Dec. 27, 1938. J. E. CLARK ET AL 2,141,378

ELECTRON DISCHARGE DEVICE

Filed Nov. 1, 1934

FIG. 1

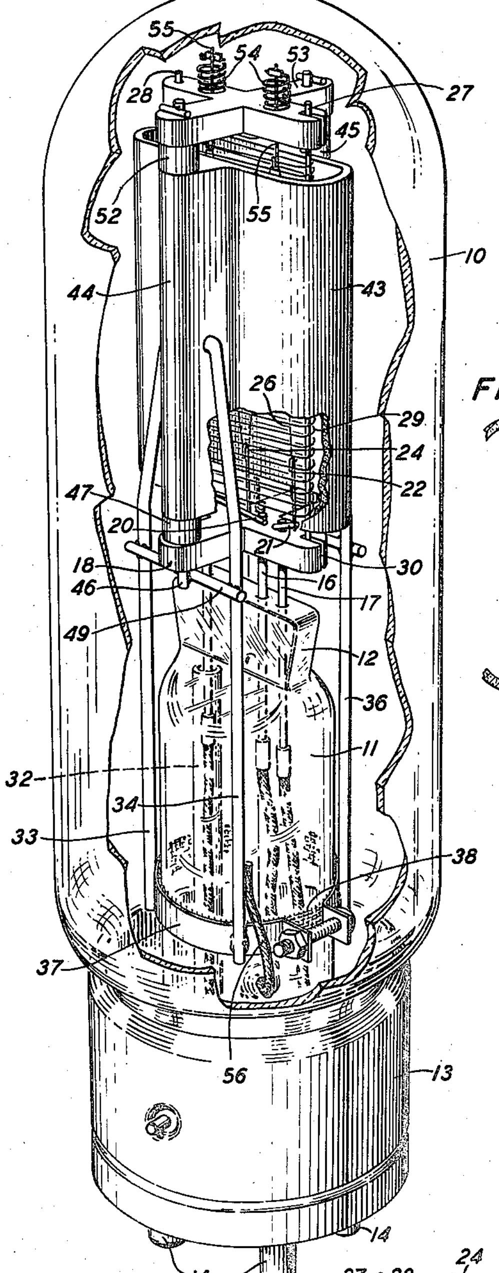


FIG. 2

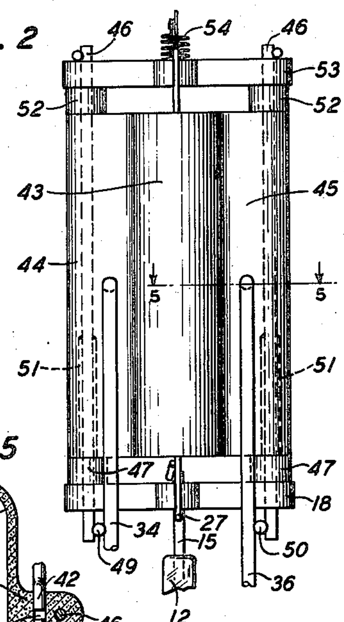


FIG. 5

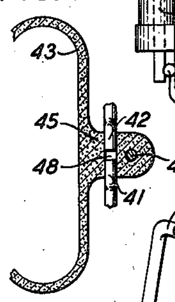


FIG. 3

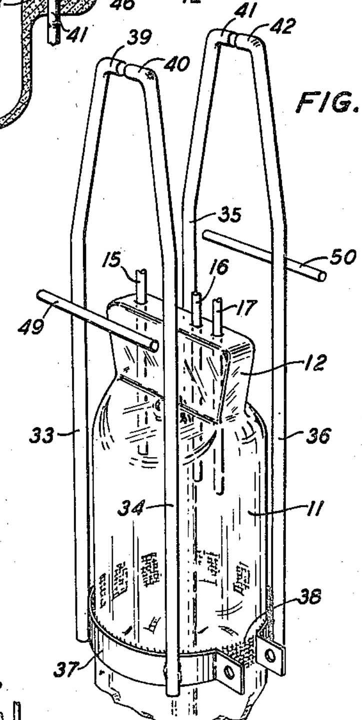
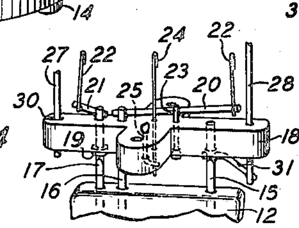


FIG. 4



INVENTORS: J. E. CLARK
V. L. RONCI

BY

Walter C. Kiesel

ATTORNEY

Patented Dec. 27, 1938

2,141,378

UNITED STATES PATENT OFFICE

2,141,378

ELECTRON DISCHARGE DEVICE

James E. Clark, Long Island City, and Victor L. Ronci, Brooklyn, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application November 1, 1934, Serial No. 750,928

14 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices capable of yielding a high power output.

One object of this invention is to construct an electrode assembly for a discharge device to withstand excessive vibrations and sudden shocks.

Another object of the invention is to form a compact assembly of the electrodes so that the spacial relation between the electrodes is constantly uniform.

According to the invention, the electrode assembly inclues an anode of high heat conserving material which encloses the other electrodes and is provided with projecting portions on opposite sides which accommodate the supporting members of the assembly to form a compact, unitary mount. An insulating member extends across each end of the anode to accurately space the cathode and a grid within the anode. The insulating members are secured to the anode by rigid rods enclosed in the projecting portions of the anode and these rods are connected to truss members which are joined to cooperating converging braces or supporting members which extend from the stem of the device and exert a compression force on opposite sides of each projecting portion of the anode. The electrode unit or mount is therefore rigidly held in position with the braces locked in the sides of the anode structure.

A feature of the invention relates to a unit assembly which avoids distortion or breakage of the fragile filament during extreme heat treatment of the assembly due to expansion. This is accomplished by connecting the truss member to the end of the internal rigid rods in the anode to allow a clearance between the lower spacing insulator and the truss members. This arrangement permits the unit structure to expand during the high temperature heat treatment to remove occluded gases and equalizes the stresses in the filament supporting members to overcome distortion and displacement of the filament in relation to the other electrodes.

Another feature of the invention is concerned with an assembly of the filament supports in order to damp out peak stresses either from shocks or excessive temperatures which adversely affect the alignment of the filament supports. In accordance with this invention, the filament leading-in wires extend parallel from the press and are connected to rigid wires angularly arranged above the lower spacer insulator. The ends of the filament are connected to light hook members which are arranged to form continuations of the filamentary strand and are attached to the rigid wires at the termination of the angular line of the filament.

A further feature of the invention relates to the supporting structure of the anode whereby sudden shocks applied to the device will not fracture the friable material of the anode. This arrangement consists in an assembly of the anode and the internal support rods in such a manner that the rods are unconfined for a portion of their length to obtain a certain degree of resiliency in the structure adjacent the junction of the internal supporting rod and the spacer insulator. This assembly eliminates strains in the anode material in the immediate vicinity of the bisecting members of the metallic supporting structure.

Another feature of the invention relates to the mounting of the electrode assembly on the stem of the device so that the unit is rigidly held and deflection in the supporting structure due to the large mass of electrode unit is eliminated by anchoring the unit to the stem at an intermediate point. This arrangement consists of a single band attached to the braces at the extreme end and surrounding the glass stem while the anchoring rods projecting from the top of the stem register with the lower insulator of the electrode assembly to maintain the unit in rigid position and offset deflection in the long braces connecting the electrode unit to the stem. Another advantage of this arrangement is the protection of the glass stem against excessive heating during the exhausting process of the device by high frequency induction due to the advancement of the circular metallic band around the stem to the extreme end of the stem where it is removed from the effects of the high frequency field.

These and other features of the invention will be more clearly understood from the following detailed description taken in connection with the accompanying drawing:

Fig. 1 illustrates in a perspective view a discharge device embodying the features of this invention and having a portion of the enclosing vessel and the anode broken away to more clearly illustrate the details of the construction;

Fig. 2 shows in elevation a side view of the electrode unit and the relation of the brace supports to the anode;

Fig. 3 is a perspective view of the stem and supporting braces without the electrode unit;

Fig. 4 is a perspective view of the details of the bottom insulator arrangement shown in Fig.

1 which also illustrates the anchoring rods in the press registering with the insulator; and

Fig. 5 is a cross-sectional view of a portion of the anode taken on the line 5—5 in Fig. 2 and showing the prongs of the braces extending through the anode flange.

Referring to the drawing, the device of this invention as shown in Fig. 1, includes an enclosing vessel 10 having an inwardly projecting stem 11 terminating in a press 12. The vessel is secured to a base 13 carrying a plurality of prongs or terminals 14 for connecting the electrodes to an external circuit. A plurality of strong rigid wires or anchoring members 15, 16 and 17 are sealed through the press 12 and extend above the press for a short distance to serve as anchors for the electrode assembly while the opposite ends are connected to leading-in wires which terminate at the prongs 14 in the base 13.

The electrode assembly on the stem of the vessel may conform to the specific aspect of the invention illustrated, but it is to be understood that the invention is not limited to the precise configuration of the elements nor the manner in which they are assembled in the following description since it is within the scope of this invention to apply the features of the invention to other electrode units radically different from the specific unit illustrated. Therefore, the succeeding disclosure is merely a representative embodiment of the invention and the manner in which it may be applied to a particular aggregation of elements.

The unit, as illustrated, may be assembled by placing a cross-shaped insulator 18 on the wires 15, 16 and 17, the insulator having a plurality of apertures along one of its arms to correspond with the position of the short wires in the press so that these wires may project through the apertures and form anchors for the insulator. These rods also serve to register the insulator in position on the stem. The cross-shaped insulator 18 is prevented from sliding toward the press 12 by a limiting ridge 19 formed on the anchor wire 17. The insulator 18 is locked to the anchor wires by welding the ends of anchor wires 16 and 17 projecting above the insulator to connector wires 20 and 21 which extend in opposite directions above the insulator to form spacers for hooks 22, the connector 20 being longer than the connector 21 in order to space the hooks attached thereto at an equal distance from the center of the insulator 18. A tie wire 23 extends through the insulator 18 and is connected to the midpoint of the connector 20 to maintain this wire in rigid position. A central hook 24 is located in the axis of the cross-shaped insulator 18 and is held therein by a tie wire 25. A filamentary cathode 26 having electron emitting properties is preformed in the shape of an M and the ends thereof are clamped in the hooks 22 and welded thereto while the center point is connected to the hook 24. This construction eliminates strains and stresses on the fragile filament due to high temperature treatments to which the filament is subjected during manufacture. The fine wire hooks are not liable to any bending force since they are arranged in line with the filament while the connecting wires are heavy and overcome any strain due to bending. A control electrode or grid surrounds the filamentary cathode 26 and is formed of two upright wires 27 and 28 around which is wound a helical wire 29 in a form so that the consecutive turns lie in parallel planes on opposite sides of the cathode 26. The supporting wires of the grid are disposed in the cross-shaped insulator 18 as shown in Fig. 4 with the supporting wire 27 fitting in a slot 30 while the supporting wire 28 extends through an aperture on the opposite side of the insulator arm, this wire extending below the insulator and having a tie wire 31 connecting it to the anchor wire 15 in the press 12.

The anchor wires in the press of the stem also function as the leading-in wires for the cathode and the grid in which the anchor wire 15 is connected to the grid by the tie wire 31 and the anchor wires 16 and 17 which are disposed at the opposite end of the press 12 convey current to the ends of the cathode 26. The purpose of segregating the anchor wire 15 from the other anchor wires is to provide a path of high resistance between the grid leading-in wire and the filament leading-in wires so that the heating current field of the filament will not affect the control characteristics of the grid. The grid leading-in wire is further protected in the stem 11 by a tubular glass member 32 which surrounds this wire.

One of the features of this invention relates to the bracing of the electrode unit which forms the main supporting structure of the electrodes and this arrangement consists of twin pairs of arms, braces, or support wires 33, 34, 35 and 36 which are secured at their lowermost ends to a metallic band or collar 37 which is clamped around the stem 11 and prevented from sliding thereon by an inner lining of wire mesh 38. The upper limbs of each pair of arms are bent in converging angles as shown more clearly in Fig. 3, with the extreme ends bent horizontally to form contraposed prongs 39, 40, 41 and 42. The next step in the assembly is to mount the anode in the electrode unit and this is accomplished by placing the anode 43 which, for practical reasons, is made of a solid block of graphite machined into substantially elliptical form with parallel sides to correspond with the shape of the grid which it surrounds. The anode is also formed with integral longitudinal flange portions 44 and 45 which project outwardly on opposite sides of the flat portions of the anode. Each of the flanges is provided with a longitudinal bore to receive an internal supporting rod 46 which passes through an insulating bushing 47 situated between the anode and the insulator 18. In mounting the anode in position, it is necessary to spread the upright braces, such as the pairs of rods 33, 34, 35 and 36, in order that the flange of the anode may clear the projecting prongs of the braces and when the anode is seated on the bushing 47, the prongs 39, 40, 41 and 42 spring into a transverse aperture or socket 48, as shown clearly in Fig. 5, to support the anode structure at a medial point. After the prongs are located in the transverse sockets of the anode, a truss member or bridging wire 49 is welded at a central point to the support rod 46 below the insulator 18 and at the ends is welded to the arms 33 and 34 of the brace structure. A similar truss member 50 is connected in a corresponding manner to the support rod extending through the flange 45 and to the brace rods 35 and 36. It will be noted that the truss members 49 and 50 are attached to the support rods and braces at points such that the truss members are out of contact with the bottom surface of the insulator spacer 18. The purpose of this arrangement is to permit expansion of the supporting structure and anode during high temperature heat treatment without distorting the filament connections or causing insulator fracture. The long braces which are made of steel or iron to reduce manufacturing cost of the device are necessarily elongated during heat treatment and the clearance provided between the truss members and the insulator permits the structure to expand without straining the insulator or the filament connections in the stem. The braces or converging arms of the supporting structure tend to exert a compression force on the sides of the flanges and the truss members maintain the braces in intimate contact with the flanges and at the same time increase the rigidity of the support by the bisecting connections with the internal support rods within the flanges.

Due to the fact that the anode is formed of friable material which easily cracks or chips, the least strain placed upon this material is apt to crack the anode and render it useless. In order to overcome this effect and lend a certain amount of resiliency to the combined structure, the internal support rods are adapted to yield to a bending stress or strain due to shock without causing cracks to occur in the anode and also to reduce the peak of the shocks which endanger the fragile filament. In one form, the bores in the flanges 44 and 45 are enlarged in diameter as shown at 51 in Fig. 2 for about one-third the distance at the lower end of the flanges. The enlargement of the bores eliminates strains in the friable anode in a region where they are apt to occur, namely, at the juncture of the anode with the bushing 47 and the insulator 18. At the top of the anode structure, spacing bushings 52 are arranged on the internal support rods 46 and another cross-shaped insulator 53 rests on the bushings 52 and is held in position by short stub wires which are welded to the support rod 46 extending through the flanges of the anode. The transverse arm of the insulator 53 lies parallel with the press 12 and a similar arm of the insulator 18 and is provided with an aperture to receive the upright rod 28 of the grid and the upright rod 27 in a slot which is in alignment with the slot 30 in the insulator 18. In line with the grid supports in the insulator arm are two helical tension springs 54 through which extend hooks 55 to engage the loops of the cathode 26 and after applying a suitable tension thereto the hooks are welded to the cross-piece of the tension springs 54 to complete the assembly. Current is supplied to the anode through a suitable lead-in wire 56 which is sealed through the side of the stem 11 and connected to the brace or support rod 34. In this arrangement, the current is supplied to the anode through a metallic connection which is frictionally in contact with the anode.

Due to the large mass of the anode, it is preferable during the evacuation process to outgas the anode by heating it by the high frequency induction method. In this method, a coil surrounds the exterior of the vessel 10 and generates a high frequency current which induces a magnetic field in the closed contour of the anode to heat it to such a high temperature to deprive it of gases and deleterious matter which might impair the vacuum of the device. In following this method, it is extremely difficult to localize the heating to the anode alone and it is evident that if a surrounding metallic mass is adjacent the stem 11 and within the field of the heating coil, then the stem will be subjected to unnecessary heating which might fracture the glass. Therefore, the arrangement of the narrow collar 37 on the supporting structure of the electrode assembly and the removal of this collar away from the field which might be established in the vicinity of the anode obviously relieves the stem from any excessive strains due to heating. While the narrow band or collar is employed to avoid the above effects of heating the stem, the large mass of the electrode unit might not be effectively supported in rigid position simply by this remote connection to the stem. Therefore, in accordance with this invention the main supporting structure of the electrode unit is supplemented by an intermediate anchoring arrangement in the top of the press to insure rigidity in the assembled structure and to overcome strains or shocks imparted exterior to the device.

Another advantage in the combined structure of the electrode unit on the stem is the arrangement of the anchor rods or leading-in wires in the stem which project through the lower spacer insulator and exert a dampening effect on shocks applied to the device. Any shock or sudden impact upon the glass vessel of the device produces a bending impulse in which the peaks of the shocks cause the greatest damage due to the straining of the yielding part beyond its elastic limit. Consequently, a support or rod may be bent to a permanent set which will cause misalignment and wide variation in the electrodes and their spacial relation. Due to the large mass of the anode it is apparent that a shock to this element causes a movement of the whole electrode structure and the peak of the shock is liable to cause irreparable damage. The limited yielding movement of the internal support rods in the anode flange portions tends to absorb the peak of the shock applied to the structure and the rigid anchor wires in the stem also aid in absorbing a portion of the shock peaks, thereby protecting the electrode unit against damaging effects of the shocks. On the other hand, if an extreme shock like dropping the device may cause such a peak impulse that cannot be absorbed by the limited yielding point of the supports and anchors, then the device is not rendered inoperative, provided the filament and glass vessel remain intact, because any bending strain on the anchors will not alter the spacial relation of the electrodes since all three anchor wires will bend in the same direction below the insulator. The bending of the anchor wires merely changes the position of the electrode unit with respect to the stem and no change in spacial relation is produced between the cooperating electrodes. Therefore, it is apparent that the device of this invention can withstand extreme operating usage without endangering the efficiency and operating characteristics thereof.

While the brace supports of the main supporting structure of the electrode unit are shown as separate pairs of arms, it is equally within the scope of this invention to form the braces integrally and bend them in the form shown. Similarly, other changes may be made in the details of the assembly without departing from the scope of this invention as defined in the appended claims.

What is claimed is:

1. In a discharge device, a stem, an anode having a flange portion, a support therefor comprising separate upright members arising from said stem and converging towards said flange and having free end portions thereof extending into said flange, and a truss member connecting said upright members.

2. In a discharge device, an anode having a flange portion, a support therefor comprising upright members with upper limbs converging towards said flange and having portions thereof extending into said flange, a truss member connecting said upright members, and a rod passing through said flange and connected to said truss member.

3. In a discharge device, an anode formed of a homogeneous refractory mass, and a metallic support therefor including pairs of individual converging arms extending into said mass from opposite linear directions for applying a compression force to the surface of said anode at right angles to the axis of said anode.

4. In an electron discharge device, an electrode mount comprising a hollow anode having integral flange portions, insulating spacer members at opposite ends of said anode, a plurality of electrodes within said anode held by said spacer members, and a supporting structure for said anode, said structure having converging braces projecting into said flange portions at a medial point.

5. An electron discharge device comprising a hollow anode having integral flange portions, insulating spacer members at opposite ends of said anode, a plurality of electrodes within said anode and carried by said spacer members, and a supporting structure for said anode, said structure having a pair of braces in contact with said anode at a medial point to rigidly secure said anode to said supporting structure.

6. In an electron discharge device, an anode, a support therefor comprising converging arms and a connecting truss member, said arms contacting with the center portion of said anode, said truss member connecting said arms beyond one end of said anode, and a longitudinal rod extending through said anode and connected to said truss member.

7. An electron discharge device comprising a graphite anode of hollow configuration having diametrically opposed longitudinal flange portions, supports extending through said flange portions, a spacing insulator member extending across each end of said anode and secured thereto by said supports, a plurality of cooperating electrodes within said anode and carried by said insulating member at each end, a pair of support braces for each flange portion having fork ends projecting into the sides of the flange portions, and a truss member attached to each of said supports and said braces to apply a compression force to said braces.

8. An electrode mount comprising a hollow graphite anode having integral longitudinal flange portions, said flange portions being provided with bores enlarged over a part of the length of the bores, supporting members extending through said bores, spacing insulator plates carried by said members at opposite ends of said anode, said supporting members having portions spaced from said enlarged parts of said bores, and a plurality of cooperating electrodes within said hollow anode and carried by said plates.

9. An electrode mount comprising a hollow electrode having a protruding portion on opposite sides thereof, a rigid rod extending through the portions, convergent braces extending towards said electrode on opposite sides of each of said protruding portions and engaging therewith intermediate the ends of said portions, and a truss member connected to each of said rigid rods and said braces whereby said braces exert a compression force on said protruding portions.

10. An electron discharge device comprising a vessel having a stem, an electrode assembly supported beyond said stem including a hollow anode of large mass having apertured integral side flanges, connecting members extending through said flanges, a spacing member secured to said connecting members at one end of said anode, a cathode located within said anode and spaced therefrom by said spacing member, a plurality of supports extending from said stem, the end portions of said supports being bent at angles converging toward said flanges, and means connected to said supports compressing said supports into the surface of said flanges.

11. An electron discharge device comprising an enclosing vessel having a stem, an electrode unit beyond said stem including a graphite anode of substantially elliptical form with parallel sides and integral flange portions projecting from the parallel sides, said flange portions having a longitudinal bore and a central transverse bore, spacing insulators at opposite ends of said anode, connecting rods threaded through each longitudinal bore and supporting said insulators, a cathode and a grid within said anode and supported by said spacing insulators, and a supporting structure extending from said stem and including cooperating pairs of arms, each pair having fork ends extending into said transverse bore to support said anode from said stem.

12. An electron discharge device comprising an enclosing vessel having a stem terminating in a press, an electrode unit extending beyond said press, said unit including a hollow graphite anode having integral flange portions, spacing insulating plates at opposite ends of said anode, a cathode and a grid within said anode and supported by said plates, a main supporting structure including a plurality of braces extending from said flange portions to the lower end of said stem, a collar connecting said braces to said stem, and auxiliary anchoring rods connecting said electrode unit to said press.

13. An electron discharge device comprising an enclosing vessel having a stem terminating in a press, a plurality of short wires extending in the plane of said press, parallel frame members extending from said stem in parallel relation to said wires, and an electrode unit mounted beyond said press including an insulating spacer between said unit and press, said spacer being cruciform in shape and supported in a transverse plane by said wires and frame members, said frame members having extensions engaging the side surfaces of one of said electrodes for reinforcing said electrode unit against shocks directed against the end of said vessel remote from said stem.

14. An electron discharge device comprising an enclosing vessel having a stem terminating in a press, rigid wires extending from said press, a plurality of electrodes beyond said wires and press, a multi-arm insulating spacer for said electrodes adjacent said press, said wires being rigidly attached to the arms of said spacer in the plane of said press, and frame supports arising from said stem and interconnected with other arms of said spacer, said supports having extensions engaging one of said electrodes.

JAMES E. CLARK.
VICTOR L. RONCI.