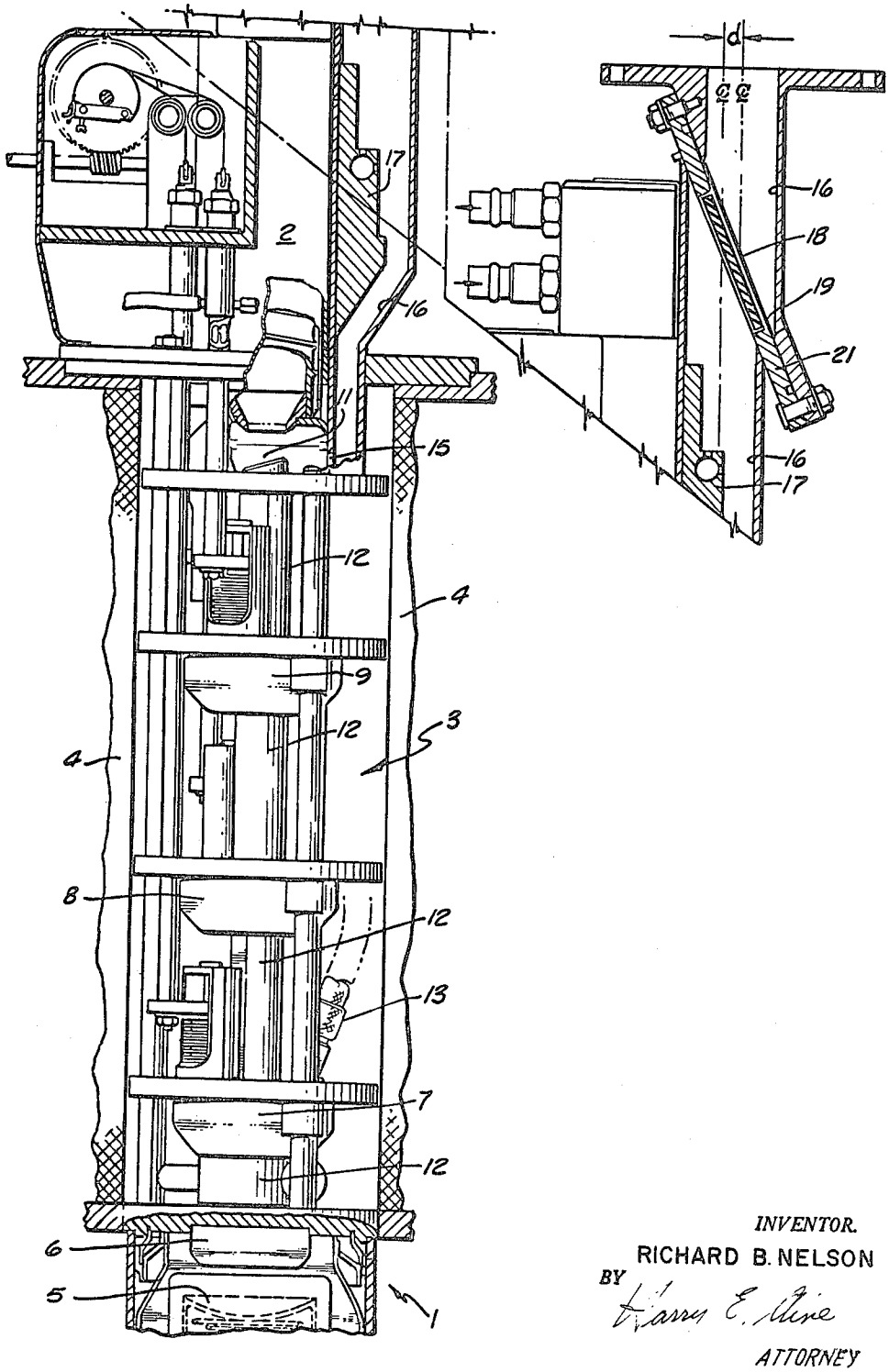
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ELECTRON TUBE APPARATUS HAVING SLANTED OUTPUT WINDOW BETWEEN OFFSET WAVEGUIDES

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*INVENTOR.*

RICHARD B. NELSON

BY Harry E. Mire

*ATTORNEY*

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# ELECTRON TUBE APPARATUS HAVING SLANTED OUTPUT WINDOW BETWEEN OFFSET WAVEGUIDES

Richard B. Nelson, Los Altos, Calif., assignor to Varian Associates, San Carlos, Calif., a corporation of California

Continuation of application Ser. No. 19,710, Apr. 4, 1960, now abandoned, which is a division under Rule 45(b) of application Ser. No. 546,624, Nov. 14, 1955, now Patent No. 2,939,036, dated May 31, 1960. This application May 1, 1963, Ser. No. 277,332

4 Claims. (Cl. 315—39.3)

This invention relates in general to electron tube apparatus and more specifically to a novel improved electron tube apparatus of the velocity modulation type employing cavity resonator devices as, for example, high power klystron tubes utilized in systems employed in radar, linear accelerators, navigation beacons, microwave transmission, etc. The present invention is a continuation of a copending application Serial No. 19,710, filed April 4, 1960, said later application being a divisional of a copending parent application Serial No. 546,624, filed November 14, 1955, now U.S. Patent No. 2,939,036, and all said applications being assigned to a common assignee. U.S. Serial No. 19,710 will now be allowed to lapse in favor of the present application.

The life of a high power tube, heretofore, has been seriously limited by the unreliability of output windows. Failure of the output window normally causes a leak allowing the vacuum within the tube to go up to atmospheric pressure thereby rendering the tube inoperative and permanently damaging the cathode necessitating its replacement.

It is, therefore, the principal object of the present invention to provide a novel high-power, high-gain electron tube apparatus which is relatively compact in construction and which offers gang tuning, long life, easy maintenance and electrical stability.

One feature of the present invention is a novel offset section of waveguide disposed outwardly of the output window assembly whereby the sending end impedance of the tube apparatus is matched to the load over a wide band of frequencies.

A further feature of the present invention is a novel offset window whereby the power reflections from the window assembly are substantially reduced.

Other features and advantages of the present invention will become evident upon a perusal of the following specification taken in connection with the accompanying drawings wherein,

The drawing shows a longitudinal elevational view of the novel tube apparatus of this invention shown partly in section, the top portion of the tube being offset to the right in this view and the well-known focusing magnet and cathode structure of this tube apparatus being shown only fragmentarily.

The construction of the novel tube apparatus will now be described with reference to the drawing followed by a description of its operation.

Shown at the bottom of the depicted structure in FIG. 1 is a partial view of a cathode assembly 1. At the other end of the structure is a collector assembly 2 and interposed between the cathode assembly 1 and the collector assembly 2 is a radio frequency section 3. Surrounding the radio frequency section is a magnetic beam confining and focusing solenoid 4.

The cathode assembly 1 contains an electron emissive element or cathode 5 which in use provides a ready source of electrons. A positive potential with respect to the cathode 5 is applied to an apertured anode 6. The electric



field thus established between the cathode 5 and anode 6 accelerates the electrons to a high velocity and draws them through the apertured anode 6 toward the collector 2.

Successively arranged between the cathode 5 and collector 2 in the R.F. section 3 are a plurality of cavity resonators, input resonator 7, first buncher cavity 8, second buncher cavity 9 and output cavity 11. Mutually spaced apart drift tube sections 12 interconnect the cavity resonators and provide interaction spaces or gaps within the respective cavity resonators. A signal-input coaxial line 13 is coupled into the input cavity 7 by coaxial loop 14.

The output cavity resonator 11 is coupled to the load through an output iris 15, an output waveguide 16 which incorporates a waveguide impedance transformer 17, and output window 18.

The conventional three step binomial impedance transformer 17 has been disposed outwardly of the output iris 15 thereby alowing a shallow high admittance section of output waveguide 16 to be employed in the immediate vicinity of the output cavity 11. The shallow section of waveguide 16 is then brought away from the output iris 15 parallel to the longitudinal axis of the tube apparatus whereby the R.F. section diameter is kept to a minimum in the vicinity of the output cavity 11, thereby allowing the beam confining solenoid 4 to extend upwards of the tube apparatus adjacent the initial portions of the collector 2. Carrying the confining solenoid 4 up to and around the collector region minimizes beam interception in the output cavity and collector entrance whereby unwanted secondary emission in this vicinity is kept to a minimum.

A novel output window assembly is shown in FIG. 1 and comprises a disk-shaped output window 18, as of alumina ceramic, sealed to an annular flanged window cup 19. The flanged portion of the window cup 19 is fixedly held by an apertured window frame member 21. The window frame member 21 is secured transversely in the output waveguide 16. The flanged window cup 19 has a plurality of indentations or dimples P equally spaced around its perimeter. The indentations extend inwardly a distance of approximately 0.003" and make physical contact with the metalized edge of the ceramic window 18 thus providing a 0.003" gap between the metalized ceramic and the window cup 19. A solder alloy 20 such as, for example, copper-gold is disposed between the ceramic window and the window cup and alloys with the metalized ceramic and the window cup 19 thereby forming a vacuum-tight ductile seal. The window cup member 19 is made relatively thin, for example, approximately 0.020". The cup is made thin to prevent undue stress on the ceramic-to-solder-to-cup seal caused by differential coefficients of thermal expansion of the ceramic, solder and cup members.

The window cup 19 may be made of a ductile material as of, for example, copper or it may be made of a copper coated less ductile but stronger material as of, for example, iron or nickel. The copper coating is provided to assure high electrical and thermal conductivity of the seal and cup member 19 whereby R.F. heating in the joint is minimized and in addition heat generated in the ceramic may be conducted away.

The output waveguide 16 (FIG. 1) has been offset outwardly of the output window 18. It has been found that power reflections from the window assembly are substantially eliminated over a broad band of frequencies by providing a certain amount of offset between the axial center lines of the segments of waveguide abutting the window assembly and the center of the circular window. In the present tube apparatus it has been found that an offset of approximately 0.325" substantially eliminates power reflections over the frequency range of the tube.

However, the amount of offset required for different tubes will vary. The dimensions given here are to be considered only exemplary and not in a limiting sense.

In addition it has been found that power reflections from the window assembly may be further reduced by adjusting the geometric center of the dielectric window such that it is slightly radially displaced from the axial center line of the adjoining segment of waveguide 16 on the tube side of the window 18.

In operation electrons are emitted from the cathode 5, focused into the beam by the focusing electrode 6 and accelerated through the first drift tube 12. The signal to be amplified is fed into the input cavity 7 over coaxial line 13 where the beam is velocity modulated. As the modulated beam travels down the drift tubes 12 it is further modulated by the intermediate bunching cavities 8 and 9. While within the drift tube the beam is confined in diameter against forces tending to spread the beam, such as space charge forces, by the magnetic field lines supplied by the focusing solenoid 4, said lines of flux being parallel to the drift tube in this region. The output cavity extracts electromagnetic energy from the modulated beam and said energy is then coupled out of the output cavity through iris 15 and propagated through waveguide 16 and window 18 to the load.

Tuning of the tube is accomplished by the shielded tuning plungers and associated tuning apparatus within the cavities.

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

What is claimed is:

1. A high frequency electron tube apparatus including: means for forming and projecting a beam of electrons over an elongated beam path; means arranged along the beam path for electromagnetic interaction with the beam; means for abstracting high frequency wave energy from the beam for propagation to a suitable load; said abstracting means including a gastight wave permeable window assembly including, a first section of hollow waveguide having a first axial center line, a second section of hollow waveguide having a second axial center line, a third section of hollow waveguide joining together said first and second sections of guide and forming a transition section between said first and second guides with the first and second center lines displaced from each other in the direction of the electric field lines, a platelike wave permeable gastight window member sealed across said third transition section of guide, said platelike window member being inclined in said transition guide with the plane of said platelike window being disposed at a substantial angle to the axial center lines of said first and second guides, and said transition section of guide having a height taken in the direction of the electric field vector in said guide which is greater than the height of said adjoining first and second sections of guide whereby said window assembly is rendered substantially reflectionless over a broad band of frequencies.



2. A high frequency gastight wave permeable window assembly including a first section of hollow waveguide having a first axial center line, a second section of hollow waveguide having a second axial center line, a third section of hollow waveguide joining together said first and second sections of guide and forming a transition section between said first and second guides with the first and second center lines displaced in the direction of the electric field lines, a platelike wave permeable gastight window member sealed across said third transition section of guide, said platelike window member being inclined in said transition guide with the plane of said platelike window being disposed at a substantial angle to the axial center lines of said first and second guides, and said transition section of guide having a height taken in the direction of the electric field vector in said guide which is greater than the height of said adjoining first and second sections of guide whereby said window assembly is rendered substantially reflectionless over a broad band of frequencies.

3. The apparatus according to claim 2 including a pair of axially spaced apart abrupt waveguide discontinuities formed at the junctions of said first and second waveguide sections with said intermediate transition section, a metallic window frame structure surrounding said wave permeable window member and being sealed thereto, and said frame member with said window member sealed therein being sealed across said transition section of guide from one of said abrupt waveguide junctions to the other of said abrupt waveguide junctions.

4. The apparatus according to claim 3 wherein the geometrical center of said platelike window member is offset with respect to the axial center line of both said first and second sections of guide.

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