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R. B. WILDS ET AL

2,807,785

LINE-ABOVE-GROUND ATTENUATOR

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2 Sheets-Sheet 1

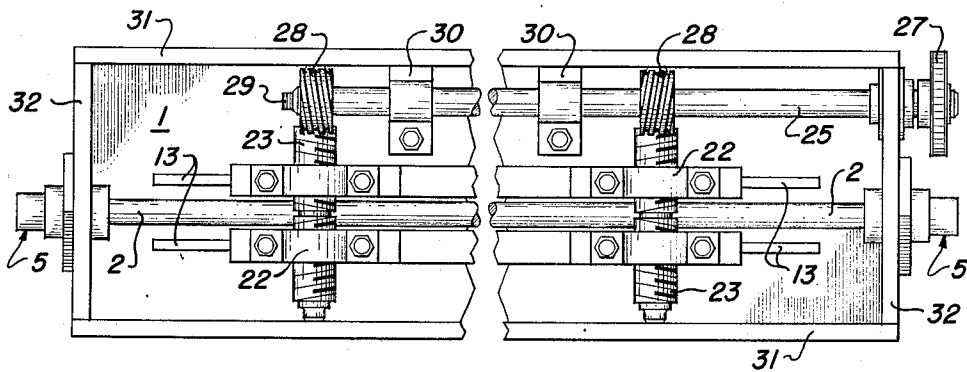


Fig. 1

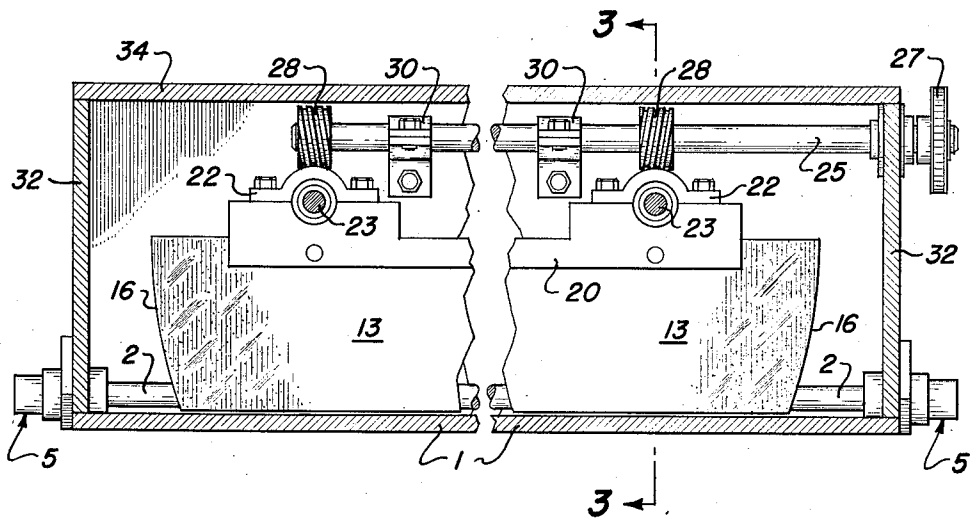


Fig. 2

INVENTORS:
Robert B. Wilds
John R. Ames
BY
Roland A. Anderson
Attorney

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2 Sheets-Sheet 2

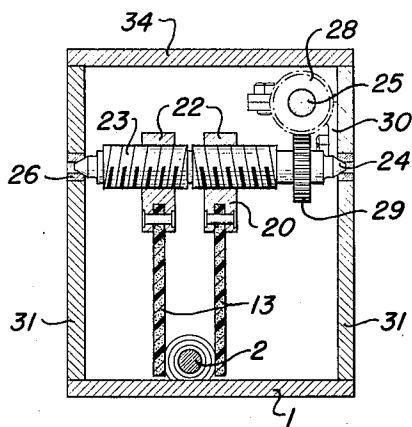
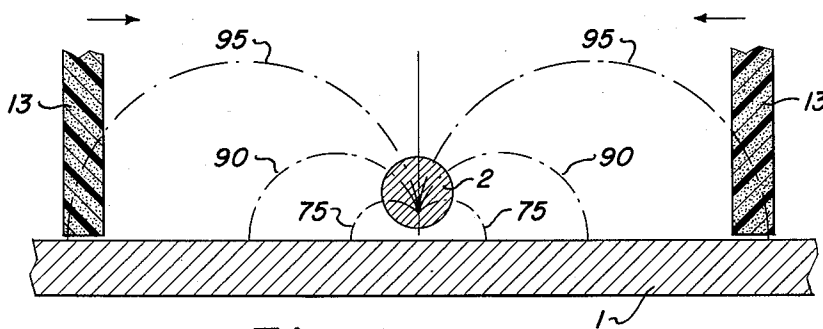
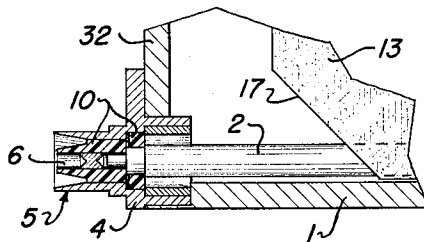


Fig. 4



INVENTORS:
Robert B. Wilds
John R. Ames

BY

Edward A. Anderson
Attorney

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LINE-ABOVE-GROUND ATTENUATOR

Robert B. Wilds and John R. Ames, Albuquerque, N. Mex., assignors, by mesne assignments, to the United States of America as represented by the United States Atomic Energy Commission

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3 Claims. (Cl. 333—81)

The present invention relates to variable attenuator means for coaxial transmission lines.

In addition to capability for relatively high attenuation as well as ability to handle relatively high power with low insertion loss, it is desirable that, for accurate and fine adjustments, an attenuator embody facility for gradual attenuation over at least a portion of its variable range without requiring special controlling mechanisms such as cams, linkages, or the like.

If a field or power flow distribution is very closely or intensely concentrated about the transmission line, relatively slight movement of an attenuator vane toward or away from the line may cause excessive attenuation increase or decrease. Optimum "fineness" and accuracy of attenuator control or adjustment is very difficult or lacking.

The present invention aims to obviate or minimize difficulties such as the above by providing new and improved attenuator means which employs a ground plane member for connection with the outer conductor of a coaxial cable and a conductor rod above, and in proximity to the ground plane member which connects with the inner or central conductor of the coaxial cable. This line-above-ground construction distributes or spreads the power flow outwardly along the ground plane member at opposite sides of the line-above, the major distribution axis extending generally along the ground plane member, so that attenuator vanes may be selectively moved over the ground plane through the expanded power flow zones. That is, the power flow field of a coaxial cable is expanded by a line-above-ground construction so that attenuator vanes may be shifted through and exert an attenuating influence throughout relatively wide effective zones. Attenuator vanes may be shifted appreciable distances through portions of such expanded power flow zones without causing excessive attenuation per unit of vane movement, and consequently fine attenuation adjustments may be readily obtained.

An object of the present invention is to provide new and improved attenuator means for use with coaxial transmission lines.

Another object of the invention is to provide variable attenuator means for use with coaxial lines which provides gradual and fine attenuation control.

Another object of the invention is to provide attenuator means which laterally expands the power flow distribution of a transmission line for improved attenuation control.

Still another object of the invention is to provide a variable attenuator which utilizes line-above-ground transmission line features for obtaining gradual and fine attenuation.

A still further object of the invention is to provide a new and improved variable attenuator of relatively simple construction and operation.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the

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appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

A preferred embodiment of the invention and various modifications thereof have been chosen for purposes of illustration and description. The preferred embodiment and the modifications are not intended to be exhaustive nor to limit the invention to the precise form disclosed. They are chosen and described in order to best explain the principles of the invention and their application in practical use to thereby enable others skilled in the art to best utilize the invention in various embodiments and modifications as are best adapted to the particular use contemplated.

In the accompanying drawings,

Fig. 1 is a top plan view of the attenuator of the present invention, with cover removed;

Fig. 2 is a side elevational view, partly in section of the present attenuator, with cover in place;

Fig. 3 is a sectional view taken generally along line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary view showing electrical interconnection of ground plane member and conductor rod with a connector for joining with a coaxial transmission line; and

Fig. 5 is an enlarged, fragmentary, cross-sectional view showing the association of attenuating vanes with ground plane and conductor rod and their relationship with power flow distribution diagram.

As shown, the attenuator means comprises a section of line-above-ground type of transmission line including a ground plane member 1, of aluminum or other suitable conducting material, and a line-above or conductor rod 2, of silver-plated steel or other suitable conducting material. The ground plane member 1 is in firm electrical contact at its opposite ends with outer conductors 4 of coaxial cable connectors 5 and the line-above or conductor rod 2 electrically connects adjacent its opposite ends with central conductors 6 of the coaxial connectors 5. Nonconducting washers and inserts 10, of "Teflon" (polytetrafluoroethylene) or other suitable material, maintain the central conductor rod 2 and central conductor 6 electrically isolated from the ground plane 1 and the outer conductor 4 and provide an impedance match. The coaxial connectors 5 may connect with usual coaxial cables (not shown). Attenuating vanes or fins 13 are disposed at opposite sides of the conductor rod 2 with their lower extremities terminating intermediate conductor rod 2 and ground plane member 1 and in close proximity to the surface of the latter member, to thereby insure optimum influence on power flow.

The enlarged fragmentary view of Fig. 5 shows the relationship of vanes 13 and line-above-ground transmission line section, together with power flow distribution between the conductor rod 2 and ground plane 1. It will be noted that the major axis of the distribution pattern extends along the ground plane 1, about ninety-five percent of the power flow being included within the zone indicated generally by boundaries 95—95, about ninety percent being within the zone indicated by the boundaries 90—90 and about seventy-five percent of the power flow being within the zone indicated generally by boundaries 75—75.

About twenty-five percent of the total power flow is thus expanded outwardly along the ground plane 1 so that the attenuating vanes 13 may be moved appreciable distances therethrough to obtain very accurate and fine attenuation control therein, as well as greatly improved attenuation control in the zone portion between side edges of conductor rod 2 and boundary lines 75. Improved control in this latter area or zone is due to the fact that power flow intensity therein is less intense than if total

power flow were concentrated instead of being expanded outwardly along the ground plane 1 is disclosed.

The attenuating vanes 13 may be of any suitable lossy material, for example, the materials referred to at page 133, volume 9 of the Radiation Laboratory Series, entitled "Microwave Transmission Circuits," published 1948 by McGraw-Hill Book Company, Inc. Excellent results are obtainable with the referred to polyiron, which is commercially available from Henry L. Crowley and Company of West Orange, New Jersey. To facilitate matching or gradual change in characteristic impedance along the line, ends of the vanes 13 are preferably of appropriate curvature 16 (Fig. 2) or taper 17 (Fig. 4).

The vanes may be riveted, bolted, or otherwise secured adjacent upper edges to channels 20 and the latter carried adjacent opposite ends thereof by internally threaded blocks or nuts 22 which threadedly engage rotatable screw threaded members 23. Each of the rotatable members 23 is provided with screw threaded portions of opposite hand or sense so that their rotation in one direction causes the cooperating internally threaded nuts to move toward each other and thereby move the lossy vanes 13 over the surface of the ground plane member 1 toward the conductor rod 2, and so that rotation of the rotatable members 23 in an opposite direction moves the vanes away from the conductor rod 2. As the vanes approach the conductor rod 2 the loss increases. The vanes disposed at opposite sides of the conductor rod 2 move simultaneously together or apart upon rotation of the shafts 23 so that they are always spaced equidistant from the conductor rod 2 and each interrupts similar portions of the power flow pattern which is disposed at opposite sides of the central conductor 2.

As shown more particularly in Fig. 3, the rotatable shafts have tapered end portions 24 projecting into appropriate recessed members 26, but it will be clear that any other suitable supporting means may be utilized. Simultaneous rotation of the longitudinally spaced shafts 23 may be obtained by turning knob 27 and drive shaft 25, which in turn rotate worm gears 28 keyed thereto that mesh with drive gears 29 secured to rotatable shafts 23.

The drive shaft 25 may be supported on brackets 30 attached to an adjacent wall 31.

A metal shielding and protective housing comprising opposite side walls 31, end walls 32 and cover member 34 encloses the conductor rod 2 and vanes 13 together with their actuating mechanism. The ground plane member 1 forms the bottom of the housing.

While any suitable dimensions may be utilized, superior results are obtainable with a ground plane member 1 having a length intermediate the end walls 32 about 14½ inches and width intermediate the side walls 31 about 4 inches, conductor rod 2 about ¼ inch in diameter spaced about .05 inch above the ground plane, and polyiron vanes 13 about ⅜ inch thick, 12 inches long and 2 inches deep, with lowermost edges terminating about .015 inch above the surface of ground plane member 1.

It will be seen that the present invention provides a

new and improved attenuator of relatively simple and inexpensive construction, of low insertion loss and high power capability which expands a power flow field for cooperation with attenuator fins or vanes. The vanes may be moved selectively through the expanded power flow field toward or away from a conductor rod or line-above-ground to provide accurate and fine attenuation control. The simple and mechanically rugged construction makes the device well adapted not only to usage in the laboratory, but also under generally abusive conditions encountered in work out in the field.

As various changes may be made in the form, construction and arrangement of the parts herein without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in a limiting sense.

We claim:

1. Attenuator means comprising a conducting ground plane member, a conductor rod parallel and in proximity to said member, a pair of mutually spaceable vanes each composed of lossy material and each generally parallel to the conductor rod and perpendicular to said member and disposed one at each side of and substantially equidistant from the conductor rod each having edge portions parallel and in proximity to and equidistant from said ground plane member, means supporting the vanes at locations spaced from the conductor rod and maintaining said vane edge portions at a fixed distance from said ground plane member, and means for simultaneously moving the supporting means and vanes broadwise bodily to and fro over the ground plane member and toward and away from each other through equal distances while maintaining the vanes generally parallel to and equidistantly spaced from the conductor rod and perpendicular to the member.

2. Attenuator means as claimed in claim 1, wherein the means for simultaneously moving the supporting means comprises a rotatable shaft having screw threaded portions of opposite hand adjacent opposite ends thereof.

3. Attenuator means as claimed in claim 1, wherein the means for simultaneously moving the supporting means comprises a pair of rotatable shafts disposed one adjacent each end of the supporting means and each having screw threaded portions of opposite hand adjacent opposite ends thereof.

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