Aug. 25, 1959 A. G. HOGG 2,901,712

MATCHING DEVICE

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Fig. 1.

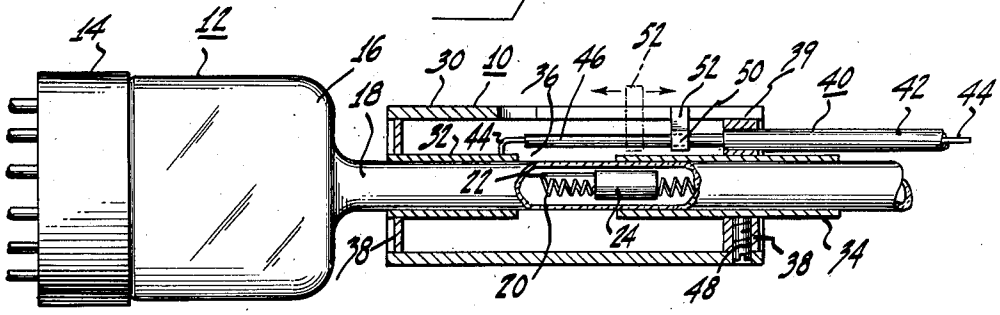
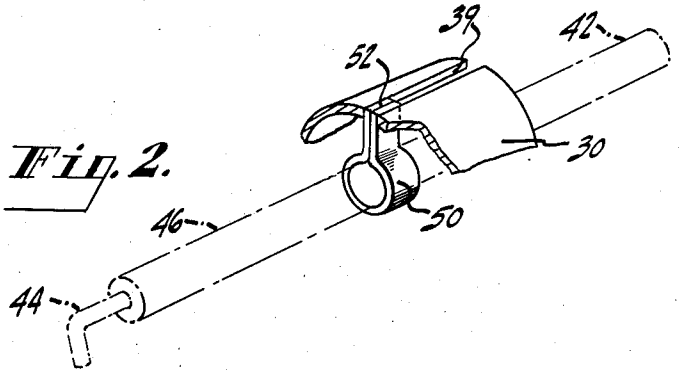


Fig. 2.



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MATCHING DEVICE

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The invention relates to an impedance matching device for a cavity coupler, and has for an object to provide an improved impedance match between a cavity coupler and its associated coaxial transmission line.

The invention is particularly adapted for use with a traveling wave tube coupler having a hollow inner portion positioned within a hollow outer portion, and a coaxial transmission line which provides a connection between the traveling wave tube coupler and external circuitry. The outer conductor of the coaxial line is terminated and connected to the outer portion of the coupler. The inner conductor of the coaxial line extends within the hollow outer portion of the coupler and is terminated at and connected to the inner portion of the coupler. The delay line or helical portion of a traveling wave tube fits within the hollow inner portion of the coupler, and radio frequency energy is applied to or derived from the helical portion of the traveling wave tube through the coupler. The other end of the transmission line is connected to external circuitry. In the use of the coupler just described, it has been found that the impedance of the coaxial transmission line is not always matched to the coupler impedance as well as might be desired. The invention provides means for matching these impedances, and comprises a metallic strip or tab which surrounds a portion of, but is insulated from, the inner conductor of the line within the outer portion of the coupler, and which is connected to the outer portion. The strip of conducting material provides a capacitance between the inner conductor of the coaxial line and the outer portion of the coupler. If the ends of the strip are passed through a slot in the outer portion of the coupler, it is possible to vary the capacitance provided by the strip by moving the strip along the slot. When the optimum capacitance is determined, the strip may be fastened and connected by any suitable means.

The invention is explained in detail in connection with the accompanying drawing, in which:

Fig. 1 shows a longitudinal sectional view of the coupler utilizing the invention; and

Fig. 2 shows a perspective view of the tuning strip as it is used with the coaxial transmission line and the cylindrical outer portion of the coupler, with most of the coupler broken away to more clearly illustrate the manner of connection of the strip.

Fig. 1 shows a coupler **10** positioned on a traveling wave tube **12**. While the coupler **10** is positioned at the input end of the traveling wave tube **12**, the coupler **10** can be used equally well at the output end of the traveling wave tube **12**. The traveling wave tube **12** comprises a socket **14**, an enlarged bulb **16** containing heater elements and an electron gun for the traveling wave tube **10**, and an elongated cylindrical neck or tube **18**. The elongated tube **18** contains the delay line of the traveling wave tube **12**, which in this case is shown in the form of a helix **20**. Input radio frequency signals are applied to the helix by means of an antenna-like element **22** which is connected to the end of the helix **20** and folded back in the direction of the output end of the traveling wave tube **12**. The element **22** is terminated in a sleeve **24** which surrounds the helix **22** and which serves to provide an effective coupling between the antenna-like element **22** and the coupler **10**.

The coupler **10** comprises a metallic, cylindrically shaped outer portion or casing **30**, and two coaxially arranged, metallic, cylindrically shaped inner portions **32**, **34**. The coupler **10** is closed at its ends by metallic end plates **38**, and surrounds the neck or tube **18** of the traveling wave tube **12**. The confronting edges of the inner portions **32**, **34** are separated by a gap **36**. The outer portion **30** of the coupler **10** is provided with a longitudinal slot **39** for reasons which will be explained. The inner portions **32**, **34** of the coupler **10** are dimensioned so that the neck or tube **18** of the traveling wave tube **12** passes through the inner portions **32**, **34** with no more clearance than necessary to permit expansion because of changes in temperature. The gap **36** permits radio frequency energy in the coupler **10** to be coupled to the traveling wave tube **12**. This radio frequency energy is applied to the coupler by means of a coaxial transmission line **40**. The coaxial transmission line **40** enters the coupler **10** through one end. At the point of entrance of the coaxial transmission line **40**, the outer conductor **42** is terminated and connected to the coupler **10**. The inner conductor **44** of the coaxial transmission line **40** continues within the coupler **10** toward the other end, and terminates at and connects to the cylindrical inner portion **32** of the coupler **10**. The dielectric sleeve cover material **46** surrounding the inner conductor **44** of the coaxial transmission line **40** also extends along the inner conductor **44** to its point of termination. For convenience, the one inner portion **32** is fixed within the coupler **10**, and the other inner portion **34** may be adjusted in a lengthwise direction to vary the length of gap **36**. A set screw **48** is provided to hold the inner portion **34** in a fixed position relative to the outer portion **30**. This feature permits the gap **36** between the two inner portions **32**, **34** of the coupler **10** to be adjusted to provide the desired amount of coupling between the coupler **10** and the traveling wave tube **12**. The coupling between the coupler **10** and the traveling wave tube **12** results from capacity coupling or coupling by the coupler **10** acting as a cavity resonator, or a combination of both means of coupling. However, the operation of the invention does not depend upon the exact nature of the coupling between the coupler **10** and the traveling wave tube **12**.

As previously mentioned, it has been found that the impedance match between the coupler **10** and the traveling wave tube **12** is not always optimum, particularly where manufacturing conditions permit certain tolerances in the traveling wave tube **12** and in the coupler **10**. In order that the impedance match between the coupler **10** and the traveling wave tube **12** may be improved, the invention provides a capacitance between the inner conductor **44** of the coaxial transmission line **40** and the outer portion **30** of the coupler **10**. This capacitance comprises a strip **50** of conductive metal, such as copper, which is bent or shaped to form a generally circular configuration which surrounds the dielectric material **46** of the coaxial transmission line **40** and is positioned so that the ends **52** of the strip **50** extend through the longitudinal slot **39** in the outer portion **30** of the coupler **10**. In Fig. 1, the strip **50** is shown in dotted lines with its ends **52** extending through the slot **39** in the outer portion **30** of the coupler **10**. Once the desired position of the strip **50** is found, the strip **50** is soldered to the coupler **10** and its ends **52** are clipped off to provide a smooth and compact arrangement. This feature is shown in detail in Fig. 2.

The capacitance is provided by the portion of the strip **50** that surrounds the dielectric material **46** of the coaxial

transmission line 40 serving as one plate of the capacitance, the dielectric material 46 of the coaxial transmission line 40 serving as the dielectric material for the capacitance, and the inner conductor 44 of the coaxial transmission line 40 serving as the other plate of the capacitance. The magnitude of capacitance provided by the strip may be varied by using strips of different widths, or by using several strips. The effective phase of the susceptance produced by the capacitance, as viewed from any fixed point on the coaxial transmission line 40, may be varied by moving the strip 50 to the left or right as indicated by the arrows shown in Fig. 1.

The matching device in accordance with the invention has been found to give a very good impedance match between the coupler 10 and the coaxial transmission line 40 over a very wide band of frequencies. For example, in apparatus using the RCA 8681 traveling wave tube, it was found that by the use of this matching device, a voltage standing wave ratio of less than 1.5 could be obtained in the frequency band between 2500 megacycles and 3500 megacycles. However, without the matching device the best standing wave ratio that could be obtained over this same band was 2.0. Furthermore, since the invention permits the capacitance to be located within the coupler as close as possible to the discontinuity to be matched, the maximum possible bandwidth can be obtained. The matching device has proved useful in obtaining improved impedance matches over wider bands of frequencies, and in compensating for the differences between individual traveling wave tubes and couplers which arise through manufacturing tolerances.

The matching device for traveling wave tube couplers is easily adjusted, and is low in cost. It provides a means of introducing an adjustable capacity within the coupler to reduce reflections caused by impedance mismatches in the traveling wave tubes in the couplers.

The invention claimed is:

1. In combination, a hollow coupler having a hollow metallic casing, a transmission line having an inner conductor covered with insulation extending within and coupled to said coupler, and means for matching the impedance of said coupler to said transmission line, said means comprising a metallic strip wrapped around the insulated portion of said conductor within the coupler and in close proximity to the insulation, said strip having closely spaced straight portions extending to and directly connected at their ends to said casing.

2. In combination, a hollow metallic cavity coupler having a hollow metallic casing and an inner portion positioned within said hollow casing, a transmission line having an inner conductor, an outer conductor, and a dielectric sleeve therebetween and covering said inner conductor, said inner conductor and said dielectric material extending within said hollow coupler, said inner conductor being arranged in physically parallel relation and coupled to said inner portion, and means for matching the impedance of said hollow coupler to said transmission line at the frequency of the waves to be carried by said line, said means comprising a metallic strip wrapped around and in close proximity to said dielectric material within said hollow coupler, the ends of such strip being directly connected to said casing.

3. A matching device for use with a coaxial transmission line and a traveling wave tube coupler, said coaxial line having an inner conductor, an outer conductor, and dielectric material positioned therebetween, and said coupler having a hollow cylindrically shaped outer portion and having a cylindrically shaped inner portion positioned within said outer portion and extending longitudinally therein for at least a part of the length of said outer portion, comprising means terminating said outer conductor at a first point on said outer portion and connecting said outer conductor to said outer portion at said first point, said inner conductor and said dielectric material being positioned within said outer portion between said first point and said inner portion, means terminating said inner conductor at a second point on said inner portion and connecting said inner conductor to said inner portion at said second point, said dielectric material extending between said first and said second points, a conductive strip positioned around said dielectric material between said first and second points, and means connecting said strip to said outer portion.

4. A matching device for a traveling wave tube coupler having an electrically conducting, cylindrically shaped, hollow outer portion that has a longitudinal slot therein for at least a part of the length thereof and having an electrically conducting, cylindrically shaped hollow inner portion positioned within said outer portion and extending longitudinally therein for at least a part of the length of said outer portion, said inner portion being adapted to surround a portion of said traveling wave tube, comprising a coaxial transmission line having its outer conductor terminated at and connected to said outer portion and its inner conductor extending within said coupler and terminated at and connected to said inner portion, and a conductive strip positioned within said hollow outer portion around and adjacent to but insulated from said inner conductor with the ends of said strip passing through said slot and connected to said outer portion.

5. A device for matching the impedance of a coaxial transmission line to a traveling wave tube coupler, said transmission line having an inner conductor, an outer conductor, and a dielectric material therebetween, and said coupler having a hollow outer metallic portion that has a longitudinal slot therein for at least a part of the length thereof and having a hollow inner metallic portion positioned within said outer portion and extending longitudinally therein for at least a part of the length of said outer portion, said inner portion being adapted to surround a portion of said traveling wave tube, said coaxial transmission line having its outer conductor terminated at and connected to said outer portion, its inner conductor terminated at and connected to said inner portion at a location within said outer portion, and its dielectric material extending along said inner conductor between said inner and outer portions, comprising a conductive metallic strip positioned within said outer portion around said dielectric material and said inner conductor with the ends of said strip passing through said slot, and means connecting said strip to said outer portion at the edges of said slot.

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