**Sept. 16, 1952** H. K. KUTHE ET AL **2,611,112**

THREE-ELEMENT THERMIONIC TUBE STRUCTURE

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FIG. 1A

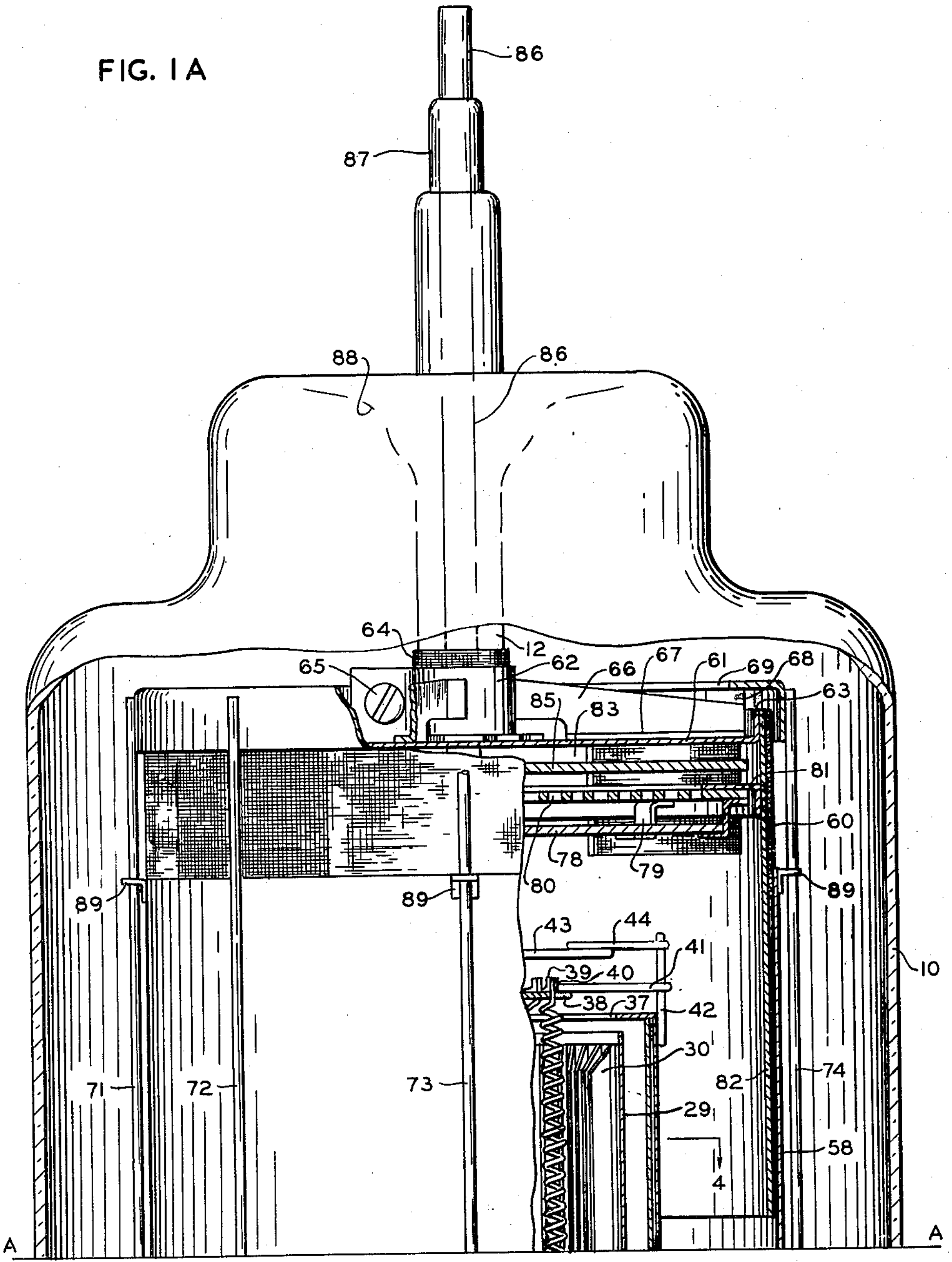

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FIG. 1B

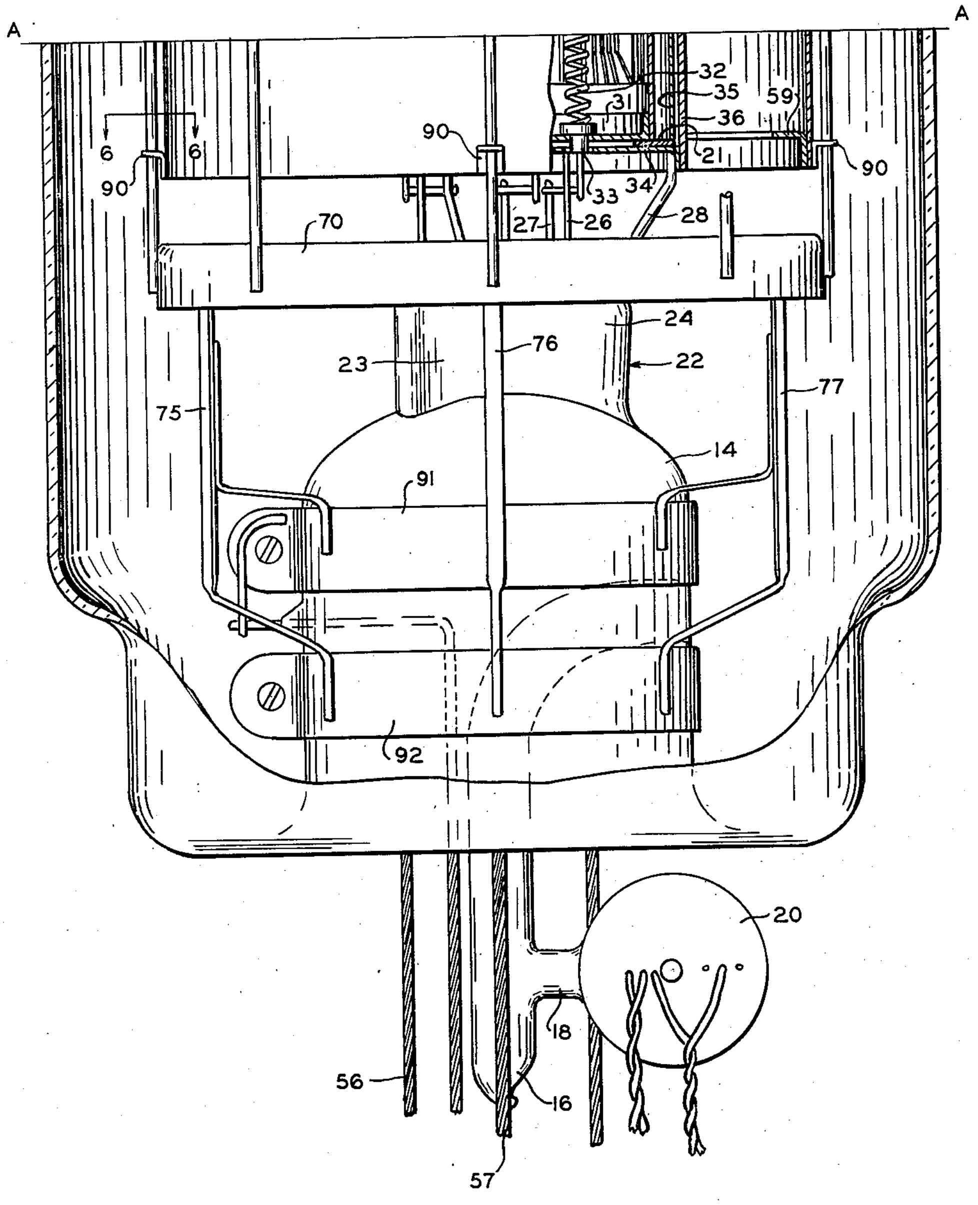

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FIG. 2

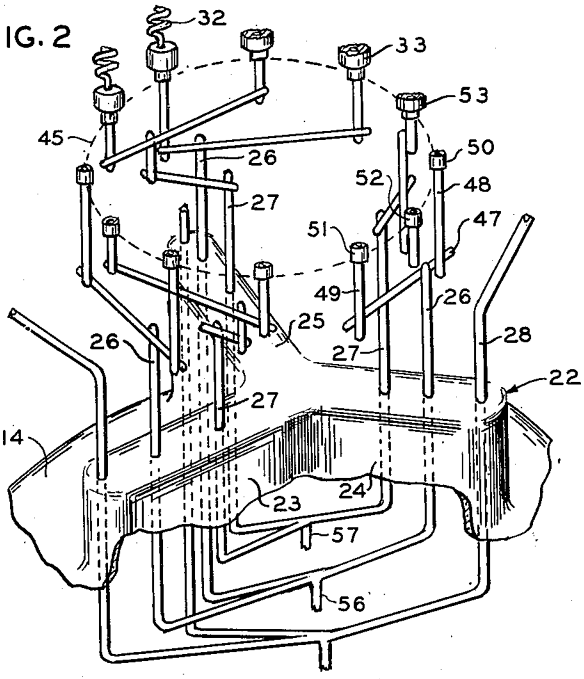


FIG. 3

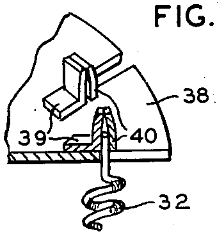


FIG. 4

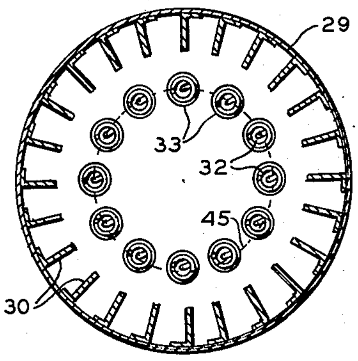


FIG. 5

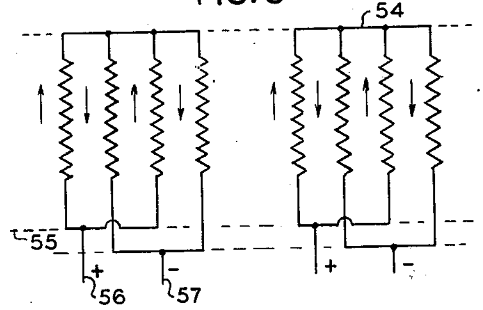


FIG. 6

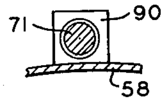


FIG. 7

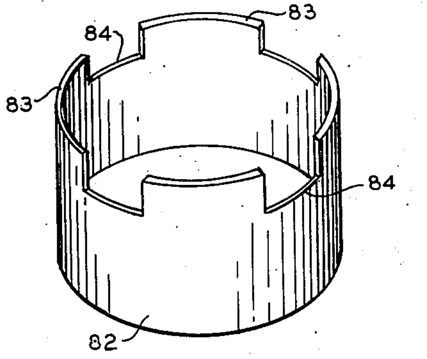
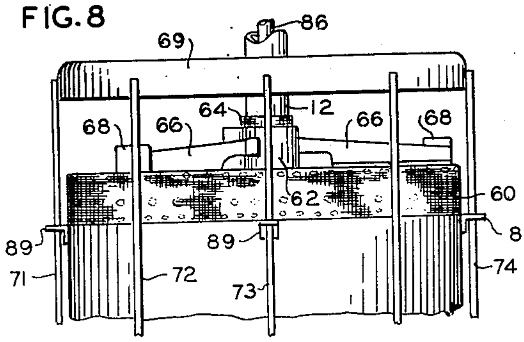


FIG. 8



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**Patented Sept. 16, 1952** **2,611,112**

# UNITED STATES PATENT OFFICE

2,611,112

## THREE-ELEMENT THERMIONIC TUBE STRUCTURE

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**Application November 14, 1949, Serial No. 127,122**

**13 Claims.** (Cl. 315—99)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This invention relates to thermionic tubes having a cathode, a grid, and an anode, and, more particularly, to the structure of such tubes.

The invention will be described in connection with a hydrogen-filled thyratron. It is to be understood, however, that the teachings of this invention are equally applicable to hard vacuum tube and gas-filled tubes using a different gaseous medium than hydrogen.

From the description that follows, it will become apparent that the invention relates to the three-element tubes of especially large size and capacity, which must of necessity assume very large dimensions. The tubes of this class are capable of transmitting peak power of the order of ten megawatts or higher. Numerous difficult problems arise in the making of this type of tube, and the invention discloses a successful solution of such problems. Thus stresses and strains imposed on the elements of the tubes during their manufacturing processes and their useful life becomes especially high, which makes it impossible to use conventional structures with this class of tubes. The invention discloses improvements in the cathode, grid, and grid-anode structures, which are eminently successful from electrical as well as mechanical viewpoints.

It is, therefore, one of the objects of this invention to provide a heavy-duty, indirectly-heated cathode structure for high powered gas-filled tubes.

It is also an object of this invention to provide a grid-anode structure for high powered tubes which is inherently capable of withstanding high mechanical stresses during the manufacturing schedule and life of the tube, and retain its shape and specified critical anode-grid dimensions in the final product.

Other objects of the invention will become more apparent from the description of the invention given below, taken with the figures, in which:

Figure 1A is a vertical, side view of the upper portion of the tube up to line A—A with the right portion of the tube appearing in sectional elevation and the left portion of the tube appearing in plan elevation;

Figure 1B is the lower portion of the same tube below line A—A with its sections and views corresponding to those illustrated in Fig. 1A;

Figure 2 is a perspective view of a cathode-grid glass press and lead-in connections for the heater, the cathode, and the grid;

Figure 3 is a perspective view of a detail illustrating the connections between the heater coils and a disk;

Figure 4 is a sectional plan view of the cathode, taken along line 4—4, of Figure 1A;

Figure 5 is a schematic diagram of connections used for the heater coils of the cathode;

Figure 6 is a sectional plan view of a portion of the grid can taken along line 6—6 of Figure 1B;

Figure 7 is a perspective view of the grid can;

Figure 8 is a side elevational view of the upper portion of the grid can with the upper portion of the squirrel cage used for mounting the grid somewhat raised.

Referring to Figures 1A and 1B, the upper portion of the tube is illustrated in Fig. 1A, and the lower portion of the same tube is illustrated in Fig. 1B. The two figures, when matched along line A—A, illustrate the previously mentioned side elevational view of the entire tube. The tube consists of a glass envelope **10** provided with a re-entrant glass stem **12** at its upper end and a large re-entrant dome **14** at its lower end. Dome **14** is also provided with a glass-seal stem **16** which is used for evacuating and degassing the tube during its manufacturing processes as well as for introducing hydrogen through a glass tube extension **18** from a hydrogen reservoir **20**. This portion of the tube will be described more in detail later in the specification. The upper portion of the glass dome **14** supports Y-shaped glass press **22**, which is illustrated more fully in Figure 2. This glass press is provided with three substantially rectangular legs **23**, **24** and **25**, forming a Y or star-shaped figure. Each of these three legs has three lead-in rods **26**, **27** and **28**, rods **26** and **27** being used for connecting the heater coils to a source of heating current. The same rods, with the addition of rod **28**, are also used for mechanically supporting the entire heater-cathode and cathode shield structures. The outer rod **28** is also used for electrically connecting the cathode to the outside circuits. The right, visible portion of the cathode is illustrated more fully in Figs. 1A and 1B where the rods **26**, **27** and **28** appear directly above the right leg **24** of the star-shaped press **22**. The cathode itself consists of a nickel can **29** with a plurailty of nickel vanes **30**, which are mounted in radial planes with respect to the longitudinal central axis of the tube and the cathode. The entire inner surface of the cathode can, as well as its vanes, are coated with usual electron-emitting oxide mixtures of barium and strontium. The lower portion of the cathode can terminates in a flanged disk **31** which seals the cathode can from continuous convection currents of hydrogen, and thus acts as the inner wall of a double-walled heater shield for the cathode. The same flanged disk **31** is also used for supporting, on one side, a plurality of heater coils, only one of which, coil **32**, being visible in Figures 1A and 1B. In order to insulate the lower portions of these coils from the cathode and the heat shield, a ceramic insulator plug **33** is used, the dimensions of this plug being proportioned to form a tight fit in a hole provided for this purpose in the disks **31** and **34**. Disks **31**—**34**, double-walled hollow cylinder **35**—**36**, and an upper ring **37** constitute the double-walled, nickel heat shield of the cathode. The upper end of the heater coils is supported by a serrated molybdenum disk **38**, the tungsten heater coils being welded to disk **38** by means of molybdenum brackets **39** and **40**, in the manner illustrated more fully in Fig. 3. Disk **38**, itself, is supported by a plurality of radially disposed horizontal rods **41** and vertical rods **42**, the latter being welded to the outer sides of the heat shield. The same vertical rods **42** are also used for supporting a cathode baffle **43** by means of a plurality of radially disposed, horizontal rods **44**, welded on one side to the respective rods **42**, and on the other side to the baffle **43**. The diameter of baffle **43** is approximately equal to the inner diameter of the opening in ring **37** of the heat shield, and the diameter of the latter is approximately equal to the inner diameter of the cathode can **29**. Since the cathode shield and the cathode can are electrically connected to each other by means of a plurality of radially disposed short pieces **21** of nickel wire which are welded to the bottom disk **34** of the heater shield and to the bottom disk **31** of the cathode can, the cathode is effectively connected to the molybdenum disk **38**, which is electrically at the midpoint of the heater arrangement. Therefore, as the voltage between the heater connections **56** and **57** varies due to an applied A. C. voltage, the molybdenum disk and, therefore, the cathode at the center of the arrangement remains at a single potential.

The sectional plan view of the cathode can **29** and of the vanes **30** is illustrated in Fig. 4. The same figure also illustrates the disposition of the heater coils **32** and of the insulating plugs **33** in the heater-cathode structure. In the illustrated example twelve heater coils are mounted on a circle **45**, the center of this circle coinciding with the longitudinal axis of the tube. Cathode can **29** and circle **45** are concentric with respect to each other. From the description of the cathode given thus far, it follows that the heater coils are centrally mounted and the cathode surrounds the heater coils in the manner illustrated in Fig. 4. Thus the entire radiation from the heater coils is completely intercepted by the inner, electron-emitting surface of the cathode. The same circle **45** and the lower ends of the heater coils are also illustrated in Fig. 2. The same figure also illustrates the actual electrical connections between the source of potential and the respective heater coils. Examination of Fig. 2 reveals the fact that rod **26** is connected to horizontal rod **47** and this horizontal rod is connected to two vertical rods **48** and **49**. These rods, in turn, are connected to the heater coils **50** and **51**, which are spaced apart from each

other by a heater coil **52**. The latter, together with coil **53**, are connected in a similar manner to rod **27**. Since the upper ends of the coils are all connected to the molybdenum disk **38**, and since rods **26** and **27** are connected to the opposite polarities of the source of potential, it follows that the circuit of all the heater coils is that illustrated schematically in Fig. 5. In Fig. 5 the cylindrical heater element formed by the twelve heater coils has been "unwrapped" so as to be in a single plane. The molybdenum disk **38** then corresponds to the upper bus bar **54**, while the horizontal rods, such as rod **47**, and the vertical rods, such as rod **26**, correspond to the bus bar **55**. The latter is the case since all outer rods **26** and all inner rods **27** are connected together to the outgoing conductors **56** and **57** respectively, which is equivalent to the circuit illustrated in Fig. 5. Examination of this schematic diagram reveals the fact that the adjacent heater coils carry currents in the opposite directions in the manner illustrated by the arrows in Fig. 5. Thus every other heater coil is connected to one polarity of the source of the heater potential, while the remaining coils are connected to the opposite polarity of the same source. As will be described more fully in the specification later, such connections produce a substantial neutralization of the electrostatic and of the electromagnetic fields produced by these heater coils with the result that the entire surface of the heater element presents itself to the cathode as a substantially equipotential surface.

Since large heater currents are used in the heater elements of this type, the disclosed heater structure represents an additional important advance in the art: A large number of parallel circuits, presented by the structure illustrated in Fig. 2, decreases the currents in the individual coils with the concomitant reduction of the magnetic field produced around each coil due to the flow of current. Moreover, since the currents in adjacent coils are flowing in opposite directions, the magnetic field produced by each coil substantially cancels that of the adjoining coil. The magnetic field within the cathode can due to the heater is, therefore, effectively cancelled. The disclosed cathode-heater structure, therefore, represents a simultaneous, novel solution of the electrical and electronic problems arising in the large tube structures disclosed by this invention. This will become more apparent in the light of the subsequent discussion of the entire tube. The grid structure itself is composed of a hollow outer cylindrical member **58** provided with a stiffening L-shaped ring **59** at its lower end. At its upper end cylinder **58** is welded to a mesh **60**, which mesh is welded to the vertical flange **63** of a disk **61**. This disk is provided with a collar **62** embracing the re-entrant glass stem **12**. A metallic mesh lining **64** is inserted between collar **62** and the glass stem **12** and collar **62** is then rigidly secured to stem **12** by means of a bolt **65** which tightens the collar **62** on the glass stem. To improve the rigidity of disk **61**, it is provided with a plurality of radially disposed reinforcing members **66**, the inner ends of which are welded to collar **62**. The reinforcing members have an L-shaped cross-section and the horizontal portion of the L, which appears at **67** in Fig. 1A, is welded throughout its length to disk **61**. The outer ends of the reinforcing members **66** are provided with metallic, vertical posts **68**, the function of which will be described later. The grid is also provided with a baffle **78** supported by such members as 79 and 80, the lower horizontal flanges of which are welded to the lower surface of baffle 78, and the upper horizontal extensions of which are welded to the lower surface of a perforated disk 80, constituting the main grid control element per se. This disk is supported by a ring 81 having an L-shaped cross-section, the horizontal extension of this ring being welded directly to the perforated disk of the grid, while the vertical portion of this ring is welded to the inner member 82 of the grid and the grid mesh 60. This inner member of the grid is illustrated in a perspective view in Fig. 7. This figure illustrates clearly that the upper portion of this hollow cylinder has extensions 83 and recessed portions 84 forming a turret-type pattern. The protruding portions of the turrets extend all the way up to and including the vertical flange 63 of the disk 61 with the result that the welded joint at this portion of the grid structure, in some instances, is between flange 63, turret tops 83, and mesh 60, all three being spot-welded together, thus forming a laterally and transversely rigid structure. The turret tops are also visible in Figure 1A where they are similarly numbered. The turret top of the hollow cylinder 82, together with mesh 60, forms a series of mesh-covered windows in the upper portion of the grid, these windows being uniformly spaced around the circumference of the grid in the manner illustrated in Fig. 7, and also illustrated in Fig. 1A. This grid construction allows the necessary cooling of the anode and of the upper grid structure with a continuous flow of hydrogen gas, and, at the very same time, it provides a uniform mechanical reinforcement of the grid mesh, which prevents its buckling or stretching, or skewing, throughout the processing period and the operating life of the tube, which includes repeated intense heating and cooling cycles.

It is to be noted here, parenthetically, that this continuous circulation of the gaseous medium through the previously mentioned screen-covered grid windows, which provides the necessary ventilation of the anode-grid combination, is accomplished without direct circulation of this gaseous medium through the heater-cathode structure, which is almost completely closed to the gas currents of this type by disks 31 and 34 of the heater-cathode heat shield structure. This shielding of the heater-cathode combination from these gas currents raises the efficiency of the heater-cathode combination by a very substantial factor.

Briefly stated, the grid thus comprises a hollow cylinder, the upper part of this cylinder being completely closed by the horizontal disk 61 and the lower end of the cylinder being open. The upper end of this cylinder is provided with the grid baffle 78 and the perforated grid disk 80, which is spaced from the upper disk 67 so as to leave sufficient room for critically mounting an anode disk 85 between these two members. This anode is welded to an anode stem 86, which is surrounded in its upper portion with the glass seal 87. This seal forms a flowing glass joint with the re-entrant seal 88 of the glass vessel 10. Thus the anode is supported by the upper closure of the glass vessel 10.

In a hydrogen thyratron, the ability of the tube to withstand the applied high voltage without premature breakdown is dependent upon the spacing between the anode 85 and the surrounding elements of the grid. In order to maintain this critical spacing, the entire grid structure must possess exceptionally rigid qualities and these rigid qualities of the grid must be matched with an equally rigid mounting of the latter with respect to the anode. The rigidity of the grid structure has been obtained by introducing the turret-topped member 82, the radial members 66 and ring 69. The turret tops 83 of member 82 serve to reinforce the mesh portion of the grid, thus preventing it from buckling in the most critical region. Moreover, due to the large mass of the grid and the large moment arm which would be present around any one mounting point, the grid, in addition to being supported from the anode stem 12 by collar 62, is laterally stiffened by means of a squirrel cage.

The squirrel cage begins at rings 91, 92, rigidly mounted on dome 14, supporting rods 75, 76, 77, etc. welded directly to the rings, the lower squirrel cage ring 70 having an L-shaped cross-section for stiffening purposes, a plurality of vertical rods 71, 72, 73, 74, and the upper squirrel cage ring 69. Thus, the upper and lower rings 70 and 69 represent the side frames of the squirrel cage and the rods 71, 72, 73 and 74 represent the squirrel cage rods rigidly interconnecting the two side frames. Since the squirrel cage is supported from its bottom side 70, and it does not have any direct connection to the upper stem 12 of the glass vessel, it follows that the squirrel cage itself does not prevent any change in the dimensions of the entire glass vessel, and especially any change in dimensions between the upper and lower re-entrant seals, when the entire glass vessel, as well as the squirrel cage, are subjected to larger temperature changes. Yet, although there is no such connection, because of large dimensions of the re-entrant dome 14 and the large number of supporting rods, the squirrel cage represents a mechanical structure of sufficient rigidity so as to be used successfully for lateral stiffening of the grid assembly. The squirrel cage rods are dimensioned in such manner that, at the time of forming the upper re-entrant seal, ring 69 abutts against the columns 68. From the description of the squirrel cage given thus far, it follows that the squirrel cage is supported exclusively by dome 14 and is not fastened in any way to the glass rod 12, and the upper re-entrant seal of the glass vessel. Therefore, there is no direct inter-connection of the lower and upper re-entrant seals 14 and 87 respectively.

The alternate rods of the squirrel cage, such as rods 71, 73 and 74, form a sliding fit with the outer cylindrical member 58 of the grid by means of a plurality of L-shaped brackets 89 and 90. All of these brackets are welded securely to the outer grid cylinder and are provided with holes which are sufficiently large so as to permit differential expansion, and the concomitant sliding of the grid with respect to the squirrel cage, when the entire tube is subjected to any temperature changes.

The detail of this arrangement is illustrated more clearly in Fig. 6. A portion of the outer grid cylinder 58 appears in the cross-sectional view and the bracket 90 is illustrated as being welded to this portion of the grid cylinder. It is also provided with a hole with rod 71 fitting into the hole. For the sake of clarity of the drawing the diameter of rod 71 has been decreased somewhat to accentuate the fact that there is only a sliding fit between the alternate vertical rods of the squirrel cage and the grid brackets 89, 90, etc. The lower ends of the squirrel cage rods are all welded to the outer surface of the ring 70 and the latter is very rigidly mounted on dome **14** with the aid of the collars **91** and **92**, and the multi-leg brackets **75, 76, 77**. The squirrel cage, therefore, is very rigidly mounted on dome **14** and represents a rigid structure capable of resisting any transverse or lateral movement. This rigidity extends all the way up to the upper ring **69** of the squirrel cage. During the degassing and hydrogen-filling schedule the grid tends to expand in the inward direction with the result that there is a decrease of the distance between the lower end of the grid and dome **14**. This travel of the grid due to expansion is not resisted by the squirrel cage, since the squirrel cage itself is expanding at this time in the opposite direction, there being only a sliding engagement between the grid and the squirrel cage. Therefore, the grid-anode combination rigidity and constancy of the critical dimensions and spacings between the grid and the anode is, in the main, the function of the rigidity of the entire glass vessel, since it is braced between the upper and lower reentrant seals. Stated differently, if for the sake of obtaining the required rigidity of all the elements with respect to each other, the grid were rigidly attached to the anode glass stem **12** at one end, and to the dome **14** at the other end, the expansion of the glass vessel and of the metallic elements in two opposite directions would either buckle the metallic structure or, if the metallic structure were made sufficiently rigid to resist such buckling, then the expansion of the metallic elements would break the glass vessel. In the light of the above description of the anode-grid-squirrel cage structure, one can very readily see that such failures are inherently impossible in the disclosed combination.

It does not appear necessary to discuss at length the necessity of surrounding the entire anode as well as the portion of the glass stem **12** with the grid elements. This is discussed more fully in such applications for patents as those of Kenneth J. Germeshausen, Serial No. 576,113, filed February 3, 1945, and fully assigned to the same assignee, and pages 337 and 338 of "Pulse Generators," M. I. T. Radiation Laboratory Series, 1948, where it is stated that such combinations of elements are desirable for reducing the mean-free path of the electrons, which in turn prevents premature ionization of gaseous medium. The last reference also discloses the re-entrant seal around anode stem, which prevents flash-overs to the anode stem.

From the above description of the tube, it becomes apparent that it has such advantages as continuous maintenance of all grid dimensions and its relative critical position with respect to the anode throughout the degassing schedule of the tube when it is subjected to especially high temperatures and also throughout the operating useful life of the tube, which also involves high temperatures when the tube is in use. Rigid and very efficient cathode structure is also provided which is mounted on a large stiff dome being provided with a multi-element star-shaped glass press for enhancing the rigidity of the cathode structure of parallel circuits for a multi-element cathode centrally mounted within the cathode. The circuits of the cathode are so arranged that, from an electronic point of view, the entire heater element presents a substantially neutral surface to the electron-emitting surface of the cathode because of the inherent neutralization between the heater elements. This is especially so when alternating power is used for heating the heater, which is usually the case in the tubes of this type. One of the uses of such tubes is in the line pulse modulators for radar systems. If alternating currents were used for exciting the heater elements in the gas-filled tubes of the prior art, in which the heater elements do not possess the neutralizing features of the heater disclosed in this invention, there is no uniform neutralization of the electron-emitting surface of the cathode because some of the surfaces of the heater present more positive surfaces with respect to the electron-emitting layer than the other surfaces of the heater with the result that the heater itself, to a degree, acts as a grid with respect to the cathode. This, besides producing the above mentioned non-uniform neutralization of the grid-emitting surfaces, also produces parasitic current between the cathode and the heater with the concomitant "spot-heating" of the cathode. Moreover, and what is sometimes more important, it produces the so-called "jitter phenomena," which is known in the radar art as a non-uniform repetition rate, even though the repetition rate of the trigger impulses impressed on the grid of the tube is uniform. Such jitter arises because of the addition or subtraction of the heater voltage to that of the grid voltage, with the result that the resultant triggering of the tube is not only the function of the repetition rate pulses, but is also the function of the voltage cycle appearing on the heater. In the majority of the cases, the latter frequency is the 60-cycle frequency.

The jitter thus is reduced due to the following three (3) factors:

(1) The cathode is tied to the center point of the heater arrangement and, therefore, the voltage between the grid and the cathode is independent of the heater voltage.

(2) Due to the flow of current in adjacent coils being opposite, the magnetic field caused by the flow of heater current is substantially neutralized, thereby eliminating the effects of a varying magnetic field on the breakdown characteristics of the field.

(3) Due to the fact that adjacent heater coils are at opposite electrical potential, current flow from the cathode to the heater is eliminated, which in turn eliminates an electrostatic field between the heater and the cathode; this absence of electrostatic variable field between the heater and the cathode makes the grid-cathode breakdown characteristic more reliable.

In the prior art, when centrally mounted heater coil is used for heating the electronically emissive layer of the heater-surrounding cathode, the upper part of the heater element is connected to the upper edge of the cathode cylinder, with the result that the entire cathode pulsates at the frequency of the potential used for heating the heater element. When alternating current is used as a source of heater energy this obviously introduces the heater potential directly into the cathode-grid-anode circuit with the result that the time of ionization is determined not only by the wave form of the positive triggering pulse impressed on the grid, but also by the phase relationship between this pulse and the frequency of the heater voltage. Obviously enough, it is impossible to attain jitter free operation under such conditions.

Moreover, there is a potential difference between the electron emitting layer and the lower portion of the heater element, with the result that there is a flow of current from the cathode proper to the heater element when the lower portion of the heater element, which is connected to the source, is at a higher potential than the cathode. The electrostatic field produced by the parasitic current will also interfere with the jitter-free operation of the tube.

The invention also discloses a grid structure in which the mesh portion of the grid, which is necessary for proper ventilation of the grid, is reinforced in such manner as to prevent any collapse of this mesh structure during its ultimate heating and cooling cycles of the tube.

While the invention was described in connection with a gas-filled triode, it is obvious that the teachings of this invention, with the exception of the cathode which is applicable only to the gas-filled tubes, are equally applicable to other types of tubes. Thus in the disclosed invention it is the grid electrode that is mounted on the upper re-entrant stem. This need not be necessarily a grid element in other tube structures. Thus it may be either a cathode or an anode electrode. Therefore, it is to be understood that this phase of the invention broadly discloses the principle and the structure for mounting an electrode element in a glass vessel so that it is supported by one re-entrant seal and is laterally braced by means of a mechanical support mounted on the other re-entrant seal with a sliding engagement between the two.

What is claimed is:

1. A thermionic tube comprising a glass vessel having top and bottom re-entrant seals, an anode supported by said top seal, a centrally mounted hollow cylindrical cathode supported by said bottom seal, an electron-emitting layer on the inner surface of said cathode, first and second sets of heater coils centrally mounted in spaced relationship with respect to inner surface of said cylindrical cathode and the electron-emitting surface of said cathode, said first and second sets of coils forming a heating element in the shape of a hollow cylinder in concentric relationship with respect to the said cathode, the coils of said first and second sets being alternately spaced, a common conductor connecting a given end of each of said heater coils to said cathode, a source of potential connected with its one terminal to the other end of each coil of said first set of coils and with its other terminal to the other end of each coil of said second set of coils whereby the surface of said heater element represents a substantially electrically neutral surface with respect to the electron-emitting layer of said cathode, a cylindrical grid surrounding said anode and said cathode, said grid being mounted on said top seal, a support rigidly mounted on the bottom seal and having a sliding mechanical engagement with a portion of said grid for laterally bracing said grid with the aid of said bottom seal and said support.

2. A thermionic tube comprising a glass vessel having top and bottom re-entrant seals, an anode supported by said top seal, a grid supported by said top seal, a multi-element cage mounted on the bottom seal, and a sliding engagement between said grid and said cage for mechanical bracing of said grid with the aid of said cage.

3. A thermionic tube comprising a glass vessel having top and bottom re-entrant seals, an anode supported by said top seal, a grid surrounding said anode and supported by said top seal, a squirrel-cage having a plurality of rods and being rigidly mounted on said bottom seal, said squirrel-cage surrounding said grid, and a sliding engagement between said rods and said grid, said cage aiding in lateral bracing of said grid for maintaining proper spacing between said anode and said grid.

4. A thermionic tube comprising a glass vessel having re-entrant top and bottom seals, an anode supported by said top seal, a cathode centrally located within said vessel, a grid surrounding said anode and said cathode, said grid being rigidly mounted on said top seal, a squirrel-cage having top and bottom sides and a plurality of rods interconnecting said sides, and a plurality of brackets on the outer surface of said grid, said brackets being in sliding engagement with corresponding rods of said cage, and means for rigidly mounting said cage on said bottom seal, whereby said grid is maintained in fixed relationship with respect to said anode with the aid of said top and bottom seals without fixed connections therebetween.

5. A thermionic tube comprising a glass vessel having top and bottom re-entrant seals, an anode supported by said top seal, a centrally mounted cathode supported by said bottom seal, a cylindrical grid surrounding said anode and said cathode, said grid being mounted on said top seal, a grid support rigidly mounted on the bottom seal, and a sliding mechanical engagement between said support and a portion of said grid.

6. A thermionic tube as set forth in claim 5, in which said grid includes a hollow cylindrical conductive member with the top portion thereof having a plurality of cut-out sections, and a conductive mesh welded to said top portion and covering said cut-out sections, said top portion preventing said mesh from changing its physical dimensions by carrying substantially all stresses imposed on said mesh.

7. A thermionic tube having a hollow cylindrical cathode, an electron-emitting layer on the inner surface of said cathode, first and second sets of heater coils centrally mounted in spaced relationship with respect to the electron-emitting surface of said cathode, said first and second sets of coils forming a heater element in the shape of a hollow cylinder in concentric relationship with respect to the longitudinal axis of said cathode, the coils of said first and said second sets being alternately spaced, a common conductor interconnecting a given end of each of said coils, a metallic connection between said cathode and said common conductor, and a source of potential connected with its one terminal to the other end of each coil of said first set of coils and with its other terminal to the other end of each coil of said second set of said coils whereby the surface of said heater element represents a substantially electrically neutral surface with respect to the electron-emitting layer of said cathode and the magnetic fields provided by each coil are cancelled.

8. A thermionic tube comprising a glass vessel having top and bottom seals, an anode supported by said top seal, a centrally mounted hollow cathode coated with an electron-emitting layer on the inner surface of said cathode and a plurality of parallelly connected heater coils between one terminal and a common line, a further plurality of parallelly connected heater coils between a second terminal and said common line, and a source of energy connected to said terminals, said first set of coils being alternately arranged with respect to said second set of coils whereby the flow of current in the first set of coils at any given instant is in the opposite

direction to the flow of current in the second set of coils for substantially neutralizing the electrostatic and electromagnetic fields produced by said respective coils, and a grid mounted on said top seal, said grid surrounding said anode and said cathode.

9. A thermionic tube having a hollow cylindrical cathode, a plurality of radially disposed vanes on the inner surface of said cathode, an electron-emitting layer mounted on the inner surface of said cylinder and on said vanes, a heater element centrally mounted within said cathode, said heater element comprising first and second sets of heater coils, the locus of said heater coils being a hollow cylinder, said first set of coils alternating with said second set of coils along the surface of said hollow cylinder, a disk interconnecting all of said coils at one end thereof, a source of heater current having first and second terminals and connections between said first set of coils and said first terminal and said second set of coils and said second terminal respectively whereby the first set is connected to one polarity of said source at any given end and said second source to the opposite polarity of said source, said connections permitting substantial neutralization of electro-magnetic and electrostatic fields created by said first and second set of heater coils.

10. A thermionic tube having a glass vessel with re-entrant top and bottom seals, a cylindrical grid mounted within said vessel, said grid comprising a top disk with a plurality of radially disposed L-shaped members welded to said disk, a collar on the top of said disk welded to said disk and to said radially disposed members, said collar being rigidly fastened to said top re-entrant seal, a wire mesh ring constituting a portion of the cylindrical wall of said grid, a mesh-reinforcing member for strengthening the ability of said mesh portion of the grid to carry stresses imposed upon said grid during processing and normal life of said tube so as to prevent buckling of said mesh, a grid support rigidly mounted on the bottom seal and having a sliding engagement around the periphery of said grid whereby said grid cylinder is laterally braced with the aid of said grid support without arresting any free movement, due to expansion and other causes, of said glass vessel and any change in spacing between said top and bottom seals.

11. A thermionic tube comprising at least a disc-shaped anode and a hollow cylindrical grid spaced from and concentric about said anode, said grid comprising a hollow metallic cylinder with cut-out sections along one edge thereof in proximity to said anode, and a metallic mesh conductively mounted on the outside of said cylinder so as to cover said cut-out sections.

12. A thermionic tube comprising at least an anode and a hollow grid substantially uniformly spaced from said anode, said grid comprising a hollow conductive member in the form of a substantially continuous surface of revolution, said member having a plurality of cut-out sections about the periphery thereof in proximity to said anode, and a conductive mesh conductively attached to said hollow conductor so as to cover said cut-out sections.

13. A thermionic tube comprising a glass vessel having top and bottom re-entrant seals, an electrode supported by said tube seal, said electrode extending through a greater portion of said glass vessel, a support for said electrode mounted on said bottom re-entrant seal, and a sliding engagement between said support and said electrode for laterally bracing said electrode with the aid of said bottom seal on said support.

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