Oct. 17, 1967 S. E. ALLEN, JR 3,348,088

ELECTRON TUBE APPARATUS

Filed Sept. 8, 1964

FIG. 1

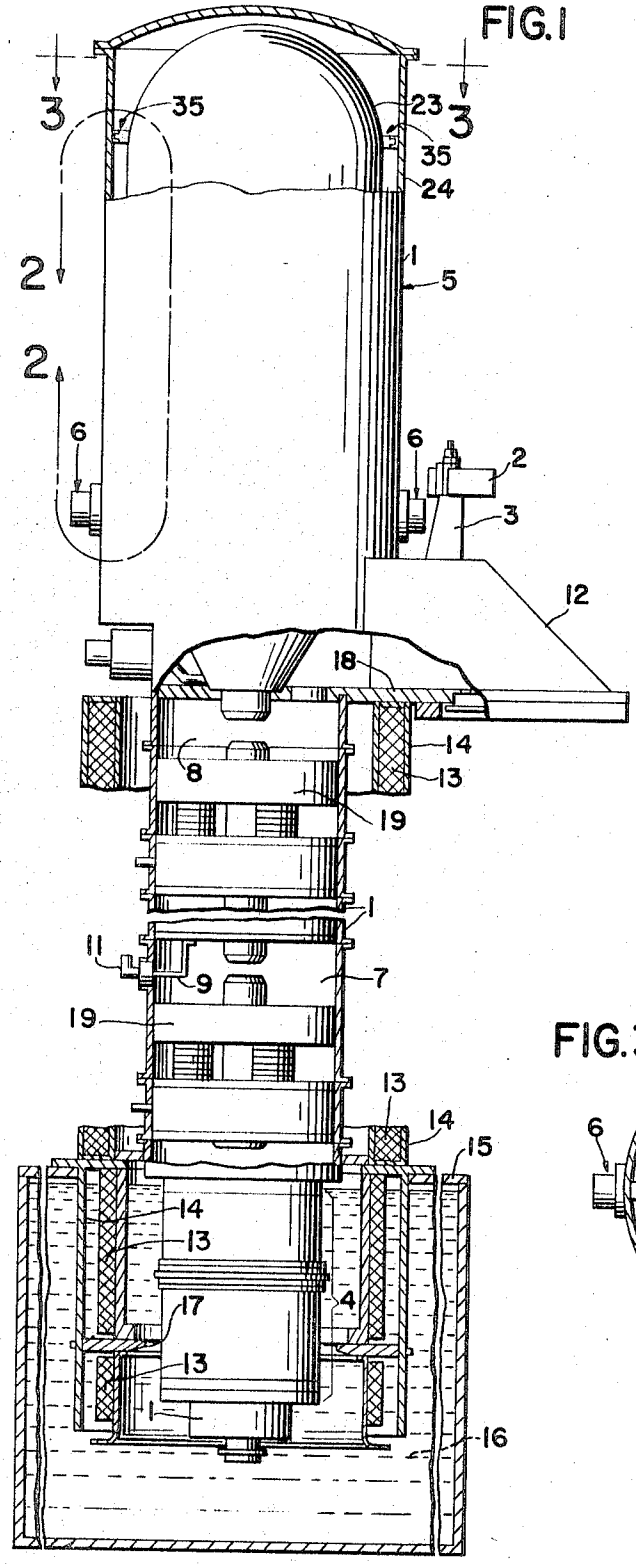


FIG. 2

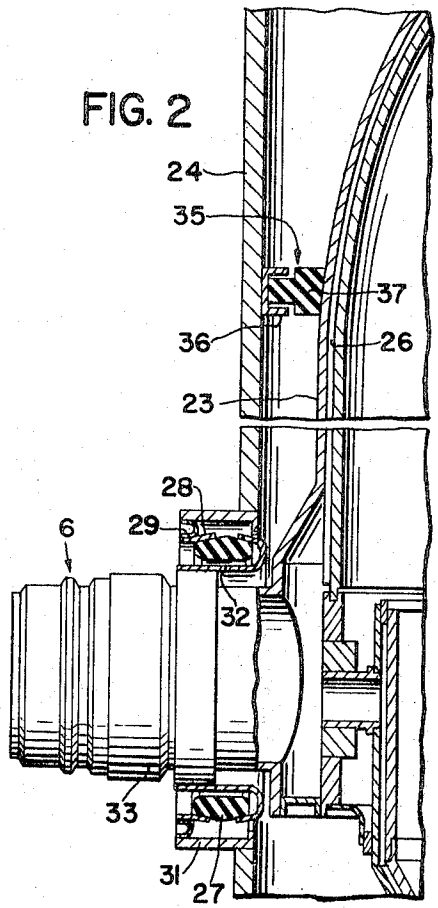
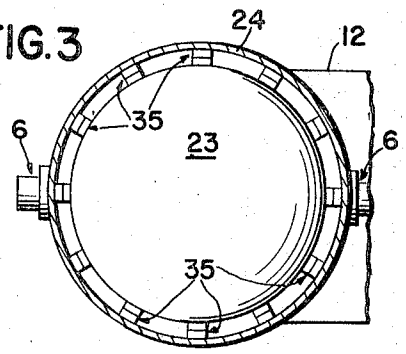


FIG. 3



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ELECTRON TUBE APPARATUS

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This invention relates in general to electron tube apparatus and more particularly to collector assemblies for high frequency high power electron tube apparatus.

Collector assemblies for high power high frequency electron tube apparatus are generally large to provide a large surface area for collecting the electron beam and dissipating the heat generated by the collected beam. For example, in super power tubes, the average beam power may be in the order or megawatts to produce hundreds of kilowatts output power. The beam power must be dissipated by the collector. This requires a relatively large structure to distribute the power so that hot spots which might burn out the collector are eliminated. Collector structures of this type are, in general, provided with a suitable means for cooling such as a water jacket. These structures are generally operated at some value above ground level which, for example, may in some instances be in the 10 to 100 kv. range and are isolated from the tube envelope so that the envelope may be at or near ground potential.

Collector structures because of their large size and because they must be made of good conductive material such as copper are relatively heavy. Conventional methods for supporting such structures include large ceramic seals which provide the requisite strengths and insulation. However, these large seals are difficult to form. Further, since the collector is relatively heavy, acceleration load will serve to stress the seals. This often results in destruction of the seal and loss of vacuum.

It is therefore, an object of the present invention to provide an improved insulating seal and support for structures in high power electron tube apparatus.

It is another object of the invention to provide a collector support and seal which is small, strong and easy to fabricate and assemble.

It is a further object of the present invention to provide a seal which serves to support substantially in shear a collector assembly.

These and other objects of the invention will become more apparent from the following description taken in conjunction with the accompanying drawings.

Referring to the drawing:

FIGURE 1 is a longitudinal foreshortened view, partly in section, of a high frequency electron device employing features of the present invention;

FIGURE 2 is an enlarged section view of one of the seal assemblies delineated by line 2—2 of FIGURE 1; and

FIGURE 3 is a sectional view taken generally along the line 3—3 of FIGURE 1.

Referring now to FIGURE 1, there is shown a high frequency electron discharge tube apparatus utilizing features of the present invention. More particularly, the tube apparatus comprises an evacuated tubular envelope 1 evacuated to a suitable low pressure, as for example, 10^{-9} millimeters of mercury via the intermediary of an appendage pump 2 in gas communication with the interior of the tube envelope 1 via a suitable tubulation 3. An electron gun assembly 4 is disposed at one end of envelope 1 and serves to form and project a beam of electrons over a predetermined path directed axially and longitudinally of the tube envelope 1. A beam collecting structure 5 is disposed at the terminating end of the elongated electron beam path for collecting the electron beam. A coolant

as, for example, water, circulates through suitable ducts formed in the collector structure. Coolant is supplied to the collector via fluid fittings 6, to be presently described in detail.

A plurality of re-entrant cavity resonators 7 and 8 are arranged along the beam path in axially spaced relation for electromagnetic interaction with the electron beam passable therethrough. Input wave energy to be amplified is supplied to the input resonator 7 via the intermediary of an input loop 9 and coaxial line 11. Amplified output wave energy is extracted in the conventional manner from the beam via output resonator 8 and propagated to a suitable load (not shown) via the intermediary of an output iris and output waveguide 12 sealed in a suitable vacuum-tight manner via the intermediary of a wave permeable vacuum-tight window.

An electric solenoid 13 coaxially surrounds the elongated vacuum envelope 1 and provides an axially directed beam focusing magnetic field, for example, 500 gauss, for confining the beam to its predetermined beam path. A hollow cylindrical magnetic shield 14, as of iron, surrounds the outside of the solenoid 13 for minimized leakage of the magnetic field to the surrounds. At the gun end of the tube 1, the shield 14 abuts an apertured plate 15, as of soft iron, forming the top of an iron tank containing an oil bath 16 in which the gun end of the tube, including the solenoid 13, is immersed. The iron of the tank forms a portion of the magnetic shield and oil bath, and having a higher dielectirc strength than air reduces the probability of an arc-over across the insulators of the gun 4.

Annular magnetic pole pieces 17 and 18 are carried substantially at the ends of the magnetic shield 14 for shaping the beam confining magnetic field within the solenoid 13.

Axially movable tuning structures 19 are disposed within the cavity resonators 7 and 8, respectively, for tuning of the tube over the frequency range of operation.

In operation, input signals are applied to the input resonator 7 via coaxial line 11. The signals are amplified in successive resonators and the amplified output signal is derived from the tube 1 via the intermediary of output waveguide 12.

A typical tube of the above described type utilizes a beam voltage of approximately 140 kv. with an average beam power in the order of megawatts to produce hundreds of kilowatts average and tens of megawatts peak ultra high frequency output power.

As previously described, the collector is relatively large to provide the requisite surface area for the collection of the beam and the dissipation of heat. The beam collecting structure includes collector 23 disposed within the upper envelope portion 24. The collector 23 may be in the form of a double-walled assembly formed to provide a plurality of fluid conducting paths 26 through which a coolant is circulated. A cooled collector of this type is described in copending application Ser. No. 299,001, filed July 31, 1963, by Albert D. La Rue and now abandoned in favor of continuation application Ser. No. 595,309, filed Nov. 16, 1966, both applications being assigned to the same assignee as the present invention.

In accordance with the present invention, the collector structure is insulated from and supported by the envelope by relatively small ceramic rings 27. The ceramic rings are disposed and arranged to support the collector in shear. The shear plane is substantially perpendicular to the axis of the rings.

The ceramic ring is brazed at one end to a sealing ring 28. The sealing ring 28 is arc welded at its other end to a U-shaped ring 29 which is, in turn, connected to the cylindrical envelope portion 31 attached to the envelope

24. In assembling, the ring 29 and cylindrical portion 31 may be brazed together. Final sealing of the assembly may, for example, comprise arc welding together the ends of the rings 28 and 29.

The other end of the ceramic ring 27 is brazed to a sealing ring 32 which, in turn, is brazed to fitting 33 which communicates with the coolant passages formed in the collector. The fluid travels into the fitting on one side of the collector and out through the fitting on the opposite side.

Stops 35 are provided to minimize a cocking of the collector within the envelope portion 24 and to provide rigidity. The stops 35 include U-shaped channel members 36 fixed to the envelope portion 24 as by spot welding which receive a plurality of free floating ceramic plungers 37 therein which plungers 37 bear at their innermost ends upon the collector 23 to limit tilting movement of the collector 23 in all directions.

Thus, the collector is supported in shear by relatively small diameter insulating numbers. The plane of shear is substantially at right angles to the axis of the insulating members. The collector is held against tilting movement within the envelope 24 by the guide assemblies 35 axially spaced along the collector from the sealing and supporting assembly.

It is seen that the seal is relatively small and can easily be made under conventional techniques and provides relatively strong shear support. There is provided a simple, economical and easy to assembly means for insulating and supporting a relatively large structure within an envelope.

Since many changes can be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not limiting in sense.

I claim:

1. In a microwave tube apparatus, means forming an electron gun for projecting a beam of electrons over an elongated predetermined beam path, means forming an elongated hollow beam collector structure disposed at the terminal end of the beam path for collecting and dissipating the energy of the beam, means disposed along the beam path intermediate said electron gun and said beam collector for electromagnetic interaction with the beam

to produce an output microwave signal, means forming an elongated evacuated envelope enclosing said electron gun, the beam path and said collector structure, means for electrically insulating and supporting said hollow beam collector structure from said enclosing envelope structure, said insulating and supporting means including a ceramic insulating ring having an axis of revolution transversely directed to the direction of elongation of said hollow beam collector, sealing means at one end of said ceramic ring for sealing said ring to said enclosing vacuum envelope, and sealing means at the other end of said ring for sealing and connecting said insulating ring to said elongated beam collector structure for supporting the weight of said beam collector structure from said vacuum envelope structure with the supporting forces being exerted in shear on said insulative ring when the tube is positioned with its elongated envelope directed in the vertical direction.

2. Apparatus as in claim 1 wherein said means for sealing the ring to the adjacent envelope and collector includes metal rings secured to the ends of said insulating ring.

3. Apparatus as in claim 1 wherein said collector is relatively long and said insulative ring serves to support one end of the same, and stop means disposed at the other end of said collector along the sides thereof between said collector structure and said enclosing envelope for limiting tilting movement of said collector.

4. Apparatus as in claim 3 in which said stops comprise a U-shaped member serving to receive a ceramic plunger.

5. Apparatus as in claim 1 including a fluid conduit fitting passing through said ceramic insulating ring to said collector structure for communicating cooling fluid through said envelope, wherein said collector includes a plurality of coolant passages and wherein said sealing means for sealing to said collector structure is sealed thereto via said fluid conduit fitting.

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