

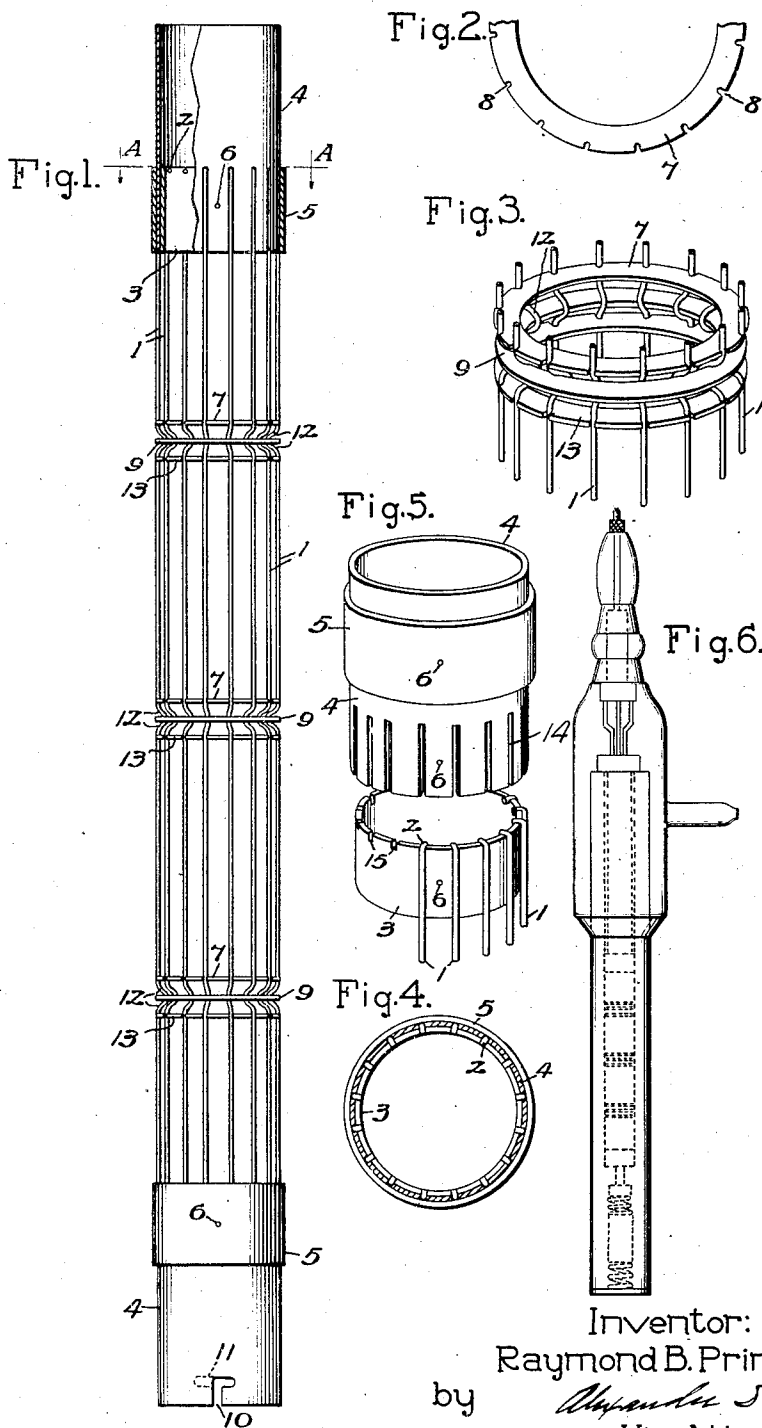
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CONTROL ELECTRODE FOR SPACE CURRENT DEVICES

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CONTROL ELECTRODE FOR SPACE-CURRENT DEVICES.

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My present invention relates to improvements in electrodes for space current devices and more specifically to improvements in the control electrode or grid used in such devices.

One of the objects of my invention is to provide a grid structure which shall be rugged in construction and capable of withstanding severe mechanical stresses.

Another object of my invention is to provide a grid which shall be free from welded portions and whose joints are free from brittleness and weak spots.

A further object of my invention is to provide a grid capable of handling heavy currents and of withstanding prolonged operation at high temperatures without the occurrence of detrimental electronic phenomena such as secondary electron emission.

In the smaller types of space current devices such as the vacuum tubes used for radio broadcast reception the grid or control electrode may be of a relatively simple and comparatively fragile type consisting, for example, of a network of small wires wound around metallic supports and disposed in electron responsive relation to the cathode and anode. Such grids do not heat up to an appreciable degree due to the relatively small amount of current handled by the device. The large size space current devices, however, which are adapted to handle relatively large amounts of power naturally require correspondingly larger grids and these may become quite hot during the operation of the device. It is obvious that the usual type of grid composed of small wires wound around metallic rods is unsuitable for use in such large devices.

Attempts have been made hitherto to provide grids composed of rigid members such as rods and bands but owing to the presence of welded joints, particularly when tungsten and molybdenum are used, these structures have not only been easily damaged but also subject to deformation stresses as well. Furthermore, such structures are difficult to assemble and almost impossible to take apart for repair without damaging the component parts thereof.

In accordance with my invention I provide a novel form of control electrode or grid which shall be free from the aforementioned disadvantages and which may be

readily assembled and mounted in its proper relation to the other electrodes of the tube in which it is to be used and as readily taken down for repair.

For a consideration of what I believe to be my invention reference is to be had to the following specification and its accompanying drawing, while the novel features of the invention will be pointed out with particularity in the appended claims.

In the drawing in which like numerals of reference designate similar parts, Fig. 1 is a view partly in section showing the improved control electrode of my invention; Fig. 2 shows a top view of a portion of one of the component elements of the electrode; Fig. 3 illustrates a portion of the grid in perspective showing the method of uniting the parts thereof; Fig. 4 is a cross-sectional view of the device of Fig. 1 taken along the lines A—A; Fig. 5 shows a detail view of the tubular members used for uniting the ends of the rods and for forming the attachment terminals of the grid; Fig. 6 presents a diagrammatic view of a power type of vacuum tube illustrating the method of using the control electrode of the invention.

My improved electrode consists of a cage-like structure composed of a plurality of rods preferably of tungsten disposed between and held together by two terminal structures, the rigidity and shape of the body of the cage being preserved by means of novel ring strengthening members which itself constitutes one of the features of the present invention.

It will be appreciated, of course, that while these ring strengthening members are employed in the preferred embodiment of my invention, an electrode may utilize other features of my invention and comprise if desired a cage-like structure devoid of these reinforcements.

The construction of the cage and its associated terminal structure will best be understood by reference to the manner in which the elements of each portion are assembled. Considering first the case in which the electrode constitutes a simple cage devoid of the ring strengthening systems, it will be observed that the innermost tubular member of the terminal structure is provided with a series of spaced notches or holes, preferably located on its periphery, into which the bent

extremities of the rods 1 are hooked so that the straight portions of the wires or rods will extend longitudinally downward alongside the outside of the member 3 as shown in Fig. 5. An intermediate tubular member 4, provided with longitudinal slots 14 is slipped over the innermost member 3 in such a manner that the straight portion of the rods 1 fit snugly within the slots and are prevented from moving in a sidewise direction by the sides of the slots. The thickness of the material of which the member 4 is made should of course preferably be the same as the diameter of the rods 1 in order to insure proper retention of the rods within the slots and a snug fit when the locking member 5 is positioned as hereinafter described. The rods are also prevented from shifting in a vertical direction by the coaction of the ends of the slots 14 with the bent portions 2 of the rods. Another tubular member 5 is then slipped over the intermediate slotted member 4 and serves to prevent the withdrawal of the rods from the slots. A single rivet 6 may be used to unite the concentric tubular members 3, 4, 5. The members 3, 4, 5 are preferably made of molybdenum as is also the rivet 6 used for uniting the various members. Either or both of the terminals may be provided with slots 10, 11 as shown in Fig. 1 or any other suitable means for securing the electrode to its supports within the space current device in which it is to be used.

Referring now in detail to Figs. 2 and 3 of the drawing the ring strengthening and spacing system comprises a plurality of annular members 7 and 13 provided with notches or analogous receiving means disposed in spaced relation to each other upon the outer edge of each annulus. A clamping or retaining ring 9 devoid of notches is disposed between the notched members 7 and 13 and parallel thereto and is used to hold the rods 1 in engagement with the notches of washers 7 and 13 in the method of assembly hereinafter described. The members 7, 9 and 13 are preferably made of tungsten and are preferably of approximately the same diameter as the cylindrical structure formed by the rods 1 while the intermediate member 9 may be of somewhat smaller diameter.

The assembly of the electrode when the aforementioned strengthening systems are employed is analogous to the method used when these units are absent.

The rods 1 in addition to being preliminarily provided with the bent ends 2 are likewise provided with the inwardly projecting U shaped kinks or bends indicated in Fig. 3. These bends are formed by means of suitable jigs and in addition to being preformed the rods are preferably heated or "baked" to remove and smooth out any

stresses which may have been engendered by the shaping process. The rods are positioned in the notches or grooves of the annular member 7, after which they are gathered together or drawn in to permit the binding annulus 9 to slip over the rods and to lodge in the U shaped depression. The portion of the rods below the central annulus 9 are then spread out so as to permit the second or lower notched annulus or ring-shaped member 13 to slide into place and to engage the lower shoulders of the U shaped depression after which the rods are again gathered together and the structure is ready for the positioning of the next strengthening system. If desired one of the notched annular members may be omitted so that either 7 or 13 may be used alone with 9. After these ring reinforcing or strengthening systems have been positioned in the manner aforesaid the end terminal structures may be fitted to the electrode. This operation is accomplished in the manner indicated for the construction of the simple type of cage described above. It will of course be understood that any desired number of such strengthening systems may be disposed along the length of the cage depending upon the size and length of the electrode. It will be understood furthermore, that the internal diameter of the cage should not be greatly constricted at the portions where the ring strengthening systems are positioned. Such constriction may be avoided by suitable design of the annular members 7 and 13. Thus, if it be assumed that the rods 1 form an imaginary cylinder and that the innermost portions of the bends 12 form another imaginary cylinder concentric with the first, then in order to avoid constriction of the internal diameter of the electrode these cylinders should practically coincide. This may be effected by deepening the notches of members 7 and 13 and modifying the curvature and depth of the bends 12 accordingly.

The electrode structure described above possesses the advantage of being free from stresses and strains owing to the total absence of welds. Tungsten is the most satisfactory metal of which the grid can be constructed owing to its high melting point. Molybdenum however is more suitable for the purpose of forming supporting terminals but the union of the two metals by welding is difficult to effect in a suitable manner. The structure described above and illustrated in the drawing constitutes a suitable solution of the problem. The absence of riveted or welded joints in the portion of the electrode exposed to electron bombardment constitutes one of the advantages of the electrode of the invention. Rivets, such as are employed in prior art structures require broad bands of metal in order to insure proper retention and strength but such

metallic bands block the path of the electrons and decrease the efficiency of the device.

It is obvious that in some types of space current devices it may be desirable to use a conical instead of a cylindrical grid. In such a case one of the terminal structures, e. g. the upper one may be made smaller than the other without departing from the scope of the invention.

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

1. A control electrode for space current devices comprising a series of metallic rods, tubular metallic terminals mounted on the ends of the rods, and means mounted on said rods intermediate said terminals for maintaining the rods in spaced relation to each other.

2. A control electrode for space current devices comprising a series of rods of refractory metal, tubular metal terminals mounted on the ends of said rods, and means intermediate said terminals and engaging said rods to maintain them in spaced relation to each other, said means comprising a notched annular member.

3. A control electrode for a space current device comprising a plurality of metal rods and a plurality of concentric tubular members mounted adjacent the ends of said rods and adapted to lock said rods to said tubular members.

4. A control electrode for a space current device comprising a plurality of rods of tungsten, a plurality of concentric tubular metallic members associated with the ends of said rods in non-welded locking relation to form a cage-like structure of said rods, and a plurality of spacing systems disposed along the body of the cage, each of said systems being composed of a plurality of annular members adapted to engage the said rods and to retain said rods in spaced relation to each other.

5. An electrode for a space current device comprising a tubular cage-like structure composed of a plurality of refractory metal rods held together by a terminal system disposed at each end of said cage and composed of a plurality of concentric tubular members, the rods of said cage having their ends bent substantially at right angles, a portion of their straight part disposed in spaced relation upon a surface of one tubular member of said terminal system and their bent ends engaging in hooked relation with said tubular member, a second tubular member concentric with said first member and provided with longitudinal openings adapted to receive the rods retained by said first member to prevent sidewise displacement of said rods, the openings of said second member being adapted to coact with the said first member and the ends of said rods to prevent

longitudinal displacement of said rods when said second member is positioned concentric with said first member and a third tubular member adapted to retain said rods in position within the slots of said second member.

6. An electrode for a space current device comprising a tubular cage-like structure composed of a plurality of refractory metal rods held together by a terminal system disposed at each end of said cage and composed of a plurality of concentric tubular members, the rods of said cage having their ends bent substantially at right angles, a portion of their straight parts disposed in spaced relation upon a surface of one tubular member of the terminal system and their bent ends engaging in hooked relation with the said tubular member, a second tubular member concentric with said first member and provided with longitudinal openings adapted to receive the rods retained by said first member to prevent sidewise displacement of said rods, the openings of said second member being adapted to coact with the said first member and the bent ends of said rods to prevent longitudinal displacement of said rods when said second member is positioned concentric with said first member and a third tubular member adapted to retain said rods in position within the slots of said second member, the concentric tubular members of the terminal system being held together in non-welded riveted relation with said rods, and a plurality of spacing systems disposed along the body of the cage-like structure of the electrode, each of said systems being composed of a plurality of notched annular members adapted to engage and retain said rods in spaced relation and an annular member devoid of notches disposed intermediate said notched members and adapted to retain said rods and said notched members in locking relation.

7. A spacing system for the rods of a cage-like electrode comprising a plurality of notched annular members adapted to retain said rods in spaced relation to each other, an annular member devoid of notches and disposed intermediate said notched members and adapted to retain said rods and said notched members in locking relation.

8. A control electrode for a space current device comprising a pair of tubular metallic terminals, a series of metal rods mounted between said tubular members to provide a cage-like structure, and a plurality of coaxially arranged annular members engaging the inner and outer surfaces of said cage-like structure to thereby maintain said rods in position.

In witness whereof, I have hereunto set my hand this 7th day of January, 1925.

RAYMOND B. PRINDLE.