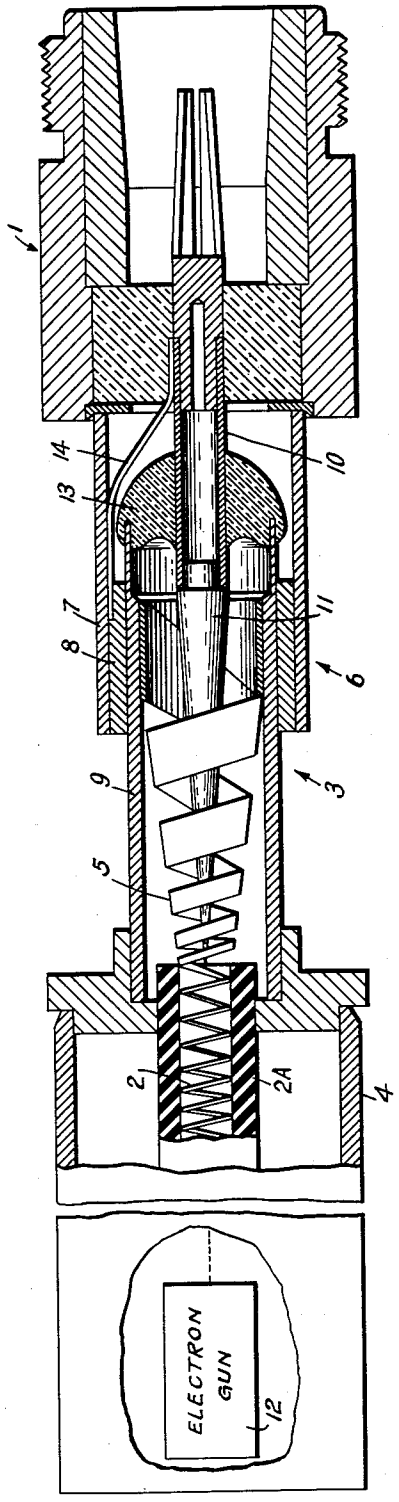
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RADIO FREQUENCY IMPEDANCE MATCHING SECTION

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RADIO FREQUENCY IMPEDANCE MATCHING SECTION

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This invention relates to radio frquency matching sections and more particularly to radio frequency impedance matching sections for transferring radio frequency energy between a helix and a coaxial transmission line.

Transfer of radio frequency energy between a helix and a coaxial transmission line is required in certain types of antenna systems, using helices as radiator or collector elements. Amplifiers of the traveling wave type also include helices which act like electrically long but physically short transmission lines and must be coupled in certain applications to coaxial transmission lines.

An object of this invention is to provide improved means for transferring high frequency energy between a helix and a coaxial transmission line.

Another object of the present invention is to provide improvements in transformer devices for transferring radio energy between a coaxial transmission line and a helix with a minimum of reflection.

Still another object of this invention is to provide an improved traveling wave tube wherein transformer devices of the described type are employed in which the metallic member axially of the helical conductor serves as the collector electrode of the traveling wave electron discharge device.

A further object of this invention is to provide transformer devices of the described type which operate efficiently throughout relatively wide frequency bands.

Still a further object of this invention is to provide transformer devices of substantially radially symmetrical structure to produce minimum distortion of electric field patterns within the elements which are to be coupled.

A feature of this invention is a radio frequency impedance matching transformer section for transferring high frequency energy between a helix and a coaxial transmission line comprising a helical conductor having increasing diameter extending from the end of said helix to the outer conductor of said coaxial line and a metallic member having an increasing diameter disposed axially of said helical conductor extending from a point adjacent the end of said helix to the inner conductor of said coaxial line.

Another feature of this invention is to provide a transformer device of the described type wherein the helical conductor of the transformer device has increasing width as well as increasing helical diameter from the end of the helix to the outer conductor of the coaxial transmission line.

The above mentioned and other features and objects of this invention and the manner of obtaining them will become more apparent by reference to the following description taken in conjunction with the drawing, the single figure of which is a longitudinal cross-sectional view of a coaxial transmission line coupled to a helix in accordance with the principles of this invention.

Referring to the figure, a coaxial fitting **1** is to be coupled to a helix **2**. Only the portion of helix **2** in the neighborhood of impedance matching transformer **3** is illustrated. The helix may be extended to the left to any required length and may be surrounded by a conductive sheath **4** either throughout its entire length or any portion thereof if the purpose for which it is to be used requires it. The helix **2** is shown supported by an insulating support member **2A** to keep the helix axially symmetric in the application described.

Impedance transformer section **3** is shown to comprise a helical conductor **5** which increases in width and helical diameter from the minimum width and diameter of the helix **2** to the maximum width and maximum diameter adjacent the outer conductor of coaxial transmission line **6** formed by cylinders **7**, **8** and **9** extending the outer conductor of fitting **1**. The helical conductor **5** is terminated in its maximum helical diameter and conductor width, at cylinder **9**, which makes a direct current connection to the outer conductor of coaxial fitting **1**. The inner conductor of coaxial line **6** is provided by tubular member **10**, an extension of the inner conductor of fitting **1**. The transformer section **3** further includes a metallic member **11** which is tapered in diameter from a maximum diameter equal to the diameter of the tubular member **10** to a very sharp point adjacent the end of helix **2**. Helical conductor **5** and tapered metallic member **11** thus cooperate to provide a gradual impedance transformation from the relatively high helix impedance to the relatively low impedance of the coaxial line **6**.

As pointed out hereinabove the impedance transformer section of this invention may be used in conjunction with antenna systems using helices as radiator or collector elements and also amplifiers of the traveling wave type where the impedance transformation problem is presented. When transformer section **3** of this invention is employed in connection with traveling wave electron discharge devices, the tapered inner conductor **11** serves as the collector electrode of the discharge device for the electron beam which travels longitudinally through the helix of the tube from the electron gun **12**. For traveling wave tube purposes, a glass seal **13** is provided substantially as illustrated to provide the necessary vacuum seal for the tube between the inner conductor **10** and the outer conductor **9** of the coaxial transmission line **6**.

Since the operation of the traveling wave discharge device requires a direct current return path for the electron beam, it is necessary to provide a current conduction path between the inner and outer conductor of the coaxial line **6**. This may be achieved with very little impedance mismatch by employing either a direct wire connection, as shown at **14**, or by use of a coaxial **T** wherein one arm of the **T**, in which the inner conductor is shorter to the outer conductor, is made to couple only a small amount of power.

Employing the transformer section **3** of this invention, the entire impedance matching arrangement is made to present very little impedance mismatch to the RF power coupled between the coaxial fitting **1** and the helix **2**.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. A traveling wave tube having an electron beam electrode and including a helix having a given diameter and a coaxial transmission line having inner and outer conductors the outer conductor having a diameter larger than said given diameter and whose axis is coincident with an extension of the axis of said helix, a device for transferring radio frequency energy between said helix and said coaxial line comprising a helical condutcor interconnecting one end of said helix and said outer conductor said helical conductor increasing simultaneously in diameter, pitch and width from said given diameter of said helix to the larger diameter of said outer conductor, and a conical electron beam collector tapering gradually from an apex disposed axially of and adjacent to said given diameter helix to a base coincident with the cross-section of said inner conductor.

2. A traveling wave tube comprising an electron gun for projecting an electron beam along a given axis, a helical slow wave structure disposed coaxially of said given axis having a given diameter and being enclosed in an insulating tube along its length, a conductive support member disposed transversely of said given axis having a coaxial aperture therein adapted to receive said insulated helix adjacent one end thereof, an annular flange portion projecting from said support member disposed axially of said given axis and extending longitudinally of said given axis, a coaxial connector having inner and outer conductors disposed coaxially of said given axis terminating said traveling wave tube, said outer conductor having a diameter larger than said given diameter, impedance matching means disposed axially of said given axis and coupled between said annular flange portion and said coaxial connector, said impedance matching means including a helical tape conductor which increases simultaneously in diameter and pitch to extend said helical slow wave structure smoothly from said given diameter to said larger diameter of said coaxial connector and an electron beam collector electrode disposed coaxially of said helical tape conductor, said member terminating at one extremity axially of and at said one end of said helical slow wave structure and terminating at another extremity with the cross-section of said inner conductor, said helical conductor and said beam collector electrode providing for impedance matching between said constant diameter helix and said coaxial connector.

3. A traveling wave tube comprising an electron gun for projecting an electron beam along a given axis, a helical slow wave structure disposed coaxially of said given axis having a given diameter and being enclosed in an installing tube along its length, a conductive support member disposed transversely of said given axis having a coaxial aperture therein adapted to receive said insulated helix adjacent one end thereof, an annular flange portion projecting from said support member disposed axially of said given axis and extending longitudinally of said given axis, a coaxial connector having inner and outer conductors disposed coaxially of said given axis terminating said traveling wave tube, said outer conductor having a diameter larger than said given diameter, impedance matching means disposed axially of said given axis and coupled between said annular flange portion and said coaxial connector, said impedance matching means including a helical tape conductor which increases simultaneously in diameter, pitch and width to extend said helical slow wave structure smoothly from said given diameter to said larger diameter of said coaxial connector, a conical metallic member disposed coaxiallly of said helical tape conductor, said conical member tapering gradually from an apex disposed adjacent to said given diameter helix to a base coincident with cross-section of said inner conductor, said helical conductor and said conical member providing for impedance matching between said given diameter helix and said coaxial connector and said conical metallic member providing the collector electrode for said electron beam, and means coupling said metallic member to the outer conductor of said coaxial connector to provide a direct current return path for said electron beam.

4. In a radio frequency system, a helix having a given diameter and a coaxial transmission line having inner and outer conductors, the outer conductor having a diameter larger than said given diameter and whose axis is coincident with an extension of the axis of said helix, means for transferring radio frequency energy between said helix and said coaxial line comprising a helical conductive tape, interconnecting one end of said helix and said outer conductor, said helical tape increasing simultaneously in diameter and pitch from said given diameter of said helix to the larger diameter of said outer conductor, a metallic member disposed axially of said helical tape, said member being coupled at one extremity with said inner conductor and terminating at its other extremity at a point axially of and adjacent to said one end of said helix, said metallic member being conical and tapering gradually from an apex disposed adjacent said helix to a base coincident with the cross section of said inner conductor.

5. In a radio frequency system, a helix having a given diameter and a coaxial transmission line having inner and outer conductors, the outer conductor having a diameter larger than said given diameter and whose axis is coincident with an extension of the axis of said helix, means for transferring radio frequency energy between said helix and said coaxial line comprising a helical conductive tape, interconnecting one end of said helix and said outer conductor, said helical tape increasing simultaneously in diameter and pitch from said given diameter of said helix to the larger diameter of said outer conductor, a conical electrode disposed axially of said helical conductor, said electrode tapering toward and being coupled at one extremity with said inner conductor and terminating at its other extremity at a point axially of and adjacent to said one end of said helix, said helical tape further increasing in width as its diameter and pitch increase.

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