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HIGH VOLTAGE RECTIFIER

Filed March 30, 1931

Fig. 1.

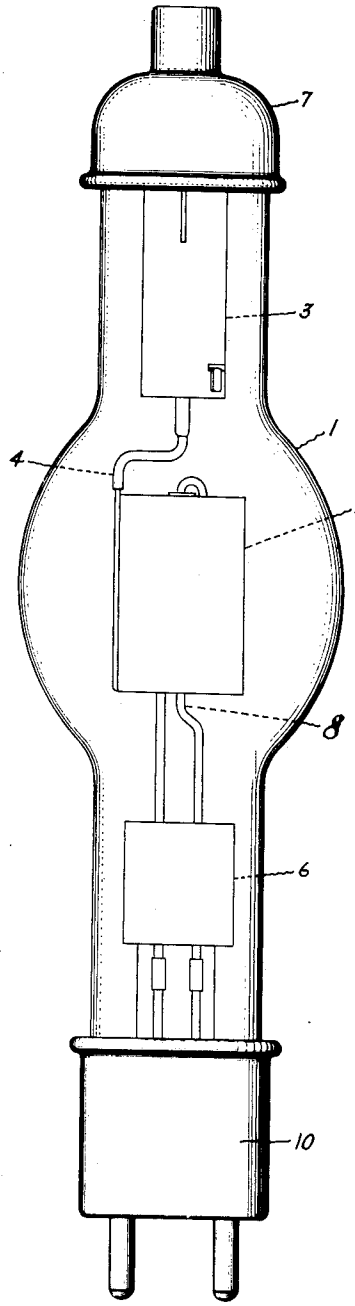
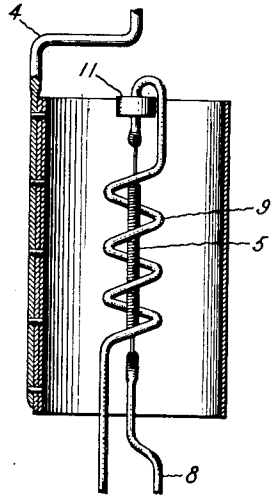


Fig. 2.



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HIGH VOLTAGE RECTIFIER

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3 Claims. (Cl. 250—27.5)

The present invention relates to electric discharge apparatus, more particularly to high voltage rectifiers.

In the operation of high voltage rectifiers of the vacuum type in which the impressed voltage is of the order of many thousands of volts, the matter of space charge becomes an exceedingly important factor and introduces problems of construction which are sometimes difficult to solve. One immediate effect of space charge is to cause the glass envelope to assume charges of a variable and transient character which tend rapidly to change the impedance of the rectifier and give rise to variations in the output voltage. These voltage variations are particularly harmful when the load is of a character such as an X-ray tube, which demands the utmost uniformity of impressed voltage in order to produce accurate and reproducible radiographic, diagnostic and similar effects.

It has been proposed heretofore in order to eliminate this particular space charge effect in high vacuum devices, to enclose the cathode by the anode so that the latter may act as a shield in protecting the envelope from electron bombardment. The anode usually takes the form of a cylinder for this purpose, and the cathode, ordinarily is a filament positioned in the main axis of the anode. It has been found however that in this form of tube construction, particularly in connection with high voltage devices, there is a tendency for the filament to bow at the middle, notwithstanding the relatively high initial tension which may be applied to the filament by the supports. The departure of the filament from its original position tends to fracture the latter and render the tube inoperative.

This bowing effect is believed to be due to a resultant force exercised on the filament by the strong electrostatic field of the anode which force exists by reason of the fact that the filament is not accurately positioned along the central axis of the cylinder. It is clear that if the filament were centrally located throughout its entire length, and further, if the anode were to define an accurate cylinder, the pull exercised by the field of the latter on the filament would under any and all voltage conditions be equal in all directions so that the net force on the filament would be zero. However, such an accurate line-up of the electrodes is difficult to obtain in commercial manufacture and even the slightest dissymmetry of electrode arrangement gives rise to severe strains in the filament caused by the large electrostatic forces resulting from the use of high voltage.

An object of the present invention is to provide an improved tube construction whereby the bowing or other displacement of the filament is substantially eliminated even under conditions of extraordinary high voltage and of substantial inaccuracy of alignment of the electrodes. This object is attained, in brief, by surrounding the filament with a protective electrostatic field which is of such a polarity as to off-set that introduced by the anode. In another aspect, the invention consists in enclosing the fragile filament by a rugged member which will bear the brunt of the deleterious effects ordinarily produced by the anode field but which, on account of its solid construction, is not adversely affected by said field.

The invention will be better understood when reference is made to the following description and the accompanying drawing in which Fig. 1 is an elevational view of a high voltage rectifier improved in accordance with the principles of the present invention; while Fig. 2 is a sectional view taken longitudinally of the anode to show the relative positions of the filament and protective shield.

In the drawings, numeral 1 designates the highly evacuated envelope of a high voltage rectifier whose output voltage is of a magnitude sufficiently high to operate a modern X-ray tube. The envelope terminates in oppositely directed stems from one of which a cylindrical anode 2 is hung by means of a spring collar 3 and a rigid lead 4. From the other stem, a cathode 5 is supported by means of a collar 6. The anode is of standard design and constitutes a molybdenum, tantalum or tungsten member riveted or otherwise secured to a flattened portion of the lead 4 which passes through the envelope and terminates in the usual contact cap 7.

The cathode, which may consist of tungsten, takes the form of a compact, helical filament, as shown in Fig. 2, in order to obtain a large electron emitting surface in a comparatively small space. The filament is supported at the lower end by a rigid conductor 8 secured in an insulating manner to the collar 6, and at the upper end by a protective member 9 which forms the subject of the present invention and which also is secured to the collar 6. The cathode leads are solid where they pass through the lower press (not shown) but terminate in a pair of flexible leads which are connected to a standard bayonet type socket 10.

The protective member 9 referred to, consists in a helix of relatively coarse pitch of stiff, large gage, tungsten wire, concentrically surrounding the filamentary helix. It may be joined to the filament at the top as shown, and can therefore be employed as one of the leads for the filament. In order to remove the resonance vibration of the filament from the frequency of the exciting current, ordinarily 60 cycles, it may be desirable to interpose a body of metal 11 between the upper extremity of the filament and the large helix.

When the improved rectifier as described is energized from a source of current having a voltage of the order of many thousands, for example 150,000, it has been found that the helix effectively precludes any transverse movement toward the anode or bowing of the filament notwithstanding dissymmetry of the electrode arrangement. It appears that the strong electrostatic pull ordinarily exercised on the filament by the field of the anode in the absence of the protective member, is now exerted to a large extent on the latter, which on account of its rugged character, fails to move perceptibly. Such force, as is not absorbed by the heavy helix, is of a negligible character and does not deleteriously affect the cathode.

It is evident that the protective member 9 being substantially at cathode potential, acts with regard to the anode in precisely the same manner as with the filament except with much less disastrous results. To that extent, the large helix offers substantial protection to the filament without interfering materially with the free movement of electrons. Viewed from another aspect, it may be considered that the negative electrostatic field generated by the large helix is more intense than that which would be offered by the relatively small filamentary helix and would more effectively neutralize the positive field of the anode.

Irrespective of theory, it is a fact established by actual operation, that the protection offered by the member is adequate, even when the filament is positioned considerably out of line, i. e. does not lie in the main axis of the cylinder or when the anode is irregularly shaped, or both, and the exciting voltages and consequent electrostatic fields are extremely high. The protective member thus endows the tube with a longer operating life and avoids the necessity of accurate and costly tube manufacture. In addition, it allows the successful use of the cylindrical anode-axial filament type of rectifier which has been found desirable in connection with loads demanding extremely high voltage of a constant amount.

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

1. An electric discharge device comprising an envelope containing a cylindrical anode and a filamentary cathode positioned in the main axis of the envelope, means for preventing bowing of the filament when voltage is applied to the device, said means consisting of a metal member surrounding the filament, said member being adapted to carry the filament current during operation, the lead-in wire for the anode being taken through the opposite end of the envelope from the filament lead-in wires.

2. A cathode structure comprising two portions and a metallic weighted member joining said portions together, one of said portions consisting of an electron-emitting relatively fragile member and the other of a rugged non-electron-emitting helix surrounding the electron-emitting member.

3. An electric discharge device comprising an envelope containing a cylindrical anode and a filamentary cathode positioned in the main axis of the envelope, means for preventing bowing of the filament when voltage is applied to the device, said means consisting of a rugged non-filamentary helix surrounding substantially the entire length of the filament and constituting a lead-in wire for the filament, the lead-in wire for the anode being taken through the opposite end of the envelope from the filament lead-in wire.

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