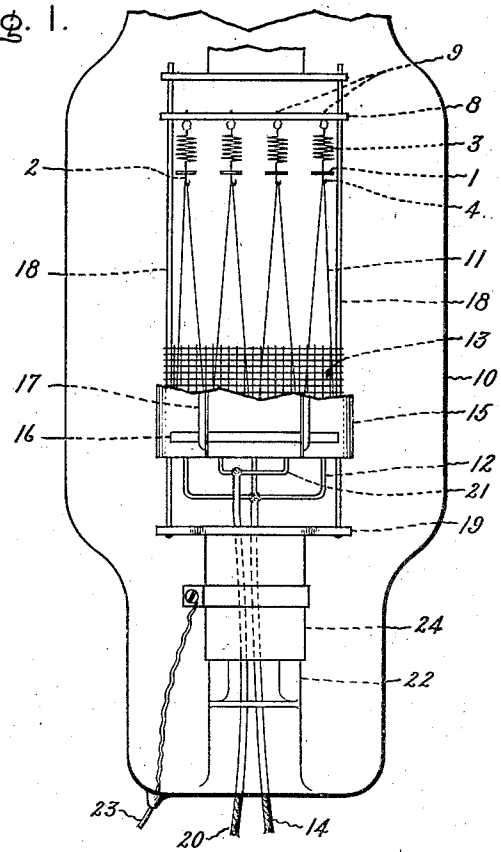
April 10, 1928. 1,665,896

W. A. RUGGLES

ELECTRON DISCHARGE DEVICL

Filed July 17. 1924

Fig. 1.



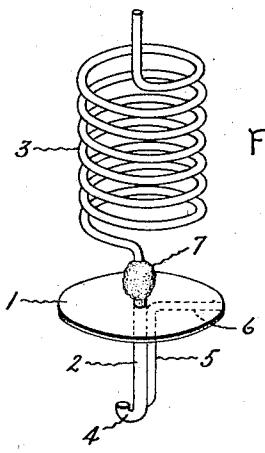


Fig. 2.

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UNITED STATES PATENT OFFICE.

WILLIAM A. RUGGLES, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRON-DISCHARGE DEVICE.

Application filed July 17, 1924. Serial No. 726,623.

My invention relates to improvements in electron discharge devices, particularly of the "power tube" type, the structure of which ordinarily comprises a plurality of electrodes such as a cathode, a plate and a grid, the space relations of which are destined to remain fixed during the operation of the device.

My invention relates more particularly to improvements in the method of supporting a filamentary cathode in devices of the above-mentioned type so that the predetermined space relation of the electrodes may remain unchanged during the life of the tube and thus prevent decrease of efficiency or actual break-down.

The cathode of the power type of vacuum tube or space current device consists usually of a metal conductor, generally of filamentary form, which is ordinarily disposed in V or zig-zag fashion upon suitable supports and arranged in electron responsive relation to a grid and other electrodes. In view of the length of filament necessary to accommodate the heavy current used in power tubes and the high temperature involved in their operation, the filament is subjected to a considerable degree of linear expansion and contraction. In order to prevent sagging of the filament and, therefore, contact thereof with the other electrodes of the device, it is necessary to keep the filament taut upon its support. This is usually effected by means of a plurality of helical or coiled springs made of tungsten or other suitable wire which are attached to an insulating cross-piece carried by the grid supports, particularly the supports located near the top of the tube, and which springs at their unattached ends terminate in hooks adapted to engage the zig-zag filament. The ends of the filament near the bottom of the tube are retained usually by clamps formed upon the current lead-in conductors or suitable branches thereof. In general, only one series or row of springs need be used although, of course, such springs may be disposed upon every filament supporting hook or clamp. When the filament expands or contracts, the hook supports, because of the elasticity of the springs, accommodate themselves accordingly and keep the filament stretched.

Springs of this type are usually heat treated in an atmosphere of hydrogen at a temperature of 1200° C. so as to impart to them a permanent "set" or definite degree of elasticity. When so treated and subsequently used in space current devices of relatively low capacity, they are capable of supporting the filament for long periods of time with sufficient tension to prevent contact of the filament with the cooperating electrodes.

It has been found, however, particularly in the case of power tubes, that during the evacuating process, during which the tubes are subjected to considerable overload, these supporting springs become very hot, their temperature approximating 800° to 900° C. This rather extreme heating is caused partly by heat conduction from the filament itself and partly by radiation from the nearby grid and anode then under bombardment.

Such heating draws the temper of the supporting springs and causes them to lose the elasticity or springy "set" imparted to them by the hereinbefore mentioned hydrogen tempering process and, inasmuch as they no longer function as springs when so detempered, they fail to hold the filament taut during its expansion and, hence, there is danger that the filament when expanded will make contact with the other elements of the device.

It is the object of my invention to provide means by which the elasticity and springy "set" of the filament supporting means may be maintained not only during the testing period but throughout the normal operating life of the filament as well. This is effected by providing heat dissipating means for shielding the springs from the heat given off by the filament and its coperating electrodes. For a clear understanding of the invention, attention is called to the specification and claims taken in conjunction with the accompanying drawing in which:

Fig. 1 shows a space current device of the power tube type containing a form of resilient filament support embodying the improvement of the invention.

Fig. 2 depicts the preferred method of attaching the protective or shielding means to the filament supporting springs.

Referring in detail to the drawing, the space current device in which the improvement of the invention is to be used comprises an evacuated glass envelope 10, the top of

which is shown broken off in the drawing, and within which the electrodes are disposed. These electrodes comprise a cathode 11 of filamentary form, a grid or control electrode 13 shown as a structure made of wire mesh surrounding the filament and an anode 15 of oval cross-section surrounding the cathode and grid. The cathode is stretched in V shaped or zig-zag fashion between suitable supports such as the insulating cross piece 8 and the branches of the cathode lead-in 12 and 21. The anode 15 which may be made of sheet metal, for example, molybdenum, is provided with strengthening ribs 16, 17 and is supported from the end of the tube which is broken away. The grid or control electrode 13 located intermediate the filament and the anode is held in position by tie-rods 18 which extend from the insulating cross-bars 8 to the metal cross-head 19. The latter is in metallic connection with and secured to clamping sleeve 24, which in turn surrounds the glass stem 22 of the device. The lead-in conductor 23 of the grid and the conductors 20, 14 serving to supply current to the cathode are sealed into the stem 22 and its flare in the well known manner. While, for simplicity in illustration, only a portion of the grid and anode are shown it will, of course, be understood that in accordance with the usual practice they surround the entire length of the cathode.

During the manufacture and operation of a device such as described, a considerable amount of heat will be conducted from the filament and radiated from the grid and anode to the supporting springs, and this heat will be sufficient to destroy the resiliency of the springs unless means are provided for protecting them.

The means used for protecting the resilient filament supports from the effect of the conducted and radiated heat comprises a thin shield preferably of the disc or washer type, represented by 1 in Figures 1 and 2. This washer or disc shield is made of sheet metal, preferably molybdenum, nickel, tungsten or other suitable metal about 5 mils in thickness. The diameter of the shield, of course, may vary with the size of the device in which it is to be used, but in general a diameter of five-sixteenths of an inch will be found suitable for tube sizes up to 1 kilowatt. The shields preferably should be made of metal or some substance which will not lead to the introduction of deleterious gas into the tube.

The method of attaching the shield to the filament support is indicated in Figure 2. The hole in the shield 1 should be just large enough to permit passage of the stem 2 of the spring 3. The shield is interposed between the filament retaining hook and the body of the spring and is held in place upon the stem or rod-like member 2 by means of a wire bracing member bent in the form of a right angle which is attached to both the shield 1 and the stem or rod-like member 2 of the spring by welding arm 5 of said brace to the rod-like member or prolongation 2 of the spring and arm 6 of said brace to the under side of shield 1.

This type of construction obviates the danger of warping or distorting either the shield or spring by the expansion and contraction stresses which occur during the heating and cooling of the electrodes. The rod-like member 2 may be a prolongation of the body of the spring or it may be a separate hooked rod welded to the spring body member as shown at 7. In either case, it is integral therewith, and the reason for forming the unit from a plurality of pieces resides in the convenience with which quantities of the spring members and hooked rods may be made up individually and then assembled to suit the needs of different sizes of tubes. For convenience in attaching the hooked rod by welding, one end of the spring may be flared slightly to present a larger surface.

The disposition of the filament supporting spring and its shield in a space current device is conventionally indicated in Figure 1. Depending upon the capacity of the device either one or a plurality of such supports may be used. In the usual form of construction, the spiral is supported by an insulating cross-piece 8 through which the upper end of the spring passes, the protruding extremity being shaped so as to form a supporting head as shown at 9.

The determination of the proper degree of elasticity or "set" necessary for the supporting springs is, of course, a matter of mechanical skill and will depend upon the size of the filament and the degree of expansion and contraction of the same.

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

1. A resilient filament support comprising a coil spring body member, a rod-like member extending therefrom in the direction of the axis of said spring, filament retaining means upon said rod-like member and a heat dissipating metal plate disposed loosely upon said member and intermediate the spring body and the filament retaining means and perpendicular to the axis of said spring and bracing means attached to the metal plate and rod-like member.

2. In combination, an electric discharge device including a filamentary electrode and means for supporting the electrode, said means comprising an insulator rigidly supported in the device and a spring member, said member being attached at one end to said insulator and provided at the other end with an extension forming a hook adapted to engage the filamentary electrode, and a

disk mounted on said extension and adapted to shield said spring from the action of heat produced by the electrode.

3. In combination, an electric discharge device including a filamentary electrode, and means for supporting the electrode, said means comprising an insulator rigidly supported in the device and a spring member, said member being attached at one end to said insulator and provided at the other end with an extension forming a hook adapted to engage the filamentary electrode, a disk mounted on said extension, and means attached to said extension and to said disk for maintaining said disk in position.

In witness whereof, I have hereunto set my hand this 16th day of July, 1924.

WILLIAM A. RUGGLES.