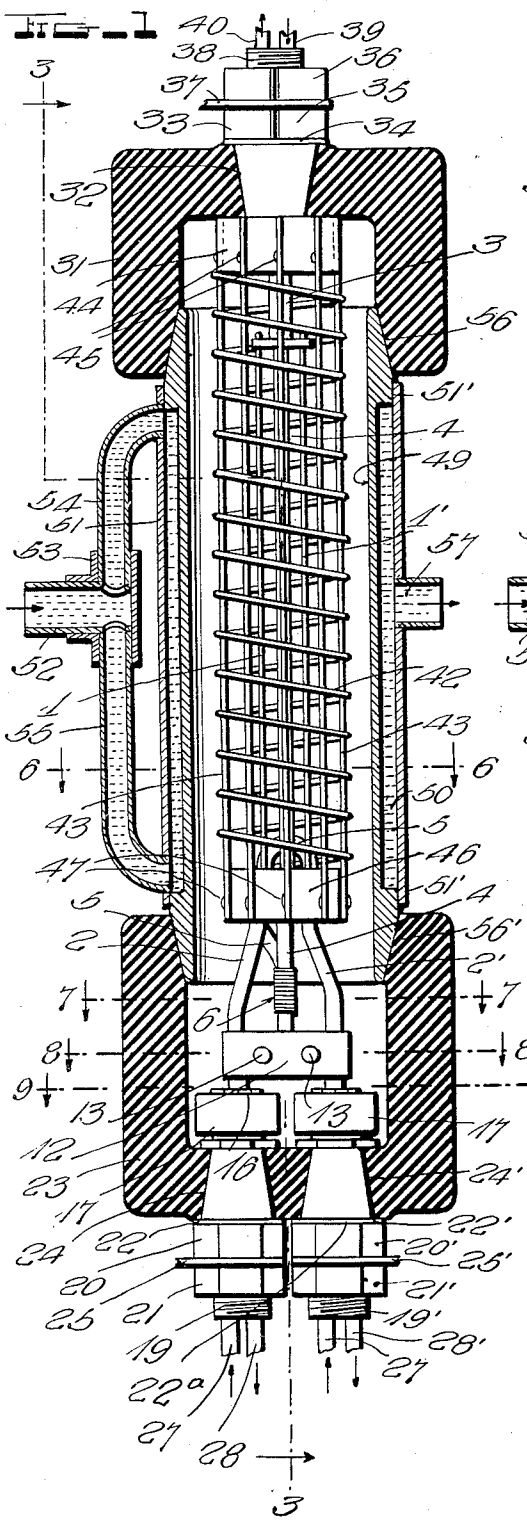
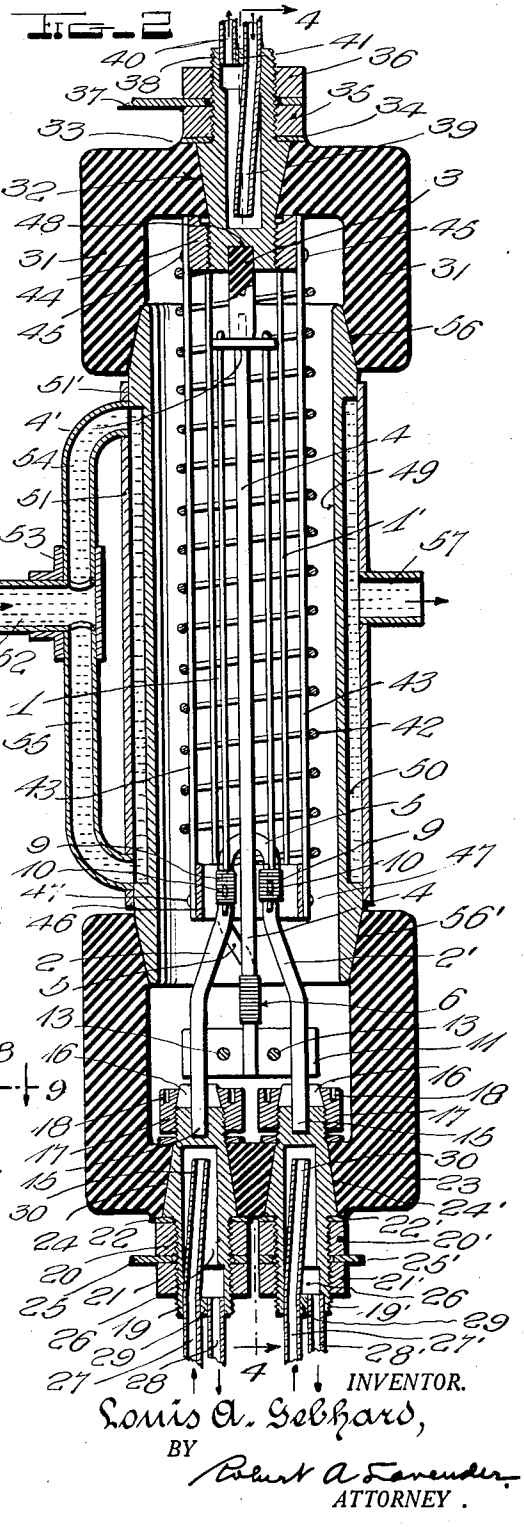
July 30, 1935. L. A. GEBHARD 2,009,444

HIGH POWER DEMOUNTABLE TUBE

Filed March 29, 1933 3 Sheets-Sheet 1





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HIGH POWER DEMOUNTABLE TUBE

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FIG. 3

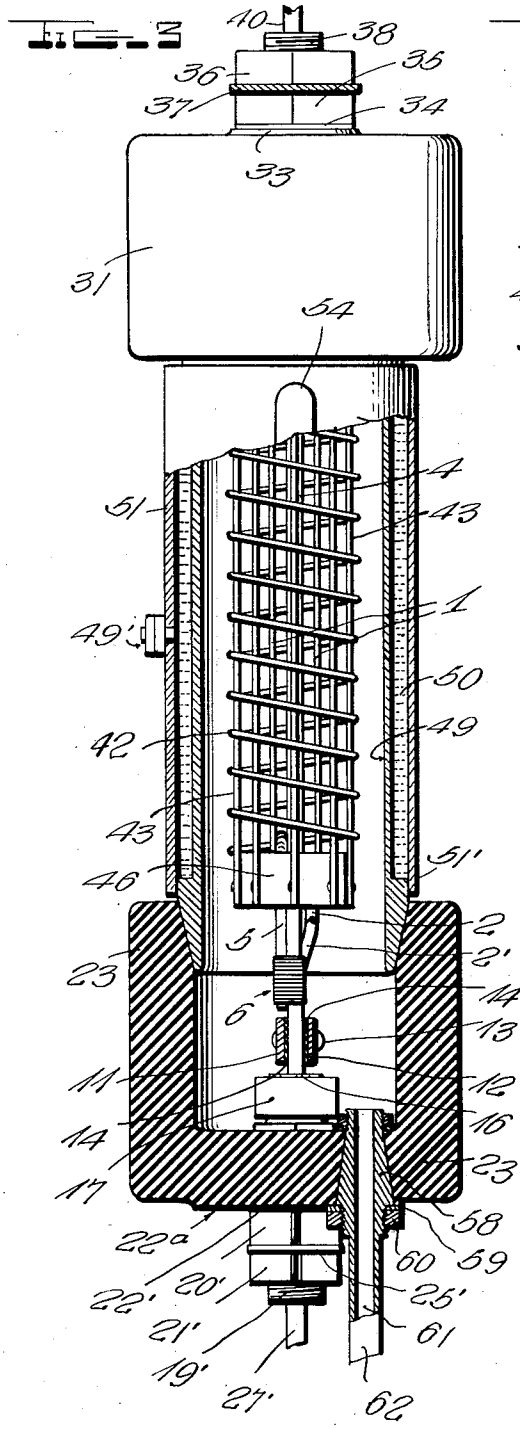
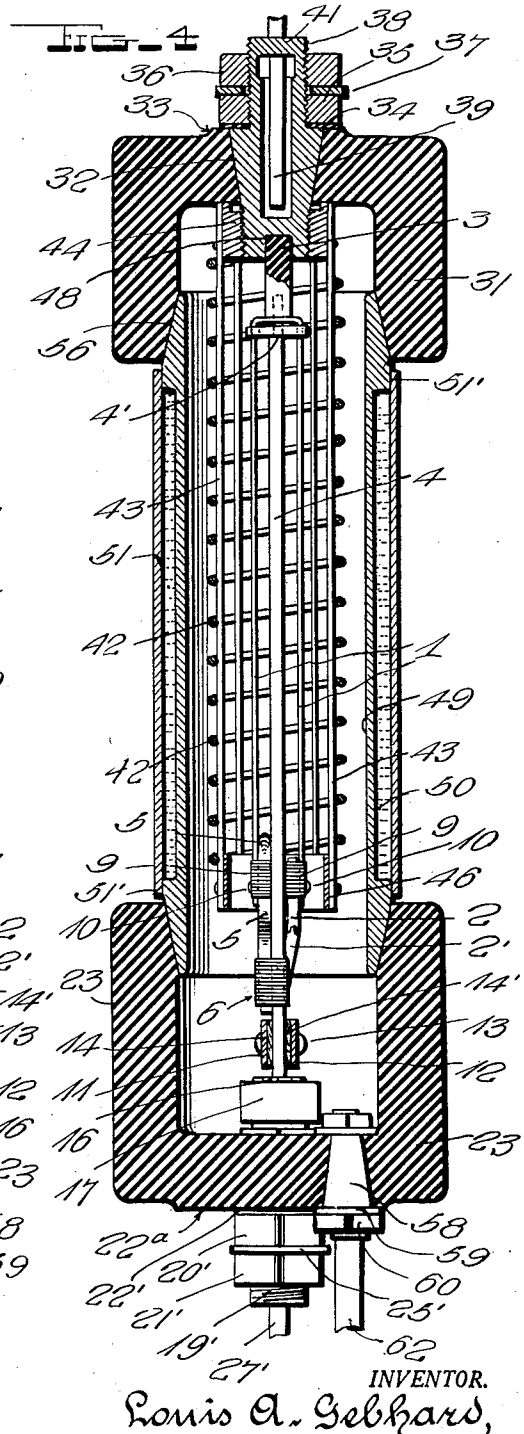


FIG. 4



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FIG. 5

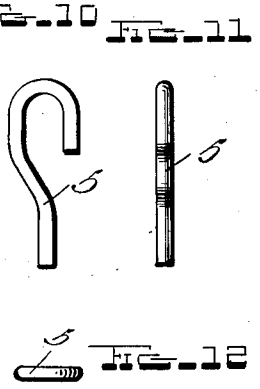


FIG. 10 FIG. 11

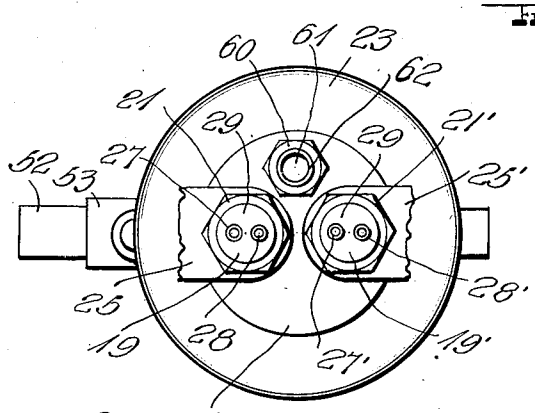
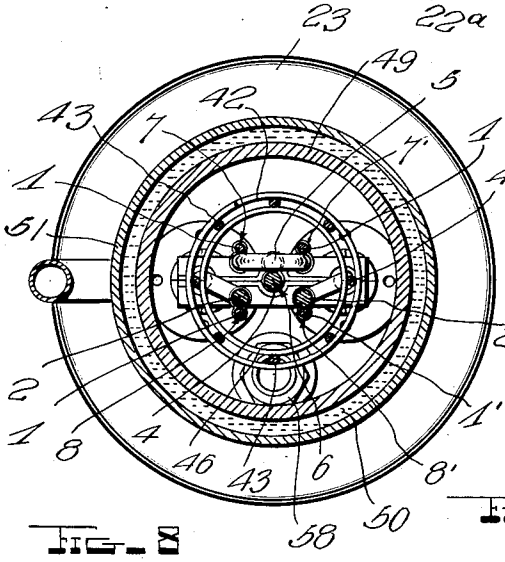


FIG. 6

FIG. 12

FIG. 7



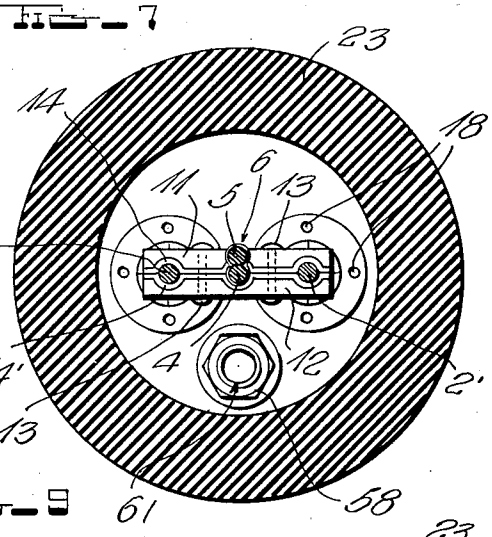
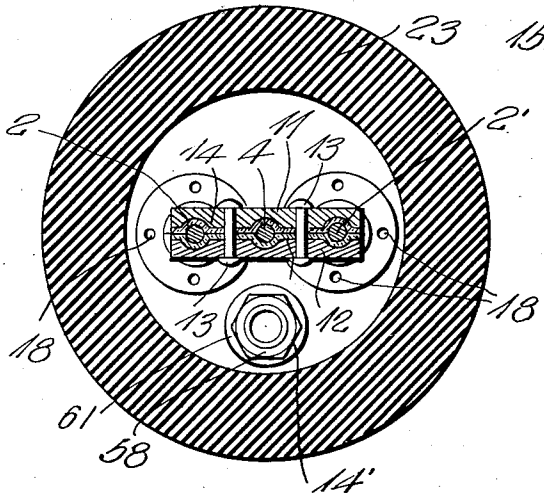
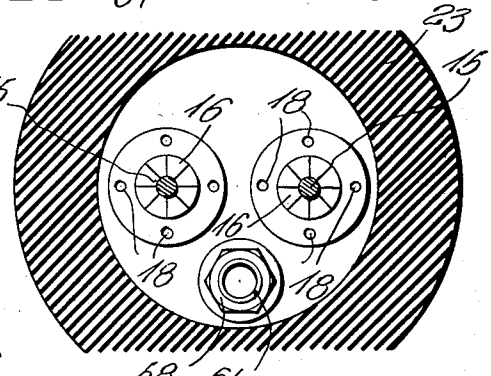


FIG. 8

FIG. 9





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UNITED STATES PATENT OFFICE

2,009,444

HIGH POWER DEMOUNTABLE TUBE

Louis A. Gebhard, Washington, D. C.

Application March 29, 1933, Serial No. 663,379

8 Claims. (Cl. 250—27.5)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

My invention relates broadly to high power electron tubes and more particularly to a construction of demountable high power transmitting tube.

One of the objects of my invention is to provide an improved construction of high power demountable electron tube in which the disassembly and assembly of the parts of the tube may be readily effected and elements within the tube replaced, the tube reassembled and evacuated at relatively small cost.

Another object of my invention is to provide a construction of demountable electron tube in which the cathode structure may be readily renewed for extending the active life of the tube.

Still another object of my invention is to provide a construction of high power tube in which a demountable cathode structure is provided with fluid cooling means for supporting the cathode element.

A further object of my invention is to provide a construction of demountable electron tube in which a pair of adjustable chucks are mounted in one end of the tube structure for supporting the cathode and another removable chuck is disposed in the insulator at the opposite end of the tube for supporting the control grid electrode, the chucks each being fluid cooled for improving the efficiency of operation of the tube.

A still further object of my invention is to provide an improved assembly for a cathode and control grid unit in a demountable electron tube.

Other and further objects of my invention reside in an improved high power demountable electron tube structure as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 is a central vertical longitudinal sectional view of a tube constructed in accordance with my invention, the structure supporting the filaments and adjacent parts being shown in elevation; Fig. 2 is a similar view in central vertical longitudinal sectional showing the filament, the grid, and the adjacent supporting structure in section; Fig. 3 is a sectional elevation taken on line 3—3 of Fig. 1; Fig. 4 is a transverse vertical section taken on line 4—4 of Fig. 2 looking in the direction of the arrows; Fig. 5 is a bottom plan view of the tube; Figs. 6, 7, 8 and 9 are detailed horizontal sectional views taken on correspondingly designated lines of Fig. 1; Fig. 10 is a detailed front elevation of the loop shaped member used to connect the filaments in series; Fig. 11 is a side elevation thereof; and Fig. 12 is a top plan view thereof.

In a demountable vacuum tube, it is desirable to have the filament structure so arranged that it can be quickly and easily replaced. The cost of replacing the filament must be low compared with the cost of constructing a vacuum tube which is not demountable in order to meet the economic requirements in the use of the demountable tube construction. It is also desirable to maintain the number of airtight joints at a minimum so as to reduce the possibilities for excessive air leakage. These joints should be as simple as possible. The insulating material necessary between the elements of the tube should have such composition as will give low loss at high frequencies and, in addition, the structure should be of such texture as to insure tight joints. The insulating material should be so disposed that excessive losses due to high intensity electric fields are avoided and that voltage breakdown is avoided. These desirable points are all incorporated in the tube structure of my invention.

The filament structure consists of two U shaped loops of wire such as tungsten, 1 and 1', connected in series and to terminal members 2 and 2'. The two loops are supported at their upper ends by insulating member 3 which has a circular flange through which the filament wire passes. Insulator 3 is supported from the upper end of rod 4 which is supported from its lower end as will be described hereinafter. A shoulder 4' on rod 4 appropriately seats insulator 3 on the vertical rod 4. The two loops are connected in series by the use of a hook-shaped member 5 which is supported from rod 4 at a point 6 near its lower end. The joints 7, 7', 8 and 8', between the lower ends of 1 and 1' and 2 and 2', are made by wrapping wire 9 around the joint and then welding the lower end of the joint, as shown at 10. Members 4 and 5 are held together by means of a wire wrapping, as shown at 6. A clamp is provided at the lower end of the filament structure so as to make a rigid unit which can easily be handled. The clamp consists of two metal members 11 and 12 held together by means of rivets 13 and 13'.

Sheaves of insulating material 14 and 14' are provided to prevent short-circuiting the filament circuit. Rod 4 is supported in the middle of this clamp.

The lower ends of the filament connections 2 and 2' project beyond the clamp, as shown at 15, into chucks. These chucks consist of central members 16 which are partially split radially and are embraced by nut members 17, causing the chucks to firmly grip the ends of the filament connections. Nut members 17 are provided with recesses, as shown at 18, so that a special spanner wrench may be inserted for tightening. Members 16 form part of the filament terminals and airtight joints. The ends 19 and 19' of the terminals are threaded to take nuts 20 and 21, 20' and 21'. Washers 22 and 22' are provided to prevent excessive localized strains. The filament terminals are supported in cup-shaped insulating member 23. The points of support are also airtight joints, as shown at 24 and 24'. These joints are conical in shape and are appropriately ground to insure against air leakage. Preferably, a suitable compound is placed on the surface before assembly to insure air-tightness. The circular boss 22a of insulator 23 is raised and ground to prevent excessive mechanical stresses from being set up in the insulating material due to tightening up the terminals. The connections of the external circuit to the filament terminals are shown at 25 and 25'.

The filament terminals and airtight joints are simultaneously water-cooled by the same cooling system. This is accomplished by making the filament terminals hollow, providing chambers 26 into which tubes 27 and 27' project. Tubes 28 and 28' are mounted in the end of these chambers. Caps 29 serve to close off the end of the chambers and to confine the tubes. The inner ends 30 of the tubes 27 are centralized by bending with respect to the inner ends of the chambers 26. A cooling liquid is passed into tubes 27 and 27', driven against the inner end of the chamber and by the side walls to the outer end of the chamber to be discharged through tubes 28 and 28'. Thus, the filament terminals, as well as the joints, are kept cool.

The grid structure is supported from cup-shaped insulating member 31 through airtight joint 32 which is constructed similar to those of the filament terminals. A boss 33 has a ground surface engaging with washer 34 held by nut 35. Nut 35 holds lead 37 to the grid terminal. A threaded member 38 is engaged by the nuts 35 and 36. The grid terminal is liquid cooled in a manner similar to that of the filament terminals by the use of tubes 39 and 40 and the cap 41. The grid proper consists of a wire spiral 42 welded to longitudinal rods 43. Rods 43 are fitted at their upper ends in recesses in member 44 and welded thereto as at 45. The lower ends of rods 43 are fastened to a ring-shaped member 46 by welding as shown at 47. Insulating member 3 fits into a recess in member 44, as shown at 48, which construction serves to centralize the filament structure.

The anode structure consists of a cylindrical member 49 which acts as the anode proper. A recess in 49 provides a chamber 50 for cooling liquid. An outer cylindrical member 51 completes chamber 50. Joints are made at 51'. The outer cylinder 51 can either be rolled as a sheet metal member around the cylindrical member 49 and soldered at the ends 51' thereof as illustrated, or one or both of the frusto-conical ends of cylindrical member 49 may be of sufficiently reduced diameter as to permit outer cylindrical member 51 to be telescopically slipped thereover in the nature of a sleeve and soldered in place. The cooling liquid enters through tube 52 and divides at joint 53 to pass through tubes 54 and 55. Tubes 54 and 55 are fastened to and pass through member 51 so that the cooling liquid enters the recess 50 adjacent to the airtight joints 56 and 56' between insulating members 23 and 31 and the anode structure. This keeps the joints reasonably cool since the cooling liquid has not yet been heated by the anode. The liquid passes around the recess and toward the center and is discharged through tube 57. The airtight joints 56 and 56' are formed in a manner similar to that of the filament terminals, that is frusto-conical surfaces are disposed in abutting contact with respect to each other. An anode terminal is shown at 49'.

The connection to the vacuum pump is made by the use of a conical shaped joint 58 which is similar in construction to the filament terminal joints. A washer 59 and nut 60 are provided for tightening the joint. A bore 61 passes up the center of the joint. The end 62 is appropriately connected to the vacuum pump.

In order to provide low radio frequency loss and airtight joints, the insulating material used in the vacuum tube of my invention preferably has, as its main constituent, magnesium silicate or a combination of magnesium and aluminum silicates. This material, when mixed with a suitable binder in suitable proportions and properly heat treated, has a very close non-porous structure which permits making a good airtight joint. Parts of the inner and outer surfaces, which are not ground, are covered with a suitable glaze to improve air-tightness and protect the surface against collection of dirt.

In service use, this vacuum tube is supplied with a number of spare filament units constructed as described. Should a filament burnout occur, the filament is replaced in the following manner: The tube is allowed to become filled with air by the use of a suitable valve in the vacuum line. The tube is opened at joint 56' and the upper half including anode and grid structures lifted up and removed from the filament structure. A special spanner wrench is passed into insulator 23 and inserted in the holes 18 in members 17 and the chucks holding the ends of the filament structure are loosened. This permits removing the filament structure and substituting a new one. The chucks are tightened, the tube assembled and evacuated and is now ready for operation.

It will be observed that the ground frusto conical portions on the insulators establish firm surface contact over a large area of ground frusto conical portions of the fluid cooled cylindrical anode which insures an airtight seal. It will also be seen that the looped structure of the cathode provides for a substantial area of electron emission from the cathode. At the same time, substantial cooling is effected by virtue of the arrangement of fluid cooled chucks in the insulator at one end of the tube. A high degree of insulation is maintained between the control grid and the cathode structure and the control grid cooled by the continuous passage of cooling fluid through the support for the control grid carried in the insulator at the other end of the tube. The continuous cooling of the cylindrical anode which forms the enclosing vessel for the tube also insures high operating efficiency in the tube. The manner of insulatingly mounting the cathode ele-

ments with respect to the control grid and concentrically disposing the cathode elements and control grid within the anode facilitates the assembly and disassembly of the elements of the tube while preventing electrical breakdown.

The tube structure of my invention provides an economical means of maintaining high power transmission systems in operation inasmuch as the number of spares may be reduced to a minimum and a renewal tube substituted for a burned out tube while repair is being made of the burned out tube without the necessity of purchasing new tubes of large cost.

While I have described my invention in certain of its preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

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

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A high power electron tube comprising a cylindrical anode, frusto-conical end portions on said cylindrical anode, end members of insulation material each having a frusto-conical annular face disposed interiorly thereof in coacting relation to the frusto-conical end portions of said anode, an electrode removably mounted in one of said end members and projecting centrally within said anode, another electrode removably mounted on the other of said end members and projecting through said anode in a position concentric with the aforesaid electrode, and insulating means disposed between said first mentioned electrode and the opposite end member for maintaining said electrode in predetermined spacial relation with respect to said anode.

2. A demountable high power electron tube comprising a tubular fluid cooled anode structure, frusto-conical end portions on said anode structure, cup-shaped end members of insulation material, annular frusto-conical surfaces disposed interiorly of each of said cup-shaped end members and coacting with the frusto-conical end portions on said anode, a pair of expansible and contractible chuck devices carried by one of said cup-shaped members, a cathode structure removably mounted in said chuck devices, a removable supporting device carried by the other of said cup-shaped end members, a control grid carried by said removable supporting device, and means for fluid cooling said chuck devices and said supporting device.

3. A high power electron tube comprising a tubular fluid cooled anode structure, frusto-conical end portions on said anode structure, cup-shaped end members of insulation material, annular frusto-conical surfaces disposed interiorly of each of said cup-shaped end members and coacting with the frusto-conical end portions on said anode, a pair of expansible and contractible chuck devices mounted in spaced relation in one of said cup-shaped end members, means for fluid cooling each of said chuck devices, a cathode structure removably mounted in said chuck devices and projecting interiorly of said anode, a supporting member removably mounted in the other of said cup-shaped end members, means for fluid cooling said supporting member, and a control grid carried by said supporting member and projecting interiorly of said anode in a position concentrically disposed with respect to said cathode structure.

4. A high power electron tube comprising a tubular fluid cooled anode structure, frusto-conical end portions on said anode structure, cup-shaped end members of insulation material, annular frusto-conical surfaces disposed interiorly of each of said cup-shaped end members and coacting with the frusto-conical end portions on said anode, a pair of expansible and contractible chuck devices mounted in spaced relation in one of said cup-shaped end members, means for fluid cooling each of said chuck devices, a cathode structure removably mounted in said chuck devices and projecting interiorly of said anode, a supporting member removably mounted in the other of said cup-shaped end members, means for fluid cooling said supporting member, a control grid carried by said supporting member and projecting interiorly of said anode in a position concentrically disposed with respect to said cathode structure, and insulation means disposed between said cathode structure and said supporting member for maintaining said cathode structure and control grid at predetermined spacial relation.

5. A high power electron tube comprising a tubular anode, frusto conical end portions on said anode, cup-shaped end closures each having an annular frusto conical surface engaging the frusto conical end portions of said anode, a pair of expansible and contractible chuck devices disposed in spaced relation in one of said cup-shaped end closures, a member removably mounted in each of said chuck devices, a cathode structure supported by said members and extending interiorly of said anode, a removable supporting device carried by the other of said cup-shaped end closures, and a control grid mounted on said supporting device and extending interiorly of said anode in concentric relation to said cathode structure and said anode.

6. A cathode structure for a high power tube comprising in combination a pair of removable supporting devices, a conductor removably supported in each of said devices, a bridge member insulatingly suspended between said conductors, a rod insulatingly supported by said bridge member and projecting intermediate said conductors, a conductive member mounted on said rod immediately above said bridge member, an insulating member carried by the upper end of said rod, and a pair of filament members carried by said insulating member, one end of each filament connected to said conductive member, the other ends of the filaments connected to said conductors.

7. A cathode structure for a high power tube comprising in combination with a pair of supporting devices, a conductor mounted in each of said devices, a bridge insulatingly suspended between said conductors, a rod insulatingly supported by said bridge intermediate said conductors, a hook-shaped member carried by said rod immediately above said bridge, a flange carried by said rod adjacent the other end thereof, and a cathode connected at its opposite ends with said conductors and looped around said flange and said hook-shaped member for providing a double looped cathode structure.

8. A cathode structure for a high power tube comprising in combination with a pair of supporting devices, a conductor mounted in each of said devices, a bridge insulatingly suspended

between said conductors, a rod insulatingly supported by said bridge intermediate said conductors, a member carried by said rod adjacent each end thereof, a cathode having its opposite ends connected with said conductors and looped around said members for providing a double looped cathode structure and an insulating member carried by the upper extremity of said rod coacting to position said rod in positive spaced relation with respect to other elements of said tube.

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