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ATTENUATOR FOR COAXIAL TRANSMISSION LINES

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Fig. 1.

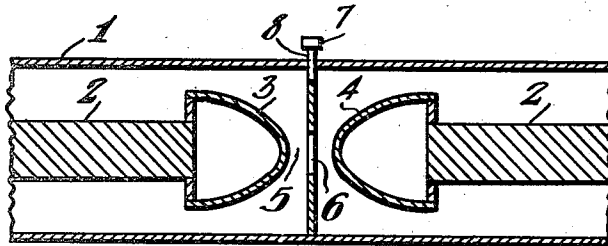


Fig. 2.

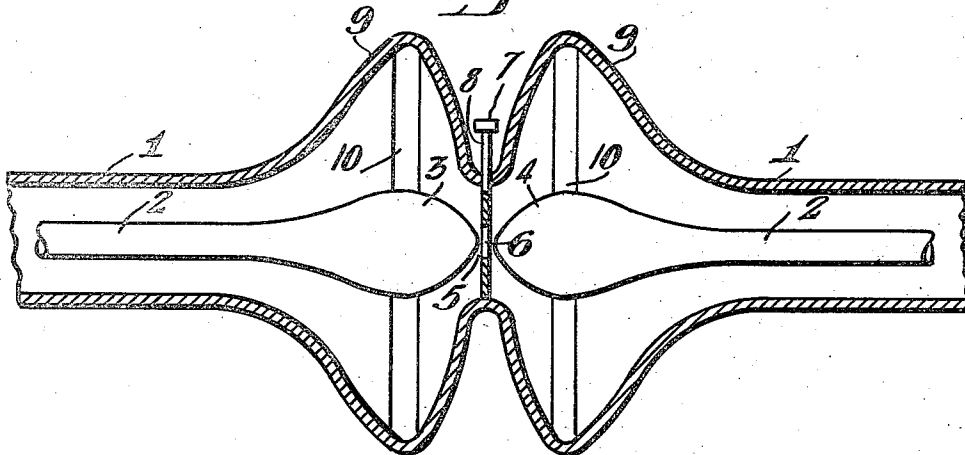
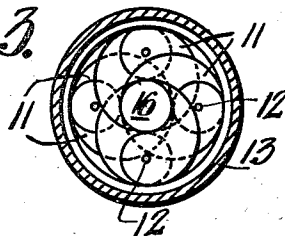


Fig. 3.



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ATTENUATOR FOR COAXIAL TRANSMISSION LINES

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9 Claims. (Cl. 178-44)

1

This invention relates generally to transmission circuits, and particularly to a variable attenuator for a coaxial transmission line in which the attenuation is proportional to the cross-sectional area of a variable mechanical aperture in said attenuator.

Various attenuators have been utilized heretofore for coaxial transmission line circuits, but in attenuator has involved the problem of compromising between linearity of attenuation and reaction upon the static characteristics of the transmission line.

The instant invention contemplates the use of a novel and relatively simple transmission line section which includes a pair of enlarged electrodes forming a gap in the inner conductor of the line and means including an adjustable mechanical conducting iris for adjusting the attenuation of the transmission line section without affecting substantially the surge impedance of the line.

Briefly, the invention utilizes the capacity coupling between the two terminating electrodes of the central conductor of the line and means including the adjustable iris for varying the capacitance between these electrodes.

Among the objects of the invention is to provide a new and improved method of and means for providing a variable attenuator for a coaxial transmission line. Another object of the invention is to provide an improved method of and means for adjusting linearly the attenuation in a coaxial transmission line section by means of an adjustable conducting iris disposed normal to the transmission line axis. A further object of the invention is to provide an improved method of and means for adjusting linearly the attenuation of a coaxial transmission line by means of an adjustable iris normal to the axis of said line, wherein the surge impedance of the transmission line remains substantially constant irrespective of the attenuation inserted in the line circuit. Another object of the invention is to provide improved means for attenuating linearly in a coaxial transmission line including a section of coaxial cable inserted in said line, wherein the central conductor of said section is enlarged to form two semi-prolate spheroidal electrodes disposed coaxially with said line, and separated by a gap which is small in relation to the distance between the inner and outer conductors of the line. A still further object of the invention is to provide an improved variable linear attenuator for a coaxial transmission line which includes two semi-prolate spheroidal elements forming a gap in the inner conductor of said line, surrounded by enlarged portions of the outer conductor of said line, whereby the ratio of the diameters of the outer and inner conductors remains substantially constant throughout the

2

attenuator section, and means including a variable conducting iris for adjusting the attenuation of said attenuator.

The invention will be described by reference to the accompanying drawing, in which Figure 1 is a cross-sectional view of one embodiment of the invention; Figure 2 is a cross-sectional view of a second and preferred embodiment of the invention; and Figure 3 is a side elevational view of the adjustable iris element. Similar reference numerals are applied to similar elements throughout the drawing.

Referring to Fig. 1, a section of coaxial cable includes an outer cylindrical conductor 1 and an inner hollow cylindrical or solid conductor 2, of conventional proportions and design. A section of the center conductor 2 is removed and enlarged conducting electrodes 3, 4 are attached to the respective ends of the center conductor to form a gap 5. This gap should preferably be substantially shorter than the distance between the inner conductor 2 and the outer conductor 1. An adjustable conducting iris 6, the aperture diameter of which may be varied by means of a knob 7 attached to a shaft 8 which extends outside of the outer conductor 1, is disposed preferably normal to the transmission line axis and substantially at the mid point between the electrodes 3, 4. The adjustable iris 6, therefore, forms a shielding element which varies the capacitive coupling between the electrodes 3, 4. As the aperture of the iris 6 is enlarged by adjusting the position of the knob 7, the capacitive coupling between the electrodes 3, 4 is increased and the attenuation of the line is decreased accordingly. By forming the electrodes 3, 4 in a semi-prolate spheroidal shape, the attenuation may be made substantially linear with respect to the size of the iris aperture. The aperture adjustment should preferably be limited to dimensions which will not affect materially the line surge impedance.

The apparatus just described has the principal disadvantage that the surge impedance varies considerably in the neighborhood of the electrodes 3, 4, due to the change in the ratio of the diameter of the outer conductor of the line to the diameter of the inner conductor of the line in this region.

The device illustrated in Fig. 2 overcomes the disadvantage described heretofore for the device of Fig. 1, by providing an enlarged tapered portion 9 in the outer conductor 1 of the transmission line. Preferably, the ratio of the diameters of the outer and inner conductors should remain substantially constant throughout the section of the line which includes the semi-prolate spheroidal electrodes. It should be understood that this relation will be only approximate, since it is also desirable to form both the inner and outer conductors in such a manner that there are no

3

sharp edges or curved sections of small radii. Therefore, the shapes of the inner and outer conductors of the line will be varied somewhat by streamlining the conductors at the point where the capacitive electrodes are inserted in the inner conductor. Otherwise, the device illustrated in Fig. 2 may be identical to the device of Fig. 1, described heretofore, and the adjustment thereof is accomplished in the same manner.

In addition, rings of carbon, or other resistance material 10, may be inserted adjacent the electrodes 3, 4, normal to the line axis, to provide terminating resistors equal to the line surge impedance. These rings may be omitted, if desired.

It should be understood that the adjustable iris 6 may be in the general form of a continuously adjustable camera iris, or if desired, may be in the form of an adjustable stop aperture device wherein a plate having different apertures of fixed dimensions is rotated to bring the desired aperture between the spheroidal elements 3, 4.

The camera iris type is illustrated in Fig. 3 wherein the vanes 11 are pivoted at the points 12, and the dimensions of the aperture 16 are adjusted by turning the outer ring 13.

Thus the invention described comprises a simple and efficient means for providing linear attenuation of a coaxial transmission line without affecting seriously the surge impedance of the line at the point where the attenuator is inserted.

I claim as my invention:

1. An attenuator comprising a coaxial high frequency transmission line which includes two cooperative semi-prolate spheroidal conducting elements disposed within the outer conductor of said line and interposed coaxially between the ends of the inner conductor of said line to form a gap therein constituting capacitive coupling between the two portions of said inner conductor, and an apertured diaphragm disposed between said elements within said gap, the conformation of said spheroidal elements providing substantially linear variation of attenuation with diaphragm aperture size.

2. Apparatus of the type described in claim 1 including means for varying the cross-sectional area of said diaphragm aperture.

3. An attenuator comprising a coaxial high frequency transmission line which includes two cooperative semi-prolate spheroidal conducting elements disposed coaxially within the outer conductor of said line and interposed between the ends of the inner conductor of said line to form a gap therein, said gap and elements providing capacitive coupling between the two portions of said inner conductor, and an apertured diaphragm disposed between said elements within said gap normal to the axis of said conductors, the conformation of said spheroidal elements providing substantially linear variation of attenuation with diaphragm aperture size.

4. An attenuator comprising a coaxial high frequency transmission line which includes two cooperative semi-prolate spheroidal conducting elements disposed coaxially within the outer conductor of said line and interposed between the ends of the inner conductor of said line to form a gap therein, said gap and elements providing capacitive coupling between the two portions of said inner conductor, and an apertured electrical shield diaphragm disposed between said elements within said gap normal to the axis of said conductors, the conformation of said spheroidal elements providing substantially linear variation of attenuation with diaphragm aperture size.

4

5. Apparatus of the type described in claim 4 including means comprising gradually expanded portions of said inner and said outer conductor adjacent each of said elements for minimizing changes in the surge impedance of said line at said attenuator.

6. A substantially linearly variable attenuator comprising a coaxial high frequency transmission line which includes an outer conductor having a gradually expanding and gradually contracting portion, two cooperative semi-prolate spheroidal conducting elements disposed coaxially within said gradually expanding and gradually contracting portions of said outer conductor of said line and interposed between the ends of the inner conductor of said line to form a gap therein, said gap and elements providing capacitive coupling between the two portions of said inner conductor, an apertured conducting diaphragm disposed between said elements within said gap, and means for varying the cross-sectional area of said diaphragm aperture, the conformation of said spheroidal elements providing substantially linear variation of attenuation with adjustment of said diaphragm aperture area.

7. A substantially linearly variable attenuator comprising a coaxial high frequency transmission line which includes an outer conductor having a gradually expanding and a gradually contracting portion, two cooperative semi-prolate spheroidal conducting elements disposed coaxially within said gradually expanding and gradually contracting portions of said outer conductor of said line and interposed between the ends of the inner conductor of said line to form a gap therein, said gap and elements providing capacitive coupling between the two portions of said inner conductor, said gap being substantially shorter than the shortest distance between said outer conductor and said elements, an apertured conducting diaphragm disposed between said elements within said gap normal to the axis of said conductors, and means for varying the cross-sectional area of said diaphragm aperture, the conformation of said spheroidal elements providing substantially linear variation of attenuation with adjustment of said diaphragm aperture area.

8. A substantially linearly variable attenuator comprising a coaxial high frequency transmission line which includes an outer conductor having a gradually expanding and a gradually contracting portion, two cooperative semi-prolate spheroidal conducting elements disposed coaxially within said gradually expanded portions of said outer conductor of said line and interposed between the ends of the inner conductor of said line to form a gap therein, said gap and elements providing capacitive coupling between the two portions of said inner conductor, said gap being substantially shorter than the shortest distance between said outer conductor and said elements, an apertured conducting diaphragm disposed between said elements within said gap normal to the axis of said conductors, and means for varying the cross-sectional area of said diaphragm aperture uniformly with respect to said axis to provide a linear relation between said area and the attenuation of said attenuator.

9. Apparatus of the type described in claim 8 including annular resistive means interposed between the conductors of said attenuator adjacent said elements to provide terminating impedances of substantially the value of said line impedance.