Nov. 20, 1928. 1,692,573

E. Y. ROBINSON

VACUUM ELECTRIC TUBE DEVICE

Filed Oct. 22, 1924 2 Sheets-Sheet 1

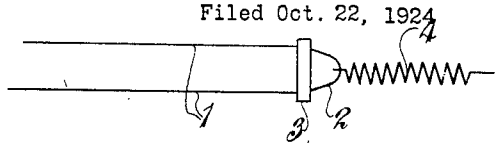


Fig. 1.

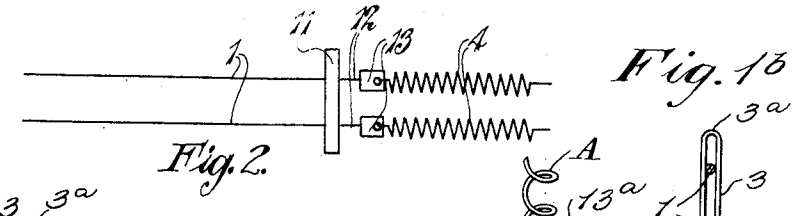


Fig. 2.



Fig. 1a

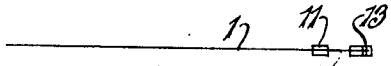


Fig. 3

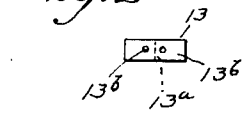


Fig. 2a

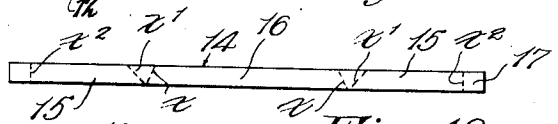


Fig. 4a

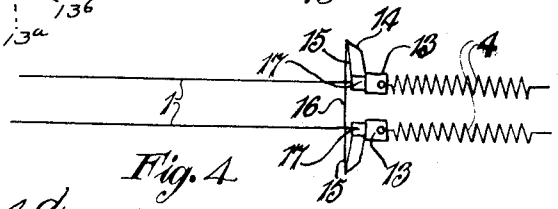


Fig. 4

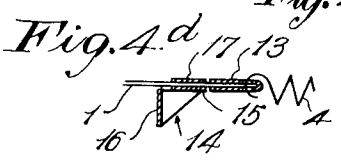


Fig. 4d

Fig. 1b

Fig. 2b

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Nov. 20, 1928.

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2 Sheets-Sheet 2

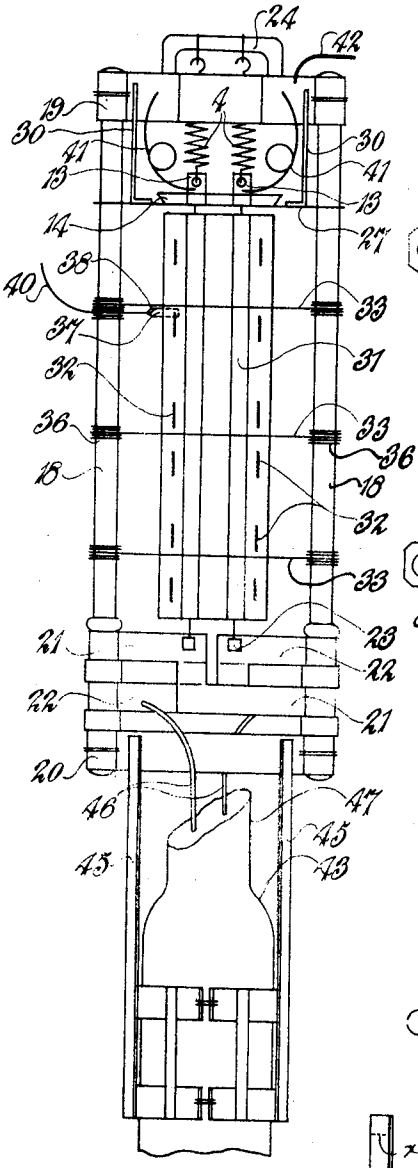


Fig. 5

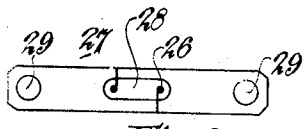


Fig. 6

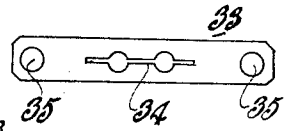


Fig. 7



Fig. 8

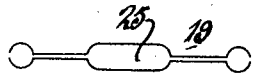


Fig. 9.

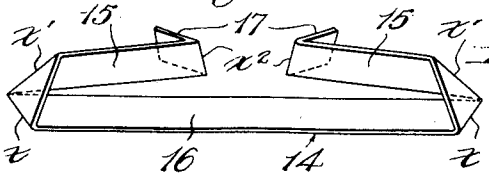


Fig. 4c

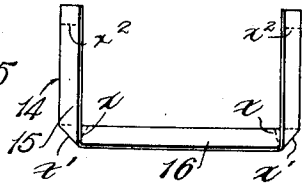


Fig. 4b

Inventor

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By Charles L. Norris

Attorney.

Patented Nov. 20, 1928. 1,692,573

UNITED STATES PATENT OFFICE.

ERNEST YEOMAN ROBINSON, OF MANCHESTER, ENGLAND, ASSIGNOR TO METROPOLITAN-VICKERS ELECTRICAL COMPANY LIMITED, A BRITISH COMPANY.

VACUUM ELECTRIC-TUBE DEVICE.

Application filed October 22, 1924, Serial No. 745,194, and in Great Britain November 9, 1923.

This invention relates to hot cathode vacuum electric tube devices and particularly to such devices in which the cathode comprises one or more pairs of series-connected filaments in U, V, hairpin or similar double formation.

In a cathode comprised of a hairpin or similar shaped filament, the loop or bight portion is generally at the maximum temperature of the filament due to the fact that the ends of the filament arms are cooled by the lead-in conductors to which they are attached. In addition if the space current is comparable in value with the filament heating current and is led into one end of the filament there will be a further inequality of heating. The inequality due to this latter cause may be reduced in various ways, such, for instance, as by heating the filament with alternating current and leading-in the space current to the centre point of an inductive winding connected across the filament. If the loop or bight portion of the filament is attached to a spring, hook or such like it will of course be subjected to slight local cooling by heat conducted away by said spring or hook. The present invention is concerned solely with the inequality of heating due to the ends of the filament being cooled by the lead-in conductors to which they are secured.

It has as a matter of fact been proposed to short-circuit the loop or bight portion of a tensioned double filament by means of a metal short-circuiting strip which must clearly reduce the temperature of this portion of the filament. When such a short-circuiting strip is employed, however, there will be a great tendency for the arms of the filament to become curved or bowed along their length, due to the fact that when the filaments, particularly when of tungsten, are first strongly heated they expand and therfore elongate, but not necessarily to the same extent, and on cooling there will be a permanent set which will almost certainly be different in the two arms of the filament. This may be due to some peculiarity in connection with the crystalline structure of the filament. For these two reasons it is quite possible, in fact probable, that whereas the short-circuiting strip was originally arranged at right angles to the two filaments it will subsequently move so that it is oblique thereto, due to the fact that one filament has expanded or contracted more than the other. Since the tensioned filament is rigidly connected with the short-circuiting strip and since the latter is no longer at right angles to the filaments, the latter must of necessity become bent. This is particularly the case when the filaments consist of tungsten, as the latter metal is very springy even when white hot.

With a view to avoiding such bending or bowing of the filaments the present invention consists in providing a short-circuiting strip which is inherently flexible. In practice this result may be obtained by employing a strip of a material such as nickel, which becomes flexible when heated, or alternatively the strip may be so constructed that it is flexible in itself. The strip must in either case be so constructed that it will not permit the spacing apart of the filaments to be changed. When the short-circuiting strip is of nickel the cross section thereof must be sufficiently small that it become heated to a certain extent, for example to red heat, by the passage therethrough of the filament heating current. It will of course be heated in addition by radiation. When the short-circuiting strip is constructed to be mechanically flexible it may be formed itself of a non-flexible material such as tungsten of molybdenum, although of course it may be constructed of nickel or other material if desired.

Some such means as that mentioned above may be additionally employed for reducing inequality of heating of the filament due to the space current flowing therein.

To enable the invention to be clearly understood it will now be described with reference to the accompanying drawings, in which Figs. 1 to 4[d] inclusive, illustrate various arrangements for carrying the invention into effect; Fig. 5 is an elevation of the electrodes of a valve having a filament in accordance with the invention and Figs. 6 to 9 inclusive are details of the arrangements shown in Fig. 5.

Referring to Fig. 1 the filament which comprises the two parallel members or arms 1 has its adjacent ends connected to lead-in wires or other supports not shown whilst its bight portion 2 is short-circuited by means of a member 3 which consists of nickel and therefore will be flexible when hot. The member 3 may be formed from a rectangular strip which is long in relation to its width as shown in Fig. 1[a] and is folded about its middle as on the line 3[a] so as to clamp the members or arms of the filament 1 which is

preferably also welded to the strip as shown in Fig. 1^b. A tensioning spring 4 for the members or arms of the filament is attached to the bight portion 2 and is anchored to a fixed member (not shown).

In the arrangement shown in plan and section respectively in Figs. 2 and 3, a short-circuiting strip 11 is provided which is similar to the strip 3 shown in Figs. 1, 1^a and 1^b and may be attached to the filament arms 1 in the same manner shown in those figures whilst two tensioning springs 4 are provided in axial alignment with respective parallel members or arms of the filaments. The springs 4 are attached to the end portions 12 of the filament members or arms by means of tabs 13 which are each composed of a flat strip folded on the line 13^a as indicated in Fig. 2^a and clamp and are preferably welded to said end portions as shown in Fig. 2^b, the strip having perforations 13^b therein which register when the strip is folded and form an eye in which the respective spring 4 is hooked. The strip 11 of nickel is so proportioned that it operates at red heat and is thus flexible.

In Fig. 4 which illustrates a modification of the arrangement shown in Figs. 2 and 3, a short-circuiting strip 14 is formed of molybdenum and is folded in such a manner that it is flexible. The strip 14 shown in its original form in Fig. 4^a, is folded first on the lines x' to bring it into the form shown in Fig. 4^b and then on the lines x to bring it into the form shown in Fig. 4^c, so that it has three legs, namely, two similar legs 15 and a third leg 16 in a plane at right angles to that containing the legs 15. The filament members or arms 1 are clamped and welded between the legs 15 and the respective portions 17 as shown in Fig. 4^d, said portions 17 being folded against the respective legs 15 on the lines x^2, as shown in Fig. 4^e. Two nickel tabs 13, like those shown in Figs. 2, 2^a and 2^b for a pair of tensioning springs 4 are attached to the ends of the filament members or arms as shown in Fig. 4^d.

Referring now to the electrode structure illustrated in Figs. 5 to 9 inclusive the arrangement is of the type described in the specification of my application, Serial No. 603,715, filed 27th November 1922 and now patented July 17, 1928 Number 1,677,850. The electrodes, namely, cathode and anode, are supported upon a framework which consists of two glass or steatite side rods 18 and two nickel end clips 19 and 20, in the manner described in the specification of my copending application, Serial No. 722,811, filed 27th June 1924. The filament is of the type illustrated in Fig. 4. The lead-in end of the filament is secured by welding to nickel cross pieces 21 and 22, nickel tabs 23 being welded over the end of the filament wires to obtain a good weld. The springs 4 attached by means of the tabs 13 to the other end of the cathode are anchored to a member 24 attached to the upper nickel end clip 19 which is of the shape shown in plan in Fig. 9. That is to say the springs 4 pass through a tubular portion 25 of the end member 19. The filament which is supported in the manner described in the specification of my copending application Serial No. 717,327, filed 2nd June 1924 aforesaid is constrained at its bight portion by means of two loops 26 of tungsten or molybdenum wire welded to a cross piece 27 shown separately in plan in Fig. 6. The cross piece 27 comprises a metal strip having a central perforation 28 for the filament and two end perforations 29 through which the side members 18 of the framework pass. The cross piece 27 is secured in position upon the framework by means of two L-shaped wires 30 welded both to the cross piece 27 and the frame member 19.

The anode 31 consists of two plates of molybdenum each pressed to the form shown separately in plan in Fig. 7 which plates are connected together by staples 32 so that two relatively long tunnels of small diameter are provided. The anode 31 is supported upon the framework by means of a plurality of molybdenum cross pieces 33, one of which is shown separately in plan in Fig. 8. A cross piece 33 comprises a metal strip having a central perforation 34 of double key-hole shape corresponding with the external contour of the anode 31 whereby the latter is registered in position with reference to the framework upon which the cross-pieces 33 are secured by passing the side members 18 of the framework through end holes 35 in the cross piece 33 and by binding with wire 36. The anode is fixed at one point with reference to the frame by means of the molybdenum strip 37 which is conveniently secured to the anode by one of the staples 32. The strip 37 is given a twist through a right angle at 38 and is welded to a nickel washer 39 which in turn is secured to the left end side member 18 of the framework by binding with wire. A lead-in wire 40 for the space current is connected to the washer 39.

The space current is led into the cathode at more than two points in the manner described in the specification of my copending application, Serial No. 722,810, filed 27th June 1924, namely in the example shown it is led into the bight portion of the filament as well as into the lower ends thereof. To this end the upper frame member 19 is electrically connected to the tabs 13 by means of flexible nickel conductors 41. A lead-in wire 42 to the bight portion of the filament is welded to the frame member 19.

The framework is supported upon a reentrant tube 43 of the valve envelope by means of a nickel or nickel steel clamp 44 and two arms 45 of L or other section adapted to provide rigidity. The cathode lead-in wires

46 are welded respectively to the lower filament supports 21 and 22 and pass through the pinch or seal 47 upon the re-entrant tube 43.

It will be understood that various modifications may be made without departing from the scope of the invention.

I claim as my invention:—

1. For a vacuum electric tube device, a cathode comprising two substantially parallel filament arms, two lead-in members to which said filament arms at one end are respectively secured, an electrically conducting elongated member secured to the cathode at right-angles to the arms at the other end, said member, when the cathode is heated being flexible in the longitudinal direction of the cathode but of fixed length in a direction transversely of the cathode whereby it maintains the space relationship of the arms thereof, and resilient means for placing said filament arms in tension.

2. For a vacuum electric tube device, a cathode comprising two substantially parallel filament arms, two lead-in members to which said filament arms at one end are respectively secured, an electrically conducting flat strip secured to the cathode at right-angles to the arms at the other end and means for placing the filament arms in tension, said strip being flexible in the longitudinal direction of the cathode under the tension on the arms thereof.

3. For a vacuum electric tube device, a cathode comprising two substantially parallel filament arms, two lead-in members to which said filament arms at one end are respectively secured, an electrically conducting elongated member secured to the cathode at right angles to the arms at the other end, and means for placing the filament arms in tension said member being flexible in the longitudinal direction of the filament arms under the tension thereon but rigid in the transverse direction of said arms whereby it maintains the space relationship of said arms.

In testimony whereof I have hereunto subscribed my name this 8th day of October, 1924.

ERNEST YEOMAN ROBINSON.