April 3, 1934. D. V. EDWARDS ET AL 1,953,906

RECTIFIER TUBE

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Fig. 1.

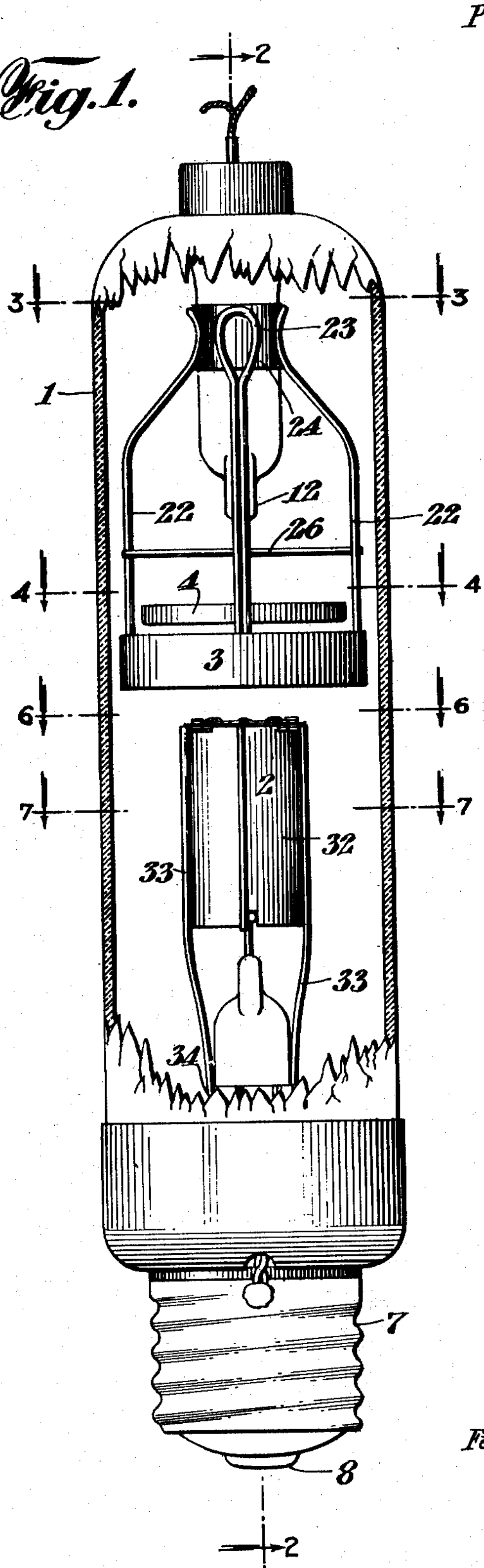

Fig. 2.

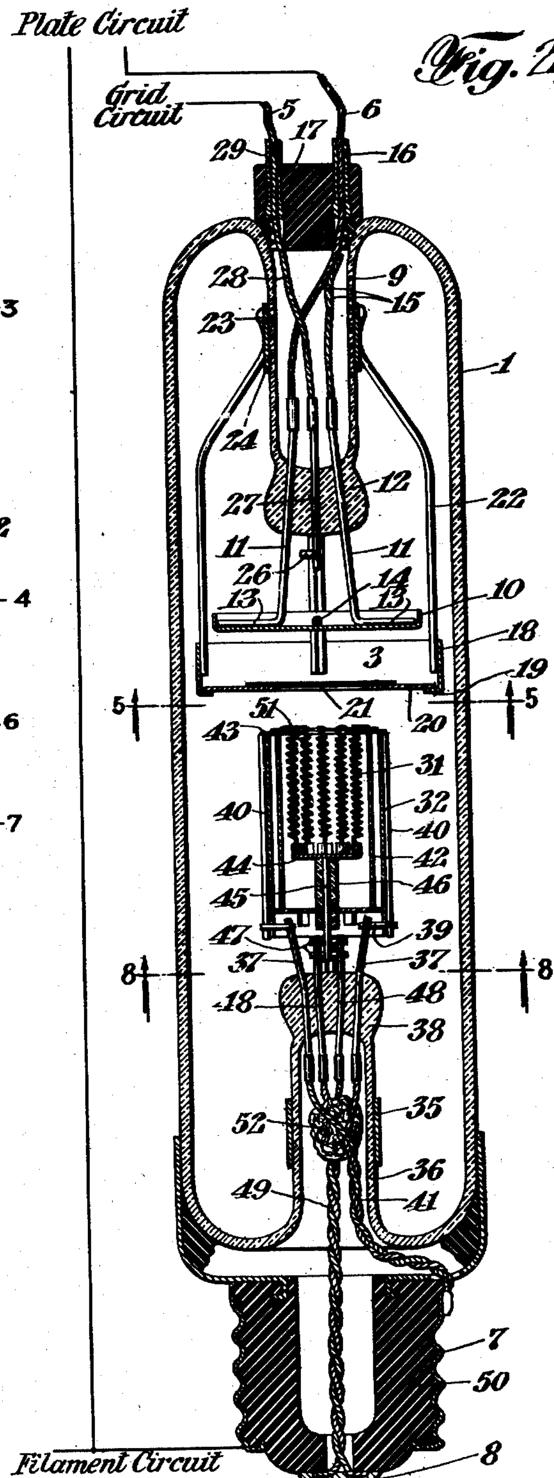

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Fig. 3.

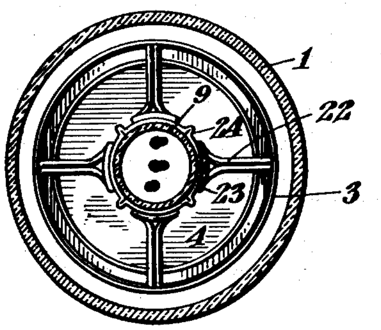


Fig. 4.

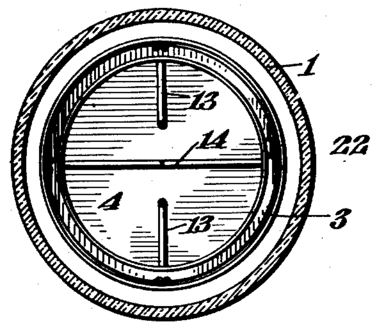


Fig. 5.

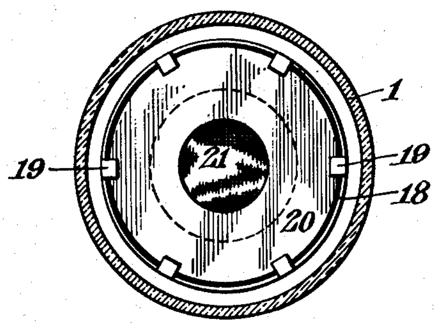


Fig. 6.

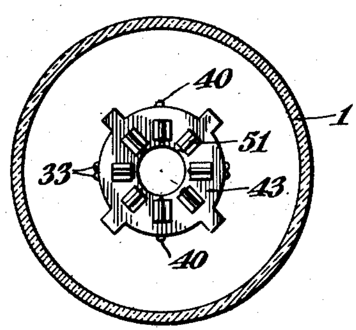


Fig. 7.

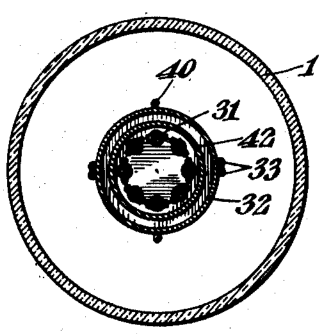
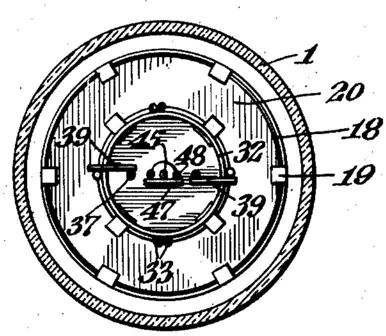


Fig. 8.



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UNITED STATES PATENT OFFICE

1,953,906

RECTIFIER TUBE

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Application December 26, 1930, Serial No. 504,830

4 Claims. (Cl. 250—27.5)

This invention relates to rectifier tubes of the gaseous type and has special reference to such tubes when adapted to carry large currents and used for industrial purposes.

The objects of the invention are to provide a tube having sturdy mechanical construction and high thermionic efficiency. To these ends further objects are to confine the arc to its proper path, to properly distribute the heat in the tube, to avoid electron emission from improper parts such as getters, grid or plate, and to maintain uniform cathode heating even after part of the heater may have been destroyed.

The invention will be explained by reference to the accompanying drawings, in which,

Fig. 1 shows the interior arrangement of elements in a tube embodying the invention,

Fig. 2 is a longitudinal sectional view of the tube of Fig. 1,

Fig. 3 is a cross section taken along the line 3—3 of Fig. 1, and shows the spacing arrangement of the supporting wires around the periphery of the grid.

Fig. 4 is a plan view looking downward along 4—4 of Fig. 1, and shows the arrangement of the stiffening wires 13 and 14.

Fig. 5 is a view looking upward along the line 5—5 of Fig. 2 and shows plate 20 with its opening covered by screen 21 through which the main discharge is caused to pass.

Fig. 6 is a plan view looking downward along 6—6 of Fig. 1, and shows the opening in the upper ring 43 of the can through which the electron stream passes, and also shows the metal pieces 51 which prevent injury to the upper ends of the filaments while being welded to the disk.

Fig. 7 is a cross-sectional view taken along the line 7—7 of Fig. 1, and shows the double wall of the can and also the spacing of the filaments.

Fig. 8 is a view of the cathode assembly, looking upward along 8—8 of Fig. 2, and shows in detail the arrangement of the supporting and conducting wires for the cathode assembly.

The glass envelope is provided with two reentrant portions, one of which 9 supports the plate 4 and grid structure 3, and the other of which 36 supports the cathode assembly 2 and its heater elements.

The cathode assembly 2 comprises a can having an outer wall 32 and spaced inner wall 42, supported by two wire supports 33 which are spot welded to the outer wall at both the top and bottom portions of the can. The supports are spaced opposite the flat portions of the press 38, and each support is bent back upon itself and may have looped portions 34 similar to looped portions 23, secured to a metal band 35 which is crimped about the stem or reentrant portion 36. Two relatively heavy supports 37 which are embedded in and extend through the press serve as additional means to rigidly support the assembly by means of cross wires 39 which are welded at one end to the wires 37, and at the other end to the wall 32 at the bottom of the can. The supports 33 are fixed at one end to the band 35 on stem 36, and are braced at a point intermediate the fixed ends of the supports and the mass supported, by means of the press and supports 37 and the bottom of the can to which each of the supports is secured. This provides a rigid truss support having a cantilever construction, reduces the bending moment about the same, and causes the force necessary to support the mass to be evenly distributed on the supporting glass stem. Wires 40 extend along the outside wall to further strengthen and stiffen the can.

The supporting wires 37 also serve as conductors for the heater currents, being connected to one side of the filament circuit by means of two flexible conductors 41, connected in multiple to give greater current carrying capacity, and soldered to the screw terminal 7. At the other end wires 37 connect to the top ring 43 of the can, to which ring are attached eight electron emitting filaments 31 connected in multiple and positioned within the can, each filament being connected at the other end to a cup shaped member 44. The latter member is connected by wire 45 and cross wires 47 to two supporting wires 48 sealed in the press 38 and they, in turn, are connected by flexible conductors 49 to the other filament terminal 8 of the tube. Conductors 49 are separated from the conductors 41 by insulating material 52, and wire 45 is insulated where it passes through the bottom of the can by a bushing 46. In order to prevent the ends of the filament coils from overheating when they are welded to the disk 43 small pieces of metal 51 are placed over the ends of the filaments and are also welded to the disk, these pieces serving to convey sufficient heat away to prevent injury to the filament ends. The filaments are coated with an oxide of the alkaline earth metal group to further increase their electronic emission. Preferably the emissive coating comprises the resultant compound of an alkaline earth metal oxide and an oxide of a metal capable of forming amphoteric compounds less acid than titanic acid, such as zirconium oxide or aluminum oxide, heated in vacuum, in order that the coating may be highly resistant to ionic bombardment.

The can has an inner wall 42 spaced from the outer wall to thermally insulate and radiate back a large part of the heat to prevent the same from being radiated away from the filaments, and produces to a certain extent an integrating effect of the heat emitted by the individual coils. Also, since the watts required to maintain the inside at operating temperature is independent of the size or cross-section of the filaments, the inside remains at a proper operating temperature although one or more of the filament coils burn out. In this case the other filaments carry more current than before but since they radiate more heat to compensate for the burnt out filaments, their temperature remains approximately the same. Therefore, the tube will continue to operate satisfactorily until only one or two filaments remain, and this results in a greatly increased life of the tube.

This arrangement also has an important advantage in that the user of the tube can tell beforehand the condition of the tube and its probable remaining life by the number of good filaments remaining, and interruptions due to filament failure can thereby be prevented. The upper ends of filaments 31 are visible through the hole in ring 43 and the failure of a filament is indicated by its color which will be darker than the color of the good filaments.

The plate 4 of the tube is in the form of a thin sheet or plate of tantalum, platinum, carbon or other substance which functions as a getter by absorption when heated to the normal operating temperatures, instead of by vaporization, whereby a deposit will not be formed on the grid or other surfaces when the tube is heated or flashed and which causes such surfaces to become emissive and interfere with the operation of the tube. The plate has a beaded or flanged edge 10 to stiffen the disc, and is rigidly supported by two relatively heavy lead-in wires 11 which are embedded in and extend through the press 12. The supporting wires also have bent portions 13 where they engage the plate, which portions are spot welded or otherwise suitably secured to the plate. A separate wire 14 of substantially the same diameter is also welded to the plate and extends across its diameter at right angles to the bent portions to stiffen the plate in that direction. Thus, the plate may be made of relatively thin sheet material without danger of bulging or warping due to heating, electrostatic stresses, or other causes when the tube is in operation. Two flexible conductors 15, connected in multiple to provide greater current carrying capacity, connect the supporting wires 11 and the plate to terminal 6 passing out through metallic sleeve 16 embedded in a composition cap 17 which serves to seal the stem 9 of the tube.

The grid comprises a relatively large circular metal band 18 to which is attached a sheet metal plate 20 by means of tabs 19. The metal plate has a restrictive circular opening covered by wire screen 21 in the direct path between the plate and filaments. The band 18 and plate 20 extend in sufficiently close relation to the wall of the tube so that the wall charge effect—which is a negative charge retained by the tube wall due to electronic emission by the filaments—will repel and prevent the electron stream from passing through the space between the grid and wall and thereby will prevent a discharge through this portion of the tube. In this manner the main discharge is restricted to passing through the central opening and wire screen of the grid and the latter thereby effectively controls the starting of the tube. The main discharge also passes between the filaments and plate by the most direct path.

The grid construction also provides an efficient means for the conduction of heat away from the central portions of the grid where the tube is hottest because metal plate 20 will conduct the heat to band 18 which comprises a radiating surface at a cooler place since the band is not surrounded by hot gas. The grid construction also prevents the formation of convection currents which circulate the heat within and cause the ends of the tube to become hot and break the seals around the presses. In the tube disclosed the heat is caused to be radiated from the glass wall of the envelop adjacent the grid, or intermediate the ends of the tube, and this portion of the glass may be forced to radiate large quantities of heat and worked at a high temperature without injury to the tube.

The grid is rigidly positioned by four supporting wires 22 spaced equally around the band 18 and connected thereto by spot welding. Each of these supports comprises relatively heavy wire bent back upon itself, the loop portions 23 of which are welded to a metallic band 24 which is crimped to the glass stem 9. The supports are bowed as in the manner illustrated in order to give a cantilever bracing action to firmly support the grid in its proper spaced relation with respect to the other electrodes and to relieve the press of the strain of supporting the grid. The grid is connected in circuit by a cross wire 26 which is welded at each end to the supports 22 and at the center to a wire 27 which is embedded within and extends through the press.

Since the supports 22 are fixed at one end to the band 24 on stem 9, and are braced at a point intermediate the fixed ends of the supports and the mass supported, by means of the wire 27 and cross wire 26, in a manner similar to the supporting means for the cathode, this provides a truss support having a cantilever construction which is rigid and strong in all directions, thereby eliminating the necessity of using a cross press which is expensive and difficult to make. A flexible conductor 28 connects the wire 27 through sleeve 29 to a terminal 5 of the tube.

The tube is preferably filled with argon or other inert gas, although mercury or other metallic vapors may also be used. If a sufficient stream of electrons is emitted by the filaments the gas will become ionized thereby and will become conductive, and the main discharge between the plate and filaments will take place during the active periods of the tube, that is, when the plate current supply is flowing in such direction as to make the plate positive with respect to the filaments. During the blocking periods of the tube when the plate is negative with respect to the filaments no plate current will flow. The grid is used to control the starting point of the tube during its active periods by impressing a proper potential upon the grid, thereby controlling the electron flow from the filaments, and thus control the ionization of the gas necessary to induce the main discharge between plate and filaments. Various means of impressing the necessary potential upon the grid at the desired times are known and employed in the art and need not be discussed here.

Various of the features of the foregoing construction disclosed are not limited to gas filled tubes, but are equally well adapted for use in vacuum tubes operating by electronic emission only, where it is desired to obtain a rugged device in which the electrodes will maintain their proper positions and operating conditions even though the size of the tube assumes large proportions, and notwithstanding that it may be subjected to severe jars and other rough treatment. The invention, therefore, is not limited to a tube of the type disclosed, but is applicable to all tubes in which the structural features may be advantageously embodied.

We claim:

1. A gas filled rectifier tube having an electron emissive cathode and grid and plate electrodes, the grid extending into proximity with the tube wall and having a peripheral surface in spaced relation thereto, said peripheral surface and the adjacent portion of the tube wall forming a space therebetween of such length relative to its width that the electrical field created in said space by the negative electron charge on said wall is more repellent to emitted electrons than the field in the grid openings.

2. A gas filled rectifier tube having an anode, an electron emissive cathode, and a control electrode interposed between said anode and cathode, said control electrode comprising a central grid portion, an annular imperforate portion and a peripheral portion having an extended surface in parallel relation with the tube wall but out of contact therewith, the peripheral surface and the adjacent portion of the tube wall forming a space therebetween which permits thermal expansion of the control electrode, the dimensions of said space being such that the main discharge from cathode to anode is excluded therefrom.

3. In a vacuum tube, a stem, a press on said stem, an electrode, a pair of supports rigidly secured to the electrode and to the stem, and another pair of supports secured to the electrode and sealed in the press, the latter supports being disposed in the plane of the press and the former in a plane substantially perpendicular thereto.

4. In a discharge tube, a stem, a press on said stem, an electrode, two pairs of supports secured to said electrode and to the stem, one pair being disposed in the plane of the press and the other pair in a plane substantially perpendicular thereto, and additional supporting means secured in the press and connected to each support of the latter pair, the combination of supports forming a cantilever construction braced against movement in any direction.

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