

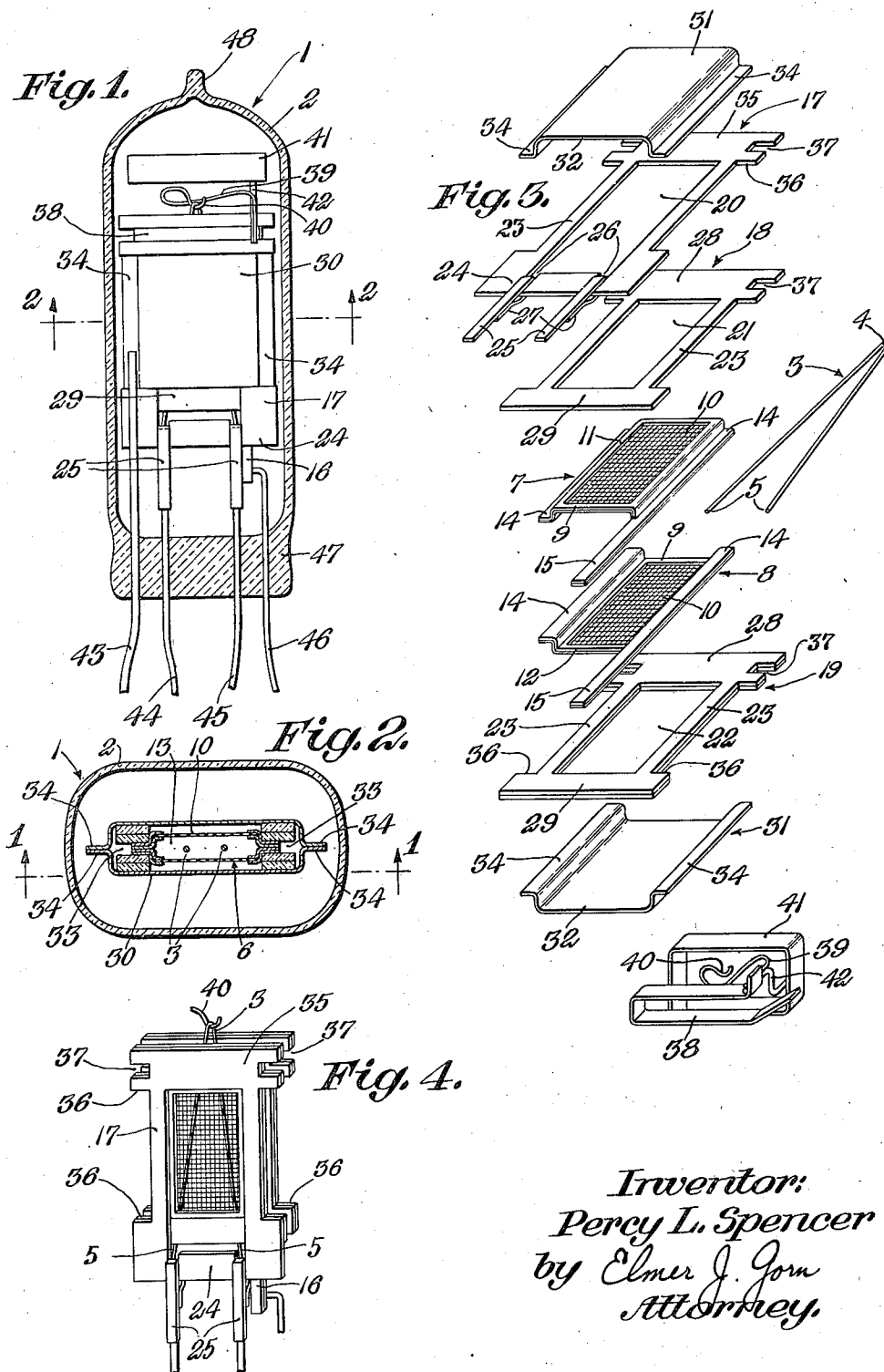
Dec. 24, 1946.

P. L. SPENCER

2,413,006

ELECTRODE ASSEMBLY FOR DISCHARGE TUBES

Filed Dec. 17, 1941



Inventor:
Percy L. Spencer
by Elmer J. Gorn
Attorney.

UNITED STATES PATENT OFFICE

2,413,006

ELECTRODE ASSEMBLY FOR DISCHARGE TUBES

Percy L. Spencer, West Newton, Mass., assignor,
by mesne assignments, to Raytheon Manufacturing Company, a corporation of Delaware

Application December 17, 1941, Serial No. 423,308

8 Claims. (Cl. 250—27.5)

1

This invention relates to an electrical space discharge device in which the dimensions of the device are reduced to relatively small values. This invention also relates to the method of constructing the same.

In an electrical space discharge device employed in high frequency circuits it has been found advantageous to employ electrodes of relatively small dimensions. Where such tubes are designed for high amplification it has been desirable that the electrodes be arranged relatively close together. In such a device the assembly of the electrodes on a mass production basis presents various difficulties because of the relatively small size and close spacing thereof. Moreover since such a spacing of the electrodes in a high gain, high frequency device of the character described is relatively critical, the further difficulty of achieving accurate spacing between the electrodes, so as to produce electrical space discharge devices of uniform operating characteristics, is encountered when using standard methods of manufacture and standard types of construction.

When devices of the character described are subjected to extreme shock, as for example when they are located in rapidly accelerating bodies, a still further difficulty is encountered. Because of the relatively small size of the elements and the necessity for close spacing thereof, it has proven difficult to construct them sturdily or to assemble them in a relatively shock-proof construction.

It is of course obvious that while I have mentioned difficulties encountered in the manufacture and in the structure of high frequency, high gain electrical space discharge devices of relatively small dimensions, these difficulties are also present to a greater or lesser degree in all types of electrical space discharge devices having relatively small dimensions.

An object of this invention is to provide a novel method of constructing and a novel arrangement of the electrode assembly whereby the electrodes may be easily and quickly assembled and thereafter handled as an integral unit, this novel method and arrangement being adapted for mass production.

Another object of this invention is to provide a novel method for construction and a novel arrangement of the electrode assembly whereby the electrodes are automatically accurately spaced from each other. Despite the relatively small dimensions of the elements included in the electrical assembly it is feasible to employ the or-

2

dinary operator in manufacturing in accordance with this invention. No unusual skill is necessary to assure accuracy in the spacing of the electrodes.

A further important object of the present invention is to provide a method of construction and a novel arrangement of the electrode assembly whereby said assembly is capable of withstanding relatively severe shocks without damage thereto.

Other objects and advantages of this invention will become apparent and the foregoing objects will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing wherein:

Fig. 1 is an enlarged cross-sectional view of a tube embodying my invention, said view being taken along line 1—1 of Fig. 2;

Fig. 2 is an enlarged cross-sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is an enlarged exploded view of the elements illustrated in Figs. 1 and 2, the glass envelope and lead-in wires being omitted; and

Fig. 4 is an enlarged perspective view of part of the electrode assembly illustrated in the prior figures, the anodes being omitted and the lead-in wires and cathode-supporting spring being shown fragmentarily.

The electrode space discharge device illustrated is a tube 1 having an envelope 2 of some suitable material such as glass.

A directly heated filamentary cathode 3 is formed in the shape of an inverted V. It is suspended in the assembly from its apex 4, the free ends 5 thereof being connected as will be described hereinafter.

When assembled with the other electrodes the cathode is arranged so that it is substantially flat and lies in a plane substantially parallel to the planes in which the other electrodes lie.

The grid 6 is formed in two sections 7 and 8, each of said sections consisting of a pair of P-shaped frames 9 of any suitable material such as nickel, having the edges of a fine wire mesh 10 arranged therebetween along the closed portions of the P, as illustrated in Fig. 3, and welded thereto and to each other.

In order to arrange the grid so that it may be interposed between the cathode and anode I prefer to upset each of the sections 7 and 8 to form therein relatively shallow pans 11 and 12 respectively. These pans 11 and 12 are then arranged opposite each other to form an opening 13 therebetween in which the cathode 3 is

3

arranged. To provide means for fastening the sections 7 and 8 together, flanges 14 are formed on opposite ends of each of the U-shaped pans 11 and 12. These flanges are thereafter welded together to thereby form a unitary grid electrode. The legs 15 of the P-shaped frames 9 are thereby arranged against each other to form a tab 16 by which the grid 6 may be connected to its lead-in.

The grid 6 is substantially flat and when arranged in the assembly lies in a plane substantially parallel with the planes in which the other electrodes lie.

In order to separate the electrodes I prefer to provide insulating members 17, 18, and 19, said members being substantially flat and of predetermined thickness. These members may be made of any suitable insulating material, such as, for example, mica. The insulating spacer member 19 may be a single spacer or, as shown, a plurality of spacers which when joined have the desired thickness, spacers 17 and 18 together being preferably as thick as spacer 19. These members serve not only to insulate the electrodes from each other but also to provide accurate spacing thereof, the accuracy of the spacing depending solely on the accuracy with which the insulating spacing members are made. Since, however, accurate control of the thickness of such spacers is readily feasible in standard manufacturing processes, this offers no difficulty.

In order to permit the electronic discharge to pass unimpeded directly from the cathode to the anode I prefer to provide openings 20, 21, and 22 in insulating spacer members 17, 18, and 19 respectively. The insulating spacer members 18 and 19 are arranged adjacent and abutting grid 6. In order that these spacers may be interlocked with the grid so as to prevent relative movement thereof the openings 21 and 22 are made of such dimensions so that the pans 11 and 12 of the grid 6 fit snugly within the openings 21 and 22, so the vertical portions 23 of spacers 18 and 19 abut the flanges 14.

It will therefore be seen that the grids and the insulating spacer members 18 and 19 are thereby interlocked so as to prevent relative movement thereof in a vertical plane when said elements are arranged as shown in Fig. 1.

Spacer 17 is especially designed so as to provide a convenient means for fastening the free ends 5 of the cathode 3. For this purpose the spacer 17 is preferably longer than the other spacers so that the lower horizontal portion 24 thereof extends below the other spacers when the electrode assembly is completed, as can best be seen in Fig. 4.

The free ends 5 of the cathode 3 are preferably secured as by welding to metal straps 25, which straps may be arranged on horizontal portion 24 of spacer 17. To secure the straps in position I prefer to provide vertical slots 26 in the horizontal portion 24, said slots being spaced and extending into opening 20.

The straps 25 formed from a strip of a suitable metal, such as nickel, each have one end 27 thereof doubled over the horizontal portion 24 adjacent the slots 26 so that a portion of each strap lies within its corresponding slot. These straps are bent tightly around the horizontal portion 24 and the ends 27 of each of these straps are welded to the main portion thereof, thereby fixing the straps in position. The free ends 5 of cathode 3, which protrude below the assem-

4

bly between the spacers 18 and 19, are bent over to the straps 25 and welded thereto.

Upon assembly when the cathode 3 is arranged within the grid opening 13 the upper horizontal portions 28 and the lower horizontal portions 29 of the insulating spacer members 18 and 19 are immediately adjacent the cathode and the lower portion 29 of 18 abuts the same. These horizontal portions help to position the cathode within the grid opening 13.

The anode 30 is preferably made of a pair of flat plates 31 upset to form channels 32 which are arranged opposite each other to provide an opening 33 therebetween within which opening the various elements are arranged.

Flanges 34 on either side of the channel 32 are provided, said flanges 34 being welded together to secure the plates together and thereby form the integral anode 30.

In order to prevent relative movement between the insulating spacer members and the plates 31 of the anode, the horizontal portions 28 and 29 of insulating spacer members 18 and 19 and the horizontal portions 24 and 35 of insulating spacer member 17 which project above and below plates 31 are extended horizontally so as to form shoulders 36 between which the anode plates 31 are held.

As will be seen the plates 31 of the anode prevent the elements forming the electrode assembly from spreading in a horizontal plane, while the shoulders 36 which interlock the spacers and the anode prevent displacement in a vertical plane. Since spacers 18 and 19 are also interlocked with the grid 6, the grid too is secured against such displacement of these shoulders.

To further insure a sturdy shock-proof structure the upper horizontal portions 28 of the insulating spacer members 18 and 19 and the upper horizontal portion 35 of spacer 17 are preferably provided with horizontal slots 37 extending inwardly from the opposite ends of these portions. A metallic band 38 is passed through said slots 27 around said portions and the ends thereof are welded together.

To support the cathode 3, a spring member 39 is provided having at one end thereof a hook 40 on which the apex 4 of the cathode 3 is hung, the opposite end of said spring member 39 being welded to the band 38.

In constructing an electrode assembly it is preferred that a ring 41 of suitable getter material be joined to the assembly by arranging said ring above the electrodes and securing it as by welding to a supporting member 42 which may in turn be welded to the band 38.

Before the assembly begins the straps 25 are secured in position on the lower horizontal portion 24 of spacer member 17 and the grid sections are welded together. The anode plate 31 is arranged on a suitable supporting surface and spacer 19, grid 6, spacer 18, spacer 17, and the upper anode plate 31 are placed thereon successively in the order named. The anode plates are welded together. The band 38, which preferably has the spring 39 welded thereto as well as the supporting member 42 which in turn is welded to the getter ring 41, is then arranged within slots 37 and the ends thereof welded together.

The cathode 3 may next be inserted in opening 13 of the grid and the free ends 5 thereof are bent over towards the straps 25 and welded thereto, while the apex 4 is arranged over the hook 40 and maintained under tension by the spring 39.

It will be seen that I have here provided an

5

integral electrode assembly which can be handled as a unit. It will be further seen that the electrodes and insulating spacer members of this unit which are arranged to lie substantially flat are stacked in layers lying in substantially parallel planes.

Lead-in wires for the electrodes may be provided as follows: lead-in 43 may be connected to the flange 34 of the anode 30; lead-ins 44 and 45 welded to straps 25; and lead-in 46 to tab 16 of the grid.

The assembly as herein above described is thereafter inserted within the glass envelope 2.

A press 47 is formed at the bottom of the envelope 2 and seals the lead-ins therein, thereby providing support for the electrode assembly. The electrodes are heated to drive off the occluded gases and the getter ring 41 is flashed to release the getter material while the tube 1 is being evacuated through the tip 48. The tip 48 is thereafter sealed.

It may be pointed out that the electrode assembly is a unit and can be handled as such in mass production. Since the accuracy of spacing is dependent solely on the dimensions of the spacers and electrodes, highly skilled operators are unnecessary despite the relatively small dimensions of the elements. By the method and arrangement hereinabove described I have been able to produce tubes of a very small size on a mass production basis. For example, tubes of the type hereinbefore described and made according to this method have been constructed on a mass production basis, the outside overall dimensions of said tubes being .275 inch thick, .365 inch wide, and 1 1/8 inches long.

This arrangement has proved so sturdy that during tests in which the assembly has been placed in several glass tubes successively and the glass broken away, the only parts damaged were the getter ring and the cathode. Tubes made in accordance with this invention have been placed in a centrifuge and the weight thereof increased from a few ounces to about one hundred pounds. Under these severe conditions, the tubes remained intact.

While I have described my invention in specific detail it is obvious that these details may be considerably varied without departing from the spirit thereof. For example, the various steps may be performed in a different order. The tube may have additional grids and anodes, the cathode may be indirectly heated, or it may be a cold cathode. The tube may be a high vacuum or gas or vapor-filled type. The getter ring may be omitted. These are but a few of the variations that would be apparent to anyone skilled in the art upon reading the disclosure hereof. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. In an electrical space discharge device, an integral electrode assembly arranged in layers and comprising a plurality of substantially flat electrodes and a plurality of substantially flat insulating spacer members interposed therebetween, said insulating spacer members lying in planes parallel to the planes in which said electrodes lie, a portion of each of said insulating spacer members projecting beyond the electrodes, and means cooperating with said projecting portions for preventing relative movement of said spacer members.

2. An electrode assembly for an electrical space

6

discharge device comprising a plurality of electrodes, each lying in a plane substantially parallel to the planes in which the other electrodes lie, and a plurality of insulating spacer members interposed between the said electrodes and interlocked therewith, said insulating spacer members lying in planes parallel to the planes in which said electrodes lie, a portion of each of said insulating spacer members projecting beyond the electrodes, and means cooperating with said projecting portions for securing said insulating spacer members together.

3. An electrode assembly for electrical space discharge devices comprising a plurality of electrodes, a plurality of insulating spacer members of predetermined thickness interposed between said electrodes, said electrodes being separated by the thickness of said spacer members, said insulating spacer members and electrodes interlocking to thereby prevent relative movement along one plane and means for preventing movement along a plane perpendicular to said first mentioned plane.

4. An electrode assembly for an electrical space discharge device comprising a cathode, a grid surrounding said cathode, said grid having a substantially rectangular cross-section, a pair of flat insulating plates placed on opposite sides of said grid, each of said insulating plates having an opening of substantially the size and shape of the corresponding side of said grid to receive said side of said grid therein, each insulating plate having a total thickness greater than the depth of the grid extending into said opening, and an anode plate member supported in contact with the other side of each of said insulating plates.

5. An electrode assembly for an electrical space discharge device comprising a cathode, a grid surrounding said cathode, said grid having a substantially rectangular cross-section, a pair of flat insulating plates placed on opposite sides of said grid, each of said insulating plates having an opening of substantially the size and shape of the corresponding side of said grid to receive said side of said grid therein, said grid having a flange extending between said pair of insulating plates on opposite sides of said grid, each insulating plate having a total thickness greater than the depth of the grid extending into said opening, an anode plate member supported in contact with the other side of each of said insulating plates, and means for clamping said insulating plates together to clamp said flange and retain said grid firmly in place.

6. An electrode assembly for an electrical space discharge device comprising a cathode, a grid surrounding said cathode, said grid having a substantially rectangular cross-section, a pair of flat insulating plates placed on opposite sides of said grid, each of said insulating plates having an opening of substantially the size and shape of the corresponding side of said grid to receive said side of said grid therein, said grid having a flange extending between said pair of insulating plates on opposite sides of said grid, each insulating plate having a total thickness greater than the depth of the grid extending into said opening, an anode plate member surrounding said grid and supported in contact with the other side of each of said insulating plates, abutments on said insulating plates engaging said anode plate member to prevent longitudinal movement thereof, and means for clamping said insulating plates together.

7. An electrode assembly for an electrical space

7

discharge device comprising a plurality of electrodes, each lying in a plane substantially parallel to the plane in which the other electrodes lie, and a plurality of insulating spacer members interposed between the said electrodes and interlocked therewith, said insulating spacer members lying in a plane parallel to the plane in which the electrodes lie, a portion of each of the outer insulating spacer members projecting beyond the electrodes, and means cooperating with said projecting portions for securing said insulating members together.

8. An electrode assembly for an electrical space

8

discharge device comprising a plurality of electrodes, each lying in a plane substantially parallel to the plane in which the other electrodes lie, and a plurality of insulating spacer members interposed between the said electrodes, said insulating spacer members lying in a plane parallel to the plane in which the electrodes lie, a portion of each of the outer insulating spacer members projecting beyond the electrodes, and means cooperating with said projecting portions for securing said insulating members together.

PERCY L. SPENCER.