May 10, 1932. W. L. KRAHL 1,857,647

UNITARY ELEMENT STRUCTURE FOR VACUUM TUBES

Filed Oct. 2, 1929

Fig. 1.

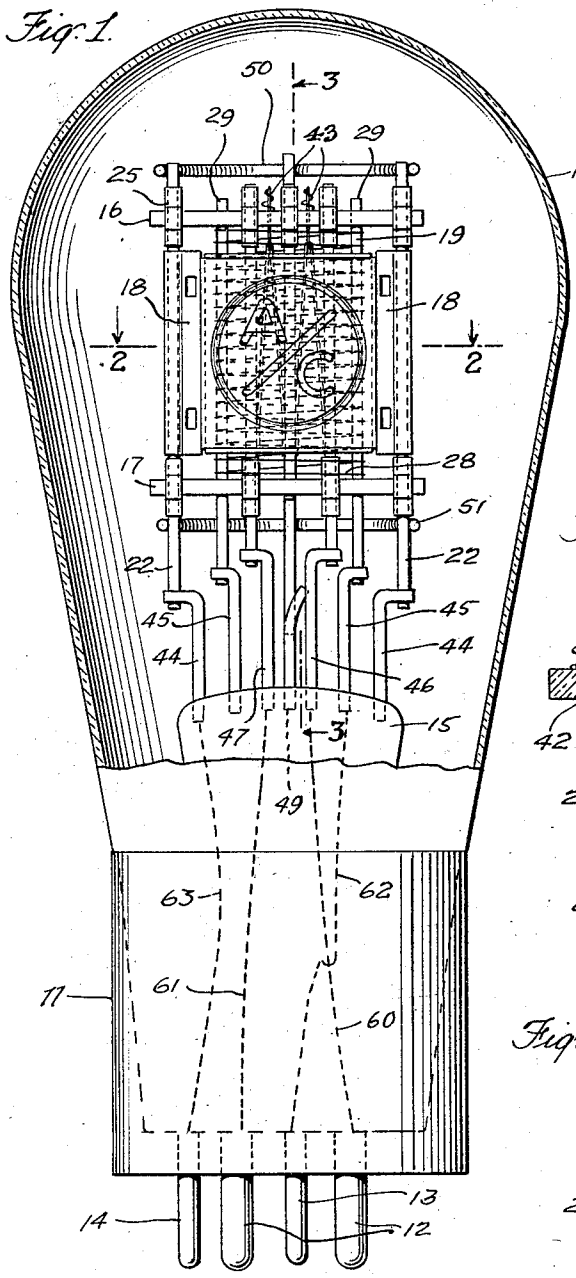


Fig. 2.

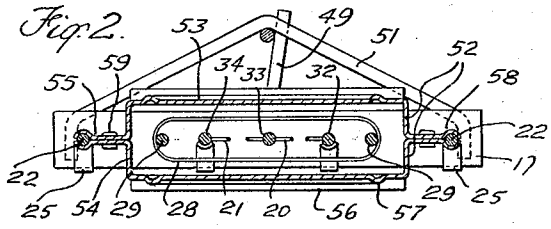


Fig. 3

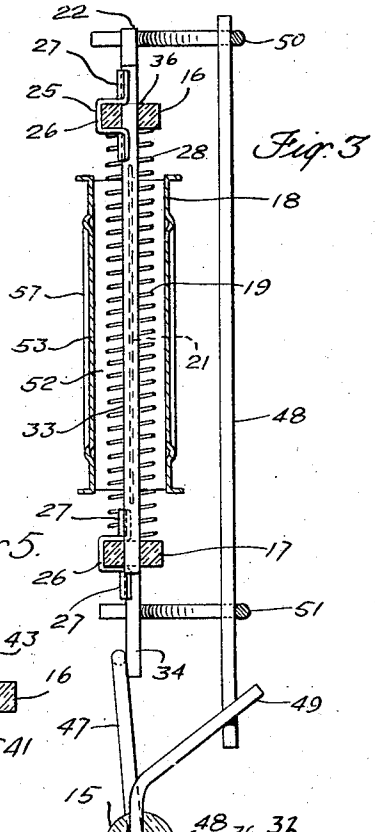


Fig. 5.

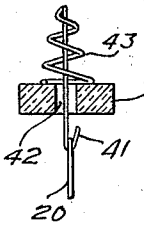
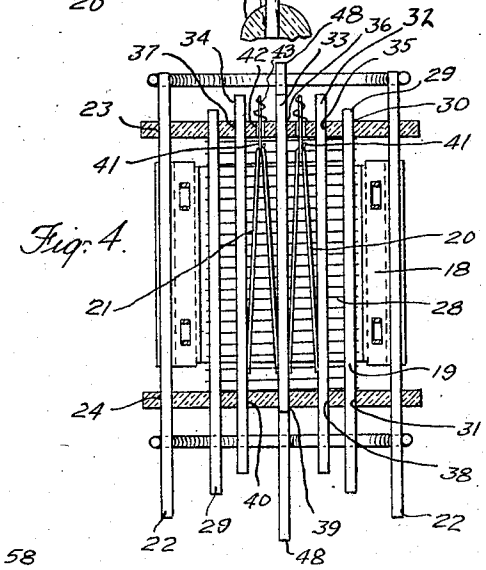


Fig. 4.



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UNITED STATES PATENT OFFICE

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UNITARY ELEMENT STRUCTURE FOR VACUUM TUBES

Application filed October 2, 1929. Serial No. 396,668.

This invention relates to vacuum tubes and has for its principal object to provide a means to mount the elements in a vacuum tube whereby they form a single unit which is easily supported upon the press.

Another object of the invention is to provide a unitary structure for vacuum tube elements in which the elements may be spaced in very close proximity with each other without any danger of touching.

Another object of the invention is to provide a means to support a filament in a vacuum tube in such a manner that it cannot touch the adjacent element.

Another object of the invention is to provide a unitary structure for vacuum tubes, whereby the elements may expand or contract longitudinally with temperature changes without changing the space relation with respect to the other elements.

Another object of the invention is to provide an anode structure in which the effective anode surface will not be moved with respect to the grid and cathode by slight movement of the anode supporting means.

Other objects of the invention and objects relating particularly to methods of manufacturing and assembling the various parts will be apparent as the description of the invention proceeds.

One embodiment of this invention has been illustrated in the accompanying drawings, in which

Fig. 1 is a front elevational view of a vacuum tube with portions of the envelope broken away to show the unitary element structure.

Fig. 2 is a sectional plan view taken on the lines 2—2 of Fig. 1 and showing the element structure;

Fig. 3 is a sectional side view of the element structure shown in Fig. 1 and taken on the line 3—3 of Fig. 1;

Fig. 4 is a sectional front elevation of the element structure and taken through the center thereof; and

Fig. 5 is a sectional detail view showing the spring for supporting one of the filaments.

Referring more in detail to the several figures, the invention is illustrated in connection with a vacuum tube having an envelope 10 mounted on the usual base 11, to which are attached the filament contact 12, a grid contact 13, and a plate or anode contact 14. The envelope 10 has an integrally formed press 15 extending upwardly within the envelope in the usual manner and adapted to support the elements of the tube.

A pair of insulating plates 16 and 17 are spaced apart and adapted to secure in rigid position between them the anode 18, the grid 19, and the filaments 20 and 21. To accomplish this the anode 18 is mounted upon a pair of parallel upright metallic posts 22 which pass through holes 23 in the plate 16 and holes 24 in the plate 17 extending preferably farther below the plate 17 than above the plate 16.

Where each of the posts 22 pass through one of the insulating plates 16 and 17 a clip 25 is provided to hold it rigid with respect to the plate. These clips have a U-shaped member 26 which is adapted to extend over the edge of the insulating plate to a point adjacent the post opening where the flanges 27 extend at right angles and are provided with grooves to fit the contour of the supporting post 22 when inserted through the opening in the plate. This clip is similar to that shown and described in my co-pending application entitled "Unitary vacuum tube structure", Serial No. 378,163, filed July 13, 1929. When the flanges 27 both above and below the insulating plates 16 and 17 are welded to the posts 22 a rigid structure is obtained, the support rods being maintained at right angle to the insulating plates and held securely without permitting any movement with respect thereto.

The grid 19 comprises a flattened helix of wire 28, the turns of which are secured to two parallel upright posts 29 which in turn pass through openings 30 in the plate 16, and 31 in the plate 17 extending beyond the two plates similar to posts 22. If desired, the grid posts 29 may be rigidly secured to the plates 16 and 17 in the same manner as the anode supporting posts 22 by use of the clips

25, but I have not shown any clips on the supporting posts 29 because I prefer to have the helix forming the grid extend from one plate to the other, thus positioning the grid with respect to the plate but at the same time permitting some slight movement of the grid posts to allow for expansion and contraction upon temperature changes.

As an illustration of my novel means of supporting the filament, I have shown two V-shaped filaments 20 and 21 supported at their lower ends upon three posts 32, 33, and 34, which also pass through holes provided for that purpose in the plates 16 and 17, extending above the plate 16 and below the plate 17. These supporting posts pass through holes 35, 36, 37 respectively in the plates 16 and through holes 38, 39 and 40 respectively in the plate 17. The V-shaped filament 20 is positioned between the post 32 and the center post 33, and the filament 21 is positioned between the center post 33 and the other post 34. The two lower ends of each filament are welded to the posts in the manner shown in Fig. 4 at a point adjacent the lower insulating plate 17. The upper or loop end of the filaments 20 and 21 are supported respectively upon hooks 41 and 42 which extends through openings 42 in the upper insulating plate 16 and are urged upwardly by coil springs 43 which may be formed as a part of the hook members 41 as clearly illustrated in the enlarged view in Fig. 5. The spring is preferably spiral so that the base rests upon the plate and is large enough to prevent it from passing through the opening therein. It will be understood that the springs 43 place a tension on each filament to maintain the filament taut and free from contact with any of the other parts of the tube. The three posts 32, 33, and 34 may be rigidly secured to the upper insulating plate 16 by means of the clips 25 already described in connection with the posts 22 for the anode. Also, if desired, these clips may be applied at the lower insulating plate 17, and I have shown them secured to the outer filament support 32 and 34, but as long as these supports are well secured to the upper insulating plate 16 it is not necessary to provide additional clips in the lower end but it may be preferable to omit them so that the posts may expand and contract freely with respect to the plate 17.

A plurality of support wires may be sealed in the press 15 to provide a means for supporting the element unit upon the press. I have shown a pair of such wires 44 adapted to connect with the posts 22, another pair 45 to connect with the grid posts 29, and, in order to connect with the outer filament posts 32 and 34, I have also shown support wires 46 and 47, respectively, sealed in the press 15 and forming the electrical connection for the filament. These support wires 44, 45, 46 and 47 may be bent at right angles at their upper ends to form a convenient means for welding to the supporting posts 22, 29, 32 and 34.

As shown the supporting posts are all in the same plane, and in order to prevent the unitary element structure from moving with respect to the press of the tube, I provide an additional support 48 spaced from the elements and extending above and below them. This support 48 may be welded at its lower end to an angular support 49 sealed in the press 15 at the center thereof and bent backwardly at an angle to meet the support 48. To connect the support 48 to the element unit a yoke 50 may be welded at its central point to the support 48 and may be bent outwardly and forwardly to engage the upper ends of the anode posts 22. A similar yoke 51 may be attached in a similar manner to the posts 22 at the lower end thereof and may be welded to the support 48 at its mid point. The quadrilateral thus formed by the elements, yokes and support 48, (see Fig. 3) having welded corner joints, provides a mounting for the unitary element structure which permits little or no movement with respect to the press.

The method of constructing the anode 18 and attaching it to the posts, forms an important feature of the invention. As shown in Fig. 2 the anode comprises two members 52 made exactly alike and adapted to be secured together to form the complete anode. Each of the members 52 has a substantially flat anode surface 53, which is adapted to be positioned at a predetermined distance from the cathode and grid of the tube, end flanges 54 at right angles to the anode surface 53, and additional right angle flanges 55 on the end flanges 54 and parallel with the anode surface 53 to attach the two members together and to attach the whole unit to the supporting posts 22. In order to prevent any distortion of the anode surface 53, I provide flanges 56 at each end thereof, these flanges being bent at an angle to the surface, and if desired, additional re-enforcing devices may be employed as by the embossed circle 57 and other insignia such as the letters "AC" shown within the circle 57 in Fig. 1. The flanges 56 together with the other re-enforcing devices make the anode surface 53 substantially rigid so that it does not warp or bend.

Special note should be taken of the fact that the flanges 54 are bent at right angles to anode surfaces 53 and the attaching flanges 55 are bent at right angles to the flanges 54. I have found that very slight changes with respect to the spacing between the cathode and anode will cause considerable change in the characteristics of the tube when in operation, and this occurs in the usual tube construction as any movement of the anode supporting posts tends to warp the anode surface causing portions of it to move with re-

spect to the cathode and grid. In the present construction any change in the position of the anode supporting posts 22 is taken up by the bending of the flanges 54 where they connect with the anode surface and with the flanges 55, and the effect on the spacing between the anode and other elements is so slight as to cause very little difference in the characteristics of the tube.

The anode flanges 55 are provided, of course, with means to secure them to the supporting posts as by the grooves 58 pressed in the ends thereof which fit around the supporting posts 22 as clearly indicated in Fig. 2. The two members 52 may be secured together by riveting or by inserting portions of one through openings in the other as indicated. In assembling the element structure the posts 32, 33 and 34 would be set in a jig spaced apart as indicated in Fig. 4, and the filaments welded at their lower ends to the posts as indicated. Then the insulating plate 16 is inserted over the ends of the posts 32, 33, and 34 and after the spring members 43 are positioned in place and properly hooked under the loop of each filament, the insulator 16 is raised slightly, placing the spring 43 under compression and the filaments under tension and the clips 25 are then securely attached to the posts by welding to hold them rigidly with respect to the insulator. The grid posts 29 with the grid helix already attached may then be inserted in the openings provided for that purpose in the insulator 16, and the anode posts 22 with the anode attached thereto may also be inserted in the holes 23 provided in the plate 16. Clips 25 may be attached then to the anode posts securing them rigidly to the plate 16 and the bottom insulator 17 may then be positioned on the lower end of the various supports with the support passing through the holes provided for that purpose in the insulator 17. Clips 25 may then be welded to the lower ends of any of the support posts where they pass through the insulator 17 although it is only necessary to use the clips on enough of the posts to maintain the two insulators rigidly spaced from each other. I prefer to put the clips on the two anode support posts 22 as indicated. The yokes 50 and 51 may then be welded to the posts 22 at the top and bottom as indicated, and the upright 48 may be welded to the center point of these two yokes, or the yokes and the support 48 may be left until the element is mounted in the tube.

The supporting posts are cut off below the elements at such a length that they will conveniently cooperate with the short wire supports which are sealed in the press of the tube, and when it is desired to mount an element unit upon a press it is only necessary to hold the element in alignment with the press and wires sealed therein and weld each post to its cooperating press support. The central angular support 29 is then welded to the upright 48 and the mounting of the tube on the press is complete.

As indicated in Fig. 1, the filament terminal 12 is connected to the support rod wire 46 by means of a wire 60, while the support wire 47 is connected to the other filament terminal 12 by means of the wire 61. In like manner the support wire 45 is connected to the grid terminal 13 by means of the wire 62 while the support wire 44 is connected to the plate terminal 14 by means of the wire 63. Thus the anode is connected through one of the posts 22, one of the support wires 44, and the wire 63 to the plate terminal 14 at the base of the tube; the grid is connected through one of the posts 29, one of the support wires 45, and the wire 62 to the grid terminal 13 at the base of the tube; and the filament is connected through one of the filament terminals 12, through the wire 60, the support 46, the supporting post 32, both filaments in series through the post 34, the wire 61, and the other filament terminal thereof.

The insulating plates 16 or 17 may be made of mica, quartz, or any other desirable material suitable to use in vacuum tubes.

With the construction shown, it will be evident that the anode, grid, and the filamentary cathode are positioned in such a manner that there can be no movement with respect to each other. This makes it possible to design a tube with the grid very much closer to the cathode, and the anode very much closer to the grid without any danger of the parts touching, and the efficiency of the tube is therefore increased. It will be evident also that the construction has great durability and strength and the tube may be used under severe conditions of vibration such as would be found in an aeroplane without damage or interference with the operation thereof.

While a tube having a filamentary cathode has been shown the invention is not necessarily limited to such a construction, as one with a separately heated cathode might also be constructed in the same way as well as other types of tubes such as shield grid tubes or tubes having a smaller number of elements such as rectifier tubes. While heavy supporting wires have been shown sealed in the press of the tube it is also evident that it is only necessary to use enough heavy supporting wires to mount the structure rigidly upon the press and the remaining wires may be attached to the other elements by flexible connections if desired.

Other modifications may be made in the unit as shown without departing from the spirit of the invention, and I do not desire therefore to limit the invention to what has been shown and described except as such limitations occur in the appended claims.

What I claim is:

1. In a vacuum tube having a stem, a pair

of spaced supports, a plurality of support posts extending between said supports and terminating above said stem thereby combining with the supports to provide a unitary structure, a filamentary cathode positioned between two of said support posts and having one end attached to one, and the other end attached to the other, a grid mounted upon another pair of said support posts, and an anode mounted upon another pair of said support posts, thereby including the filament, grid, and anode as part of the unitary structure independent of any support from the stem.

2. In a vacuum tube having a stem, a pair of spaced apart insulators, a plurality of support posts extending between said insulators and terminating above said stem thereby combining with the insulators to provide a unitary structure, a V-shaped filament positioned between two of said support posts, one end of said filament being welded to one of said support posts, and the other end of said filament being welded to the other of said support posts, means to support the loop end of the filament from one of said insulators, a grid adjacent said filament and mounted upon a pair of said support posts, and an anode surrounding said grid and mounted upon another pair of said support posts, thereby including the filament grid and anode as part of the unitary structure independent of any support from the stem.

3. In an electron discharge device having lead-in wires in the stem, the combination of a unitary assembly of elements including a grid, cathode and anode, wherein there is a post to which each of said elements is secured, and means for holding all of said posts in fixed relative positions independent of said stem, said unitary structure being supported entirely by said lead-in wires from the stem.

4. In an electron discharge device having lead-in wires in the stem, the combination of a unitary assembly of elements including a grid, cathode and anode, wherein there is a post to which each of said elements is secured, the length of each of said posts differing from the length of the post next adjacent thereto, and means for holding all of said posts in fixed relative positions independent of said stem, said unitary structure being supported entirely by said lead-in wires from the stem.

5. In an electron discharge device having lead-in wires in the stem, the combination of a unitary assembly of elements including a grid, cathode and anode, wherein there is a post to which each of said elements is secured, and means for holding all of said posts in fixed relative positions independent of said stem, the several posts projecting through one of said holding means distances differing each from the distance of projection of an adjacent post, said unitary structure being supported entirely by said lead-in wires from the stem.

6. In an electron discharge device having lead-in wires in the stem, the combination of a unitary assembly of elements including a grid, cathode and grid, wherein there is a post to which each of said elements is secured, and means for holding all of said posts in fixed relative positions independent of said stem, the several posts projecting through one of said holding means distances differing each from the distance of projection of an adjacent post, said unitary structure being supported entirely by said lead-in wires from the stem by securing the lead-in wires to the said projecting ends of the posts at distances from the stem substantially inverse to the projecting distance of the respective posts from the holding means.

In testimony whereof, I affix my signature.

WALTER LOUIS KRAHL.