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SHORT CIRCUITING PLUG FOR COAXIAL LINE

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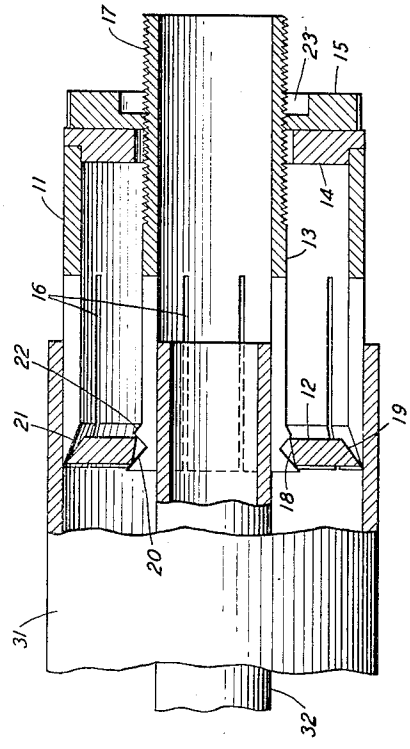

FIG. 1

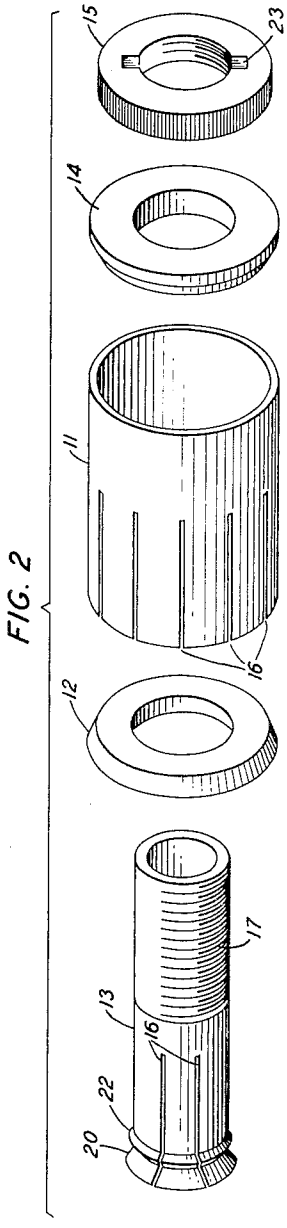

FIG. 2

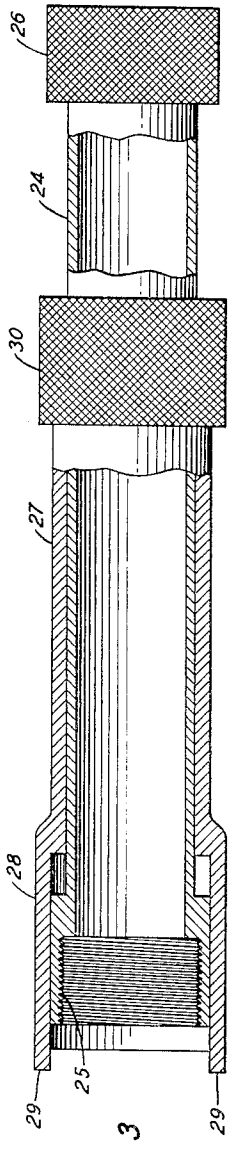

FIG. 3

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SHORT CIRCUITING PLUG FOR COAXIAL LINE

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7 Claims. (Cl. 333—97)

This invention relates to a short-circuiting plug and more particularly to an adjusting short-circuiting plug for coaxial transmission line sections.

In transmission systems it is sometimes desirable to use a section of coaxial line of a length resonant at some particular frequency, with the end of the line terminated in a short circuit. For example, an unwanted frequency may be suppressed by connecting a length of line terminated in a short circuit to the feed line of a radio receiver or transmitter. The short circuit is positioned so that the line section resonates at the unwanted frequency. Such a stub, usually with a companion compensating stub of similar construction, constitutes a widely used form of radio frequency filter. Similar coaxial line sections are used for impedance matching.

Proper functioning of short-circuited line sections in these and other applications depends in considerable measure on the accuracy achieved in adjusting the length of line section since this determines the frequency at which the line will resonate. In addition, the means used to provide the short circuit between the inner and outer conductors must be such as to assure good contact.

Heretofore, the construction of such short-circuited transmission line sections has involved "cut and try" processes wherein the line itself was progressively shortened by sawing or other means. This method is laborious and has the further disadvantage of precluding "backing off" if the adjustment has gone even slightly below the optimum length. Accurate tuning is achieved only by application of painstaking and time-consuming methods.

Other short-circuiting means utilizing resilient fingers with contact points affixed thereto provide a discontinuous short-circuiting path and thereby introduce stray loss into the circuit.

General objects of this invention are to overcome the above-mentioned difficulties and provide a structurally simple and efficient construction for short-circuiting coaxial line sections.

A further object is to expedite and facilitate accurate tuning of coaxial transmission lines.

These and other objects of this invention are realized in one specific embodiment in a plug comprising a flat diaphragm or washer fitted between the corresponding ends of two coaxial cylindrical members. Means are provided for moving the inner cylindrical member and washer relative to the outer member. The ends of the cylindrical members housing the washer may be made resilient and by suitably shaping the engaged surfaces of the cylindrical members and the washer the resilient ends of the cylindrical members are caused to grip their adjacent coaxial conductors when the inner member and washer are moved axially. The plane surface of the washer thereby becomes the short-circuiting path between the inner and outer coaxial conductors. Preferably, a tool is provided for positioning and clamping the plug in place within the coaxial line section.

The invention in one aspect therefore comprises means for simultaneously gripping the inner and outer conductors at a desired location within a coaxial line section.

Another feature involves a particular shape of the inner and outer peripheries of the washer and the cooperating surfaces on the inner and outer cylindrical members whereby the plug is securely clamped to the coaxial conductors. A resultant advantage thereof is the provision of a short-circuit path composed of the face of the washer in substantially line contact with the inner and outer conducting surfaces.

The invention and the above-noted and other features thereof will be clearly understood from the following detailed description when read in connection with the accompanying drawing in which:

Fig. 1 is a side elevation view, partly in section, and illustrates the plug in position within a section of coaxial transmission line;

Fig. 2 is an exploded view in perspective of a plug assembly constructed in accordance with this invention;

Fig. 3 is a side elevation view, partly in section, of a tool for positioning the plug illustrated in Figs. 1 and 2, within a section of coaxial transmission line.

Referring now to the drawing, the plug therein illustrated may be constructed of any suitable conducting material, for example brass, and comprises an outer hollow cylinder **11**, a washer **12**, a tube or inner cylinder **13**, an end plate **14**, and a nut **15**.

As shown in Fig. 1, the tube **13** is positioned coaxially within the outer cylinder **11**. The inner or clamping ends of the tube and cylinder are coincident in cross-section and are rendered flexible by the provision of longitudinal slots **16**. The outer cylinder **11** is closed at its non-flexible end by the end plate **14**. The tube **13** is longer than the outer cylinder **11** and protrudes through the central aperture of the end plate. The non-flexible end of the tube is provided with a threaded portion **17** on which the nut **15** is threaded. The nut has recesses **23** into which the lugs of a wrench may be inserted for rotating the nut.

The washer **12** is fitted over the tube **13** and within the outer cylinder **11** at their flexible ends. The chamfered inner periphery **18** and outer periphery **19** of the washer form cam surfaces. The follower surfaces consist of the conical or flared portion **20** of the tube and the inside tapered surface **21** of the outer cylinder The angles of these are exaggerated in the figure in order to present the manner of their cooperation clearly. The shoulder **22** on the flexible end of the tube is a retainer for the washer.

The tool illustrated in Fig. 3 comprises an inner tubular member **24** having an internally-threaded portion **25** adjacent one end adapted to engage the threaded portion **17** of the tube **13**. The other end of the inner tool member **24** is provided with a knurled handle **26**. Coaxial with and slidably fitted over the inner tool member is the outer tool member or wrench **27**. The outer tool member is likewise furnished with a knurled handle **30** at one end. At the other end the member is provided with a short length of increased diameter **28** terminating in lugs or fingers **29** adapted to engage corresponding recesses **23** in the nut **15**.

Tuning is accomplished by sliding the plug to the desired location in the line. Thus, in a radio system for example, where the stub is connected to the transmitter feed line, the plug is positioned by utilizing a radio receiver to determine when unwanted frequencies have been "blocked out." Where the stub is in the feed line to the receiver, the plug may be located so as to suppress selected frequencies emitted by a signal generator. Where

a companion stub is provided to compensate for the reactance of the tuning stub, the short-circuiting plug is positioned in the compensating stub to produce the optimum power.

To short-circuit a section of coaxial line the tool is affixed to the plug assembly by screwing the threaded end 25 of the inner tool member 24 on the threaded end 17 of the tube 13. The plug is then fitted in the line section within the outer conductor 31 and over the inner conductor 32 utilizing the tool as a handle.

The plug having been slidably positioned at the desired tuning point, the plugs 29 of the outer tool member 27 are engaged in the recesses 23 of the nut 15. Rotation of the outer tool member drives the nut 15 against the end plate 14 and further rotation pulls the tube axially toward the open end of the line section. Axial motion of the tube 13 draws the washer 12 in the same direction. The outer periphery 19 of the washer cams the follower surface 21 of the outer cylinder 11 outward into tight contact with the inner surface of the outer conductor 31.

Coincidently as the tube moves, the washer is restrained by the outer cylinder and moves a lesser axial distance than the tube. The inner periphery 18 of the washer cams the follower surface 20 of the tube inward contracting the flexible end of the tube into gripping contact with the inner conductor 32. The tool may then be disengaged and withdrawn leaving the plug clamped in the line section.

To relocate or remove the plug the tool is reengaged and the nut 15 backed-off. The tube may then move inward axially, the shoulder 22 on the tube serving to force the washer 12 in the same direction. This movement withdraws the cam surfaces 18 and 19 from the follower surfaces 20 and 21 whereupon the flexible end of the tube expands and that of the cylinder contracts thereby unclamping the plug.

It is to be understood that the above-described arrangement is illustrative of the application of the principles of this invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A device for short-circuiting a section of a coaxial transmission line comprising a hollow cylinder for fitting within the outer conductor and a tube for fitting over the inner conductor, each having equi-spaced longitudinal slots extending from one end, means for moving said tube axially relative to said cylinder, a washer fitting within the cylinder and over the tube at their respective slotted portions, said washer adapted to move axially with said tube, said washer, tube, and cylinder having adjacent contacting conical surfaces meeting at an acute angle, said surfaces cooperating to force the slotted portions of said cylinder and said tube into contact with said outer and inner conductors respectively, when said tube is moved axially.

2. Means for short-circuiting a section of a coaxial transmission line comprising a hollow cylinder adapted to fit within the outer conductor of the line and a tube adapted to fit over the inner conductor of the line, each having equi-spaced longitudinal slots extending from one end, a washer fitting within the cylinder and over the tube at their respective slotted portions and adjacent the end of each, said washer, tube, and cylinder having adjacent contacting conical surfaces meeting at an acute angle, said tube having a threaded portion adjacent the end opposite the slotted portion, a plate for fitting against the end of the cylinder opposite the slotted portion, a nut on the threaded portion of the tube and bearing against said plate whereby said tube and said cylinder may be moved longitudinally in opposite directions, said surfaces of said washer and said tube and cylinder cooperating to force said slotted portion of said tube and cylinder into respective gripping contact with the inner and outer conductors of the line.

3. In combination, a short circuiting device in accordance with claim 2 and a device for fixing said short circuiting device in a section of coaxial transmission line comprising two hollow coaxial sleeve members, the inner of said last-mentioned members being of greater length and having an internally threaded portion at one end for engaging the threaded portion of the tube member of said short circuiting device, the outer of said coaxial sleeve members having means at the end adjacent said threaded end of said inner member for engaging the nut member of said short circuiting device, whereby rotation of said outer coaxial sleeve member with respect to said inner coaxial sleeve member causes rotation of said nut member relative to said short circuiting device.

4. Short circuiting means for a concentric conductor line, said means comprising a conductive cylinder fitting within the outer conductor and a conductive tube embracing the inner conductor, said cylinder and tube including flexible portions, and a short circuiting washer fitting within said cylinder and upon said tube at their respective flexible portions, said washer having sloping external and internal surfaces mutually inclined to juxtaposed sloping surfaces on the cylinder and the tube respectively for camming the cylinder and tube into contact with the corresponding concentric conductors upon axial movement of said tube, the fit between the cylinder, the tube, and the washer being such that a plane, uninterrupted short circuiting surface is presented to the line.

5. A device for short circuiting a section of a coaxial transmission line comprising a hollow cylinder for slidably fitting within the outer conductor of said line and a tube for slidably fitting over the inner conductor of said line, each having equispaced longitudinal slots extending from one end, means for moving said tube axially relative to said cylinder, a circular plate washer fitting within the cylinder and over the tube at their respective slotted portions, said washer adapted to move axially with said tube, said washer, tube, and cylinder having adjacent mutually-inclined, substantially line contacting surfaces, said surfaces cooperating whereby said washer cams the slotted portions of said cylinder and said tube into contact with said outer and inner conductors respectively, when said tube is moved axially with respect to said cylinder.

6. Means for terminating a section of coaxial transmission line consisting of an inner and an outer conductor, said means comprising a circular washer member having dimensions so as to substantially occupy the cross section between said inner and outer conductors, said washer having inner and outer peripheries comprising inclined camming edges, means for securely positioning said washer member within said line between said inner and outer conductors, said means comprising a hollow cylindrical member arranged to fit slidably within said outer conductor and having a longitudinally slotted, flexible end portion and an internal camming surface for engaging the outer periphery of said washer, and a tubular member arranged to fit slidably over said inner conductor and having a longitudinally slotted, flexible end portion, said end portion having a camming surface for engaging the inner periphery of said washer and a shoulder portion for retaining said washer, and means for moving said tubular member axially with respect to said hollow cylindrical member within said transmission line whereby said washer member is urged axially with said tubular member being restrained therefrom by engagement with said hollow cylindrical member whereby said flexible end portions of said hollow cylindrical member and said tubular member are urged respectively into clamping engagement with said outer and inner conductors.

7. Means for terminating a section of coaxial transmission line in accordance with claim 6 in which said means for moving said tubular member axially com-

prises a rotatable member threadably engaging said tubular member and adapted to transmit thrust to said hollow cylindrical member.

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