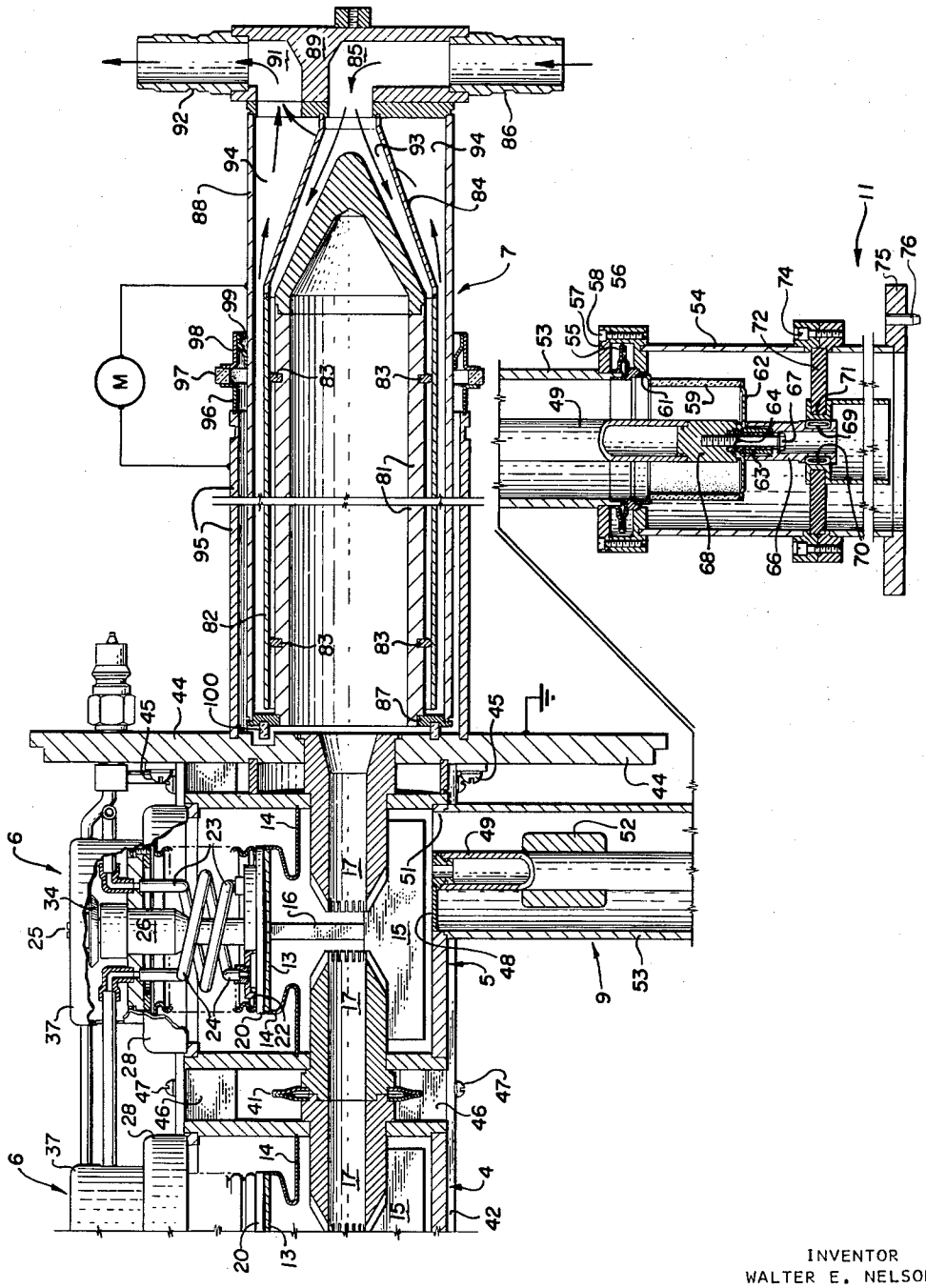
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HIGH FREQUENCY TUBE APPARATUS WITH IMPROVED OUTPUT COAXIAL CONNECTOR

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HIGH FREQUENCY TUBE APPARATUS WITH IMPROVED OUTPUT COAXIAL CONNECTOR

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Original application May 4, 1960, Ser. No. 26,891, now Patent No. 3,122,669, dated Feb. 25, 1964. Divided and this application Dec. 2, 1963, Ser. No. 327,368
2 Claims. (Cl. 315—39)

The present invention relates in general to high frequency tube apparatus and more specifically to a novel high frequency, high power velocity modulation tube which is extremely useful for providing a continuous wave output at high average powers and which is easily tunable over a wide frequency range. Such tubes are especially useful as output tubes in tropospheric forward scatter communication links, and for transmitting tubes covering the UHF-TV band. This application is a divisional of a copending patent application, Serial No. 26,891, now U.S. Patent No. 3,122,669 filed May 4, 1960, and issued February 25, 1964, for improvement in high frequency tube apparatus with fluid cooled tuner, such divisional application being a divisional of a copending parent application Serial No. 749,225, now U.S. Patent No. 2,994,009, filed July 17, 1958, and issued July 25, 1961.

Heretofore multi-cavity klystron amplifiers have been built which would provide high output powers in the order of 15 kw. average. These tubes were tunable over the heretofore relatively wide tuning range of approximately 10 percent. In these high power amplifiers the individual cavities were synchronously tuned by tuning plungers which varied predominantly either the capacity or inductive parameters of the cavity.

The present invention provides a high power multicavity klystron amplifier capable of delivering average output powers in the order of 12 or more kw. and at the same time have the greatly enhanced tuning range of approximately 40 percent. The four fold increase in tuning range has been obtained by the use of a novel cavity tuner, claimed in the aforementioned Patent No. 2,994,009, in which both the inductive and the capacitive parameters are varied in a desired manner to tune the cavity. The provision of such a wide tuning range in one klystron amplifier results in substantial savings to the user of these tubes because the number of different tube types required to cover a certain bandwidth is greatly reduced. For example, heretofore, it required six different klystron amplifier tubes to cover the UHF-TV channels, 14–83. This entire band of frequencies may now be covered by only two tube types utilizing the features of the present invention. More specifically, two tubes utilizing the features of the present invention now adequately cover the frequency range from 470 megacycles to 1,000 megacycles.

The principal object of the present invention is to provide a novel high power high gain amplifier tube apparatus having exceptionally wide frequency tuning range which is especially useful, for example, in UHF-TV broadcasting and forward scatter communication.

One feature of the present invention is the provision of a novel high power coaxial connector apparatus which is readily disconnected as desired for the replacement of tubes as required.

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

The figure is a longitudinal cross-sectional view of the collector end portion of a multi-cavity klystron tube utilizing the output coaxial connector structure of the present invention.

Referring now to the drawing there is shown in the drawing the output coaxial connector apparatus of the present invention. More specifically, a cathode assembly, not shown, provides a source of electrons which are formed into a pencil-like beam and projected longitudinally of the tube apparatus. A plurality of rectangular cavity resonators are centrally apertured to allow the passage of the pencil-like beam of electrons therethrough.

The individual cavity resonators are tunable over a wide range via a plurality of novel tuner assemblies **6**. The beam after passing through the last or output cavity resonator **5** is collected in a collector assembly **7**. The thermal energy generated by the impinging electrons within the collector **7** is carried away by a fluid coolant circulated through the collector assembly **7**.

R.F. signal energy, which it is desired to amplify, is fed to the first or input cavity via a vacuum sealed coaxial connector, not shown. The signal energy velocity modulates the beam as it passes through the input cavity. The velocity modulation of the beam is transformed into current density modulation in the drift spaces between the input cavity and the first buncher cavity. Buncher resonators further velocity modulate the beam to produce greater current density modulation of the beam at the output cavity **5**. The output cavity extracts R.F. energy from the current density modulated beam.

The output R.F. energy is coupled outwardly of the output resonator **5** via a vacuum sealed R.F. coaxial line **9** and fed to a suitable load, not shown, such as, for example, an antenna. The load is coupled to the coaxial line **9** via a novel coaxial connector assembly **11**. A magnetic solenoid circumscribes the central part of the tube apparatus, containing the cavity resonators, for providing a strong axial magnetic field longitudinally of the tube for confining the pencil-like beam of electrons.

An output coupling loop is formed by a strap **48** as of, for example, copper interconnecting the hollow center conductor **49** of the output coaxial line **9** and the inside wall of the cavity resonator **5**. The coaxial line **9** intersects with the hollow interior of the output cavity **5** via an output port **51**.

A capacitive loading slug **52** as of, for example, copper is fixedly secured to the inner or center conductor **49** of the output coaxial line **9**. The loading slug **52** is disposed in close proximity to the output coupling loop **48** and provides a fixed capacitive discontinuity associated with the loop **48** whereby the desired increasing sending end conductance versus frequency characteristic is obtained allowing a broadband match between the output waveguide and the cavity without adjusting the coupling.

The fixed capacitive loading slug **52**, positioned as shown, requires no adjustment over the range of the tube, as frequently required in the past. This high frequency coupling apparatus is taught and claimed in a copending application, Serial No. 604,535, filed August 16, 1956, entitled, High Frequency Apparatus, invented by Richard B. Nelson et al., now U.S. Patent No. 2,895,110.

The outer conductor **53** of the coaxial line **9** is sealed to a larger diameter section **54** to accommodate therewithin the wave permeable vacuum sealed window assembly which will be more fully described later. The outer conductor **53** is connected to the larger outer conductor **54** in a vacuum tight manner via the intermediary of a Heliarc welded flange seal **55**. The relatively fragile flange seal **55** is protected by an internally recessed seal protector **56** carried at one end of the outer conductor **54**. The recessed portion of the seal protector **56** is closed off via an annular flange **57** carried at the extremity of the smaller outer conductor **53**. The seal protector **56** and flange **57** are pulled together via a plurality of cap screws **58** spaced about the perimeter of the flange **57**.

The inner conductor 49 of the coaxial transmission line 9 is vacuum sealed to the enlarged outer conductor 54 via the intermediary of a hollow cylindrical wave permeable window member 59 as of, for example, ceramic. The ceramic window 59 is carried from the outer conductor 53 via a thin cylindrical metallic frame 61 as of, for example, copper which is secured to the ceramic window 59 at one end thereof as by, for example, brazing to a metallized layer on the ceramic. The other end of the cylindrical frame 61 is secured to the outer conductor 53 of the coaxial transmission line 9 as by, for example, brazing. The relatively thin cylindrical window frame member 61 allows for thermal expansion and contractions of the coaxial line 9 and window assembly during operation of the tube.

The other end of the ceramic R.F. window 59 is carried from the center conductor 49 of the coaxial transmission line 9 via a thin annular disk 62 having a central sleeve 63 extending axially of the seal and tightly fitting over a hollow cylindrical extension 64 of the center conductor 49. The sleeve 63 and the center conductor cylindrical extension 64 are sealed together at their free ends 65 via, for example, a Heliarc inert gas weld. The thin annular disk 62 is sealed at its peripheral edge in a vacuum tight manner to one end of the cylindrical wave permeable window 59 as by, for example, brazing to a metalized layer on the window 59.

A coupling segment 66 of the hollow center conductor 49 is pulled tightly over the sleeve 63 of the disk 62 via a cap screw 67. The cap screw 67 is carried internally of the coupling segment 66 and picks up a thread provided in a plug 68 closing off the hollow center conductor 49.

A tension spring 69 is wound in a helix of oval cross-section and doubled back on itself to form a resilient ring. The spring 69 is carried within an annular recess provided at the end of the inner conductor coupling segment 66 of the output coaxial line and is made of a conductive material as of, for example, silver plated Phosphor bronze. The spring 69 is carried within the recessed coupling segment 66 provides a surface of slightly larger diameter than the adjoining center conductor. The spring 69 bears in radial engagement with a concentrically disposed female inner conductor receptacle 70 forming the center conductor of the coaxial connector assembly 11. The female receptacle 70 is provided with an external annular recess 71 at the innermost end for carrying therewithin an annular dielectric support 72 as of, for example, Teflon. The Teflon support 72 is carried at its outer perimeter within a recess provided in mating flange portions of the outer conductor 54 and of the outer conductor 54 of the coaxial connector 11.

The mating flanges are pulled together via a plurality of cap screws 74 positioned about the perimeter thereof. The outer conductor 54 of the coaxial connector 11 is provided with an output flange 75 for mating with coaxial flanges, not shown, provided on equipment to which the tube apparatus is connected. An alignment pin 76 is provided on the output flange for mating with an aligning hole in the mating flange, not shown.

The coaxial connector assembly 11 incorporating the spring 69 and annular support 72 allows the female inner conductor receptacle 70 to be coupled to a male plug connector provided on equipment, not shown, without transmitting strains through the center conductor 70 of the coaxial connector 11 to the fragile vacuum sealed R.F. window 59. Such strains which are often produced while coupling and decoupling large and heavy equipments are quite likely to produce fractures of the relatively fragile window 59 if means such as, for example, the spring 69 and the annular support 72 are not provided to decouple these strains from the window 59. The connector assembly 11 includes elements 54, 69, 70, 71, 72, 74, 75, and 76.

Since many changes could 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 in a limiting sense.

What is claimed is:

1. A high frequency power amplifier discharge tube apparatus including, a vacuum sealed coaxial transmission line having a center and outer conductor and being connected to the tube apparatus for withdrawing amplified wave energy therefrom, a coaxial connector having a center and outer conductor for connecting said transmission line to a load, a resilient electrically conducting member coupling the center conductor of said transmission line to said center conductor of said coaxial connector, said resilient coupling member being disposed between said center conductor of said connector and the vacuum seal of said transmission line and serving to prevent the transmission of substantial stress to the vacuum seal when stress is applied to said center conductor of said connector, a wave permeable window disposed within said transmission line and vacuum sealed to said outer and center conductors thereof, and a support member, independent of said window, interconnecting said inner and outer conductors of said connector.

2. Apparatus according to claim 1, wherein said resilient member is carried within a recess in said center conductor of said transmission line, the outside diameter of said resilient member in the uncompressed state being slightly larger than the outside diameter of said center conductor of said transmission line and said resilient member being located within and exerting pressure upon said center conductor of said transmission line.

References Cited by the Examiner

UNITED STATES PATENTS

2,461,125	2/1949	Nergaard	315—39
3,122,669	2/1964	Nelson	313—24

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