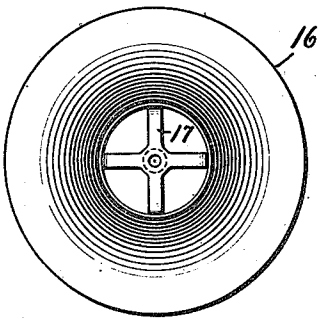


Fig. 3.



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UNITED STATES PATENT OFFICE.

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STATIC PROTECTOR FOR VAPOR ELECTRIC APPARATUS.

996,582. Specification of Letters Patent. Patented June 27, 1911.

Application filed January 5, 1906. Serial No. 294,731.

To all whom it may concern:

Be it known that I, JOSEPH LE ROY HAYDEN, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Static Protectors for Vapor Electric Apparatus, of which the following is a specification.

My present invention relates to vapor electric devices, and finds its most useful application to such of these devices as employ alternating current.

It is one of the objects of my invention to protect the apparatus from deterioration during use, and to guard against the phenomenon known as arcing in which one of the anodes of the apparatus temporarily becomes the cathode for a discharge from the companion anode.

The various features of novelty which characterize my invention I have pointed out in the appended claims. The invention itself, however, will be better understood by reference to the following description taken in connection with the accompanying drawings in which,

Figure 1 represents my invention as applied to a mercury arc rectifier tube of a type especially adapted for high voltage work. Figs. 2 and 3 are views of a modification.

In the drawings, the rectifier tube to which my invention is applied is of a now well known form. It consists of a highly exhausted glass envelop provided with two upwardly extending arms 1 and 2 each of which carries at its upper end a graphite electrode which in operation serves as an anode. The anode in the left-hand view is indicated at 3, while that in the right-hand view is partially concealed. The tubes 1 and 2 are connected by a tubular bow-shaped member 4. From this member extends upwardly a relatively large chamber 5 which serves as a condensing chamber for the surplus mercury generated during the operation of the apparatus. Directly below the mouth of the condensing chamber there extend downwardly three pockets or tubes 6, 7 and 8, each of which is nearly filled with mercury. The central body of mercury contained in the member 7 constitutes the cathode or negative electrode of the apparatus, while the bodies of mercury on either side constitute the starting anodes. Inasmuch as my present invention is not concerned with the particular construction of the rectifier tube it will be unnecessary for me to go into further description thereof, since the tube which I have illustrated is of a type well known in the art.

Tubes of the kind which I have described, although they are of the best construction so far known, are subject to certain troubles during operation. This is especially the fact when they are used with excessively high voltages such for example as would be necessary when the rectifier is used to supply direct current to a series arc light circuit of say 75 lights. In this case the effective alternating voltage across the main graphite anodes of the tube may amount to as much as 16,000 volts, while the peaks of the waves may reach a value probably not far removed from 50,000 volts. In some instances it is found that these rectifier tubes deteriorate rapidly. This is indicated in a number of ways. Thus it may happen that a tube after running for a short time fails to give the required voltage on the direct current circuit although the proper alternating voltage is maintained across the anode terminals. This is the phenomenon which has come to be known by the term "fading". The direct current voltage continues at intervals to decrease until finally it is found to be impossible to supply the normal current to the load. After this action has progressed for a time the current passes through a minimum value and the rectifier goes out. Sometimes, especially on starting a tube, some line disturbance may cause a static discharge from an anode lead to the glass wall of the rectifier so as to puncture the same and ruin the tube.

I will now explain what I believe to be the most probable cause of the deterioration of the tubes, but I wish it to be understood that I do not hold myself responsible for the accuracy of this theory.

Primarily I believe that the deterioration is due to gas obstructing the arc stream, which gas, before the rectifier tube is started, is occluded by the anodes and by the glass walls of the rectifier tube but, as soon as the arc is started, is driven off by the heat or other causes into the arc stream and thus obstructs it. I do not consider that heat is necessarily the most important factor in

driving off this gas. It is of course understood that when the rectifier is running the anodes alternate in potential from positive to negative. When positive, current flows therefrom through the rectifier tube, while when they are of negative polarity there is no current flowing. During these half periods when the anodes are of negative potential there is I believe a discharge from the anode, then negative, of negatively electrified particles. The tendency is for the least stable portions of the anode to be driven off and to some extent disintegrated. The gas absorbed or occluded in the anode is probably the first driven off, while to some extent probably the anode itself may be disintegrated. The action which I have thus described is probably accountable to some extent at least for the deterioration in the vacuum of the tube. There is however another action which I believe to take place. It will be understood that during the preceding half wave when the anode was of positive potential, it resulted that the space in the vicinity of the anode was filled with mercury vapor electrostatically charged. As soon as the anode reverses in polarity a strong electrostatic attraction is exerted upon the particles which thereupon are impelled toward or past the anode and strike either the anode or the anode support in the rear of the anode. This impact forms a vaporization center or cathode spot from which an arc may develop extending from that spot around through the rectifier tube to the opposite anode which obviously is then of positive potential. This action which is known as "arcing" may occur with more or less frequency and obviously in time disintegrates the anodes, destroys the vacuum, and so ruins the tube. To overcome these and other difficulties, I surround the anode space, by an electrically conducting shell, of copper for example, such as indicated in Fig. 1 at 9 and 10. The shell 9 is represented in cross section to show more clearly the relation of the parts, while the shell 10 is represented in full view. Each of the shells is electrically connected as by flexible wires 11 and 12 with the corresponding anode leads. The shells may of course assume a variety of shapes though for the present purpose I have found good results by making the shell in the form of a bell. This bell may rest upon a glass rod 13 surrounding the lead wire 14 and extend down below the lower end of the anode and be flared outward as indicated. This bell I call a "static protector." It is separated from the glass by an air space as indicated and may be held in position by any suitable means as for example, by adjustable spacing-screws 15 of some non-conducting material such as fiber. In order that the presence of the static protector may not cause the anode space to become too hot I provide the protector with numerous perforations in order to secure proper ventilation. Instead of perforating the protector I may make the same as shown in Figs. 2 and 3 in which the protector 16 is of imperforate sheet metal practically open at the top except for the skeleton cross pieces 17. The open top of this protector permits efficient ventilation and keeps down the temperature of the anode space.

It will be understood that the protector, by reason of its electrical connection to the leading in conductor of the anode, is at all times at the same potential as the anode itself. This being the fact, there is no tendency for the particles within the space circumscribed by the protector to be attracted in one direction or the other because every point within said space is, by well known electrical laws, at the same potential. The dissipation of matter from the anodes, and the arc-provoking action of the anodes on the surrounding vapor are thus prevented. Moreover, static discharges from the anode leads are no longer able to puncture the glass walls of the tube.

By the above theory I explain the remarkable results which I have achieved by the use of the static protector, though I wish it understood that this explanation even if accurate, is at best incomplete. Regardless, however, of what the true explanation may be, the beneficial effects of my invention may be obtained without reference to any theory of operation. I have found that with the use of my invention, rectifier tubes, which without the static protector were absolutely useless in practice, could for the second time be made to operate, and would continue to operate successfully, while tubes which otherwise were likely to deteriorate were prevented from so doing by the use of the protector.

It is of course evident that my invention is of wide application, and is not limited to use in connection with alternating current apparatus.

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

1. In a vapor arc apparatus, the combination of an exhausted envelop, electrodes therefor one at least of which is of vaporizable material, and means for rendering the entire space about a given electrode of the same potential as the electrode itself.

2. The combination with a rectifier tube, electrodes for the tube one at least of which is vaporizable material, and a good conducting shell surrounding one of the electrodes and electrically connected thereto the rim of said shell extending beyond the end of said electrode.

3. The combination of a rectifier tube, electrodes therefor one at least of which is of vaporizable material, and means for

equalizing the potential of the space surrounding one of the electrodes.

4. In a vapor arc apparatus, the combination of an exhausted envelop, electrodes therefor one at least of which is of vaporizable material, and a static stress equalizer for one at least of said electrodes whereby the space about said electrode is made of the same potential as the electrode itself.

5. The combination of a rectifier tube, electrodes therefor one at least of which is of vaporizable material, a good conducting shell surrounding one of said electrodes, and an electrical connection between said shell and the supply lead for said electrode.

6. The combination of an evacuated tube, electrodes therefor one at least of which is of vaporizable material, and a shell of high conductivity outside of said tube and surrounding one of said electrodes and electrically connected thereto said shell extending beyond said electrode.

7. The combination of a vacuum arc tube, an electrode therefor, and a flared shell of high conductivity surrounding said electrode and electrically connected to it, said shell extending at least as far as the free end of the electrode.

8. The combination of a vacuum arc tube provided with electrodes one of which consists of easily vaporizable metal, and means for rendering the space surrounding one at least of said electrodes of the same potential as the electrode itself, said space having its potential grading off in the direction of the coöperating electrode.

9. The method of preventing deterioration of alternating current vapor arc tubes, which consists in bringing the space about one at least of the electrodes to the same potential as the electrode itself.

10. The method of protecting alternating current mercury vapor tubes and preventing deterioration thereof, which consists in maintaining one of said electrodes in a space the points in which are of substantially the same potential.

11. In a vapor arc electric apparatus, the combination of an exhausted envelop, a plurality of anodes, a coöperating vaporizable cathode and a shell consisting of a good electrical conductor surrounding each of said anodes outside of said envelop and electrically connected to said anodes.

12. In an alternating current vapor electric apparatus, the combination of an exhausted envelop, a cathode, coöperating anodes and means at the anodes for preventing an abnormal lag of the starting of the arcs with respect to the phase of the impressed electromotive force.

In witness whereof, I have hereunto set my hand this 4th day of January, 1906.

JOSEPH L. R. HAYDEN.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.