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H. F. MATARÈ

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ATTENUATOR FOR VERY HIGH FREQUENCY WAVES

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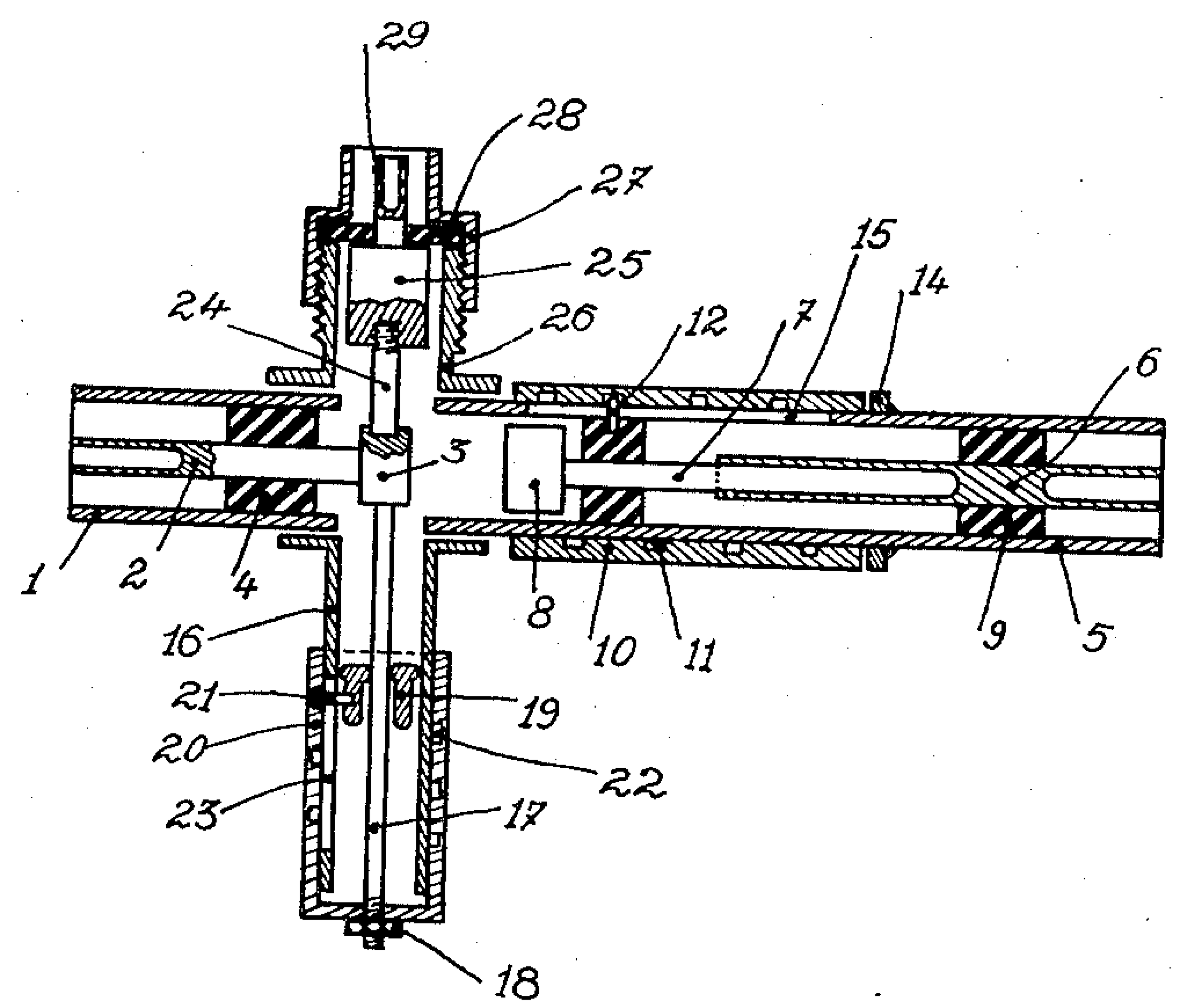

Inventor
Herbert Francois Matare
By Robert E Burns
Attorney

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ATTENUATOR FOR VERY HIGH FREQUENCY WAVES

Herbert François Mataré, Vaucresson, France, assignor to Societe Anonyme dite Compagnie des Freins & Signaux Westinghouse, Paris, France

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This invention relates to attenuators, more particularly to attenuators for very high and ultra-high frequency radio waves. By very high frequency waves it is intended in this specification to designate the wave-length range of from one to ten decimeters, and by ultra-high frequency waves, the wave-length range of from one to ten centimeters.

It is often desirable to adjust in an accurately controllable manner the power output of a high frequency oscillation-generator, and it is an object of this invention to provide for this purpose an improved attenuator particularly designed for use in connection with very high and ultra-high wave frequencies, which is very simple to construct and operate, and which is reduced in size.

Another object is to provide such an attenuator which is capable of accurately adjusting a power output within a range extending from a predetermined maximum value down to a value in the order of about 10^{-15} or 10^{-20} watts.

Another object is to provide such an attenuator which is particularly simple in that no special means are provided in it to prevent impedance-mismatching effects, while remaining highly efficient in operation.

A further object is to provide such an attenuator with means for varying the input energy as desired, and with means for immediately reading the value of the thus-adjusted input energy.

The above and further objects and advantages of the invention are achieved by providing an attenuator of the type specified which comprises a high-frequency input guide tube with a central rod therein, the outer end of said guide being connected with the high frequency generator and the inner end carrying a fixed coupling element, and an output guide tube arranged in coaxial alignment with the input guide also having a central rod therein, and having its outer end connected with a receiver apparatus and its inner end carrying a movable coupling element adjustably displaceable relatively to the fixed input coupling element. The fixed coupling element of the input guide is connected with a short-circuiting means for adjustment of the power input into the device. Further said fixed input coupling element carries a crystal or diode rectifier connected in series with the short-circuiting means and which acts as a probe element for measuring the input energy.

The invention will now be described in greater detail with reference to the accompanying diagrammatic drawing, which illustrates by way of indication and not of limitation in cross-section one preferred embodiment of an attenuator for very high and ultra-high frequency waves according to the invention. As shown, the attenuator comprises a high-frequency input guide or tube 1 axially of which is supported a rod 2 the outer end of which may be connected through any appropriate connecting means as by the plug-socket shown with a high-frequency oscillation-generator and the inner end of which carries a fixed coupling piston 3. The rod 2 is supported in its axial position by an annular insulating block or ring 4 which may be made of polystyrene such as known on the market under the trade-mark "Trolitul" or the like. In coaxial alignment with the input guide 1 is disposed an output guide or tube 5 axially of which is supported a rod 6 having its outer end connectable through any suitable connector device as with the plug-socket shown with a load or receiver for the attenuated high frequency energy and which at its inner end supports for sliding movement relatively to said rod 6, the piston-rod 7 of a movable coupling piston 8 carried in a position adjacent to, and adjustably-spaced from, the input coupling piston 3. The rod 6 is supported in the output guide 5 by an insulating ring 9 made of polystyrene such as known on the market under the trade-mark "Trolitul" or the like. For axial positional adjustment of the movable piston 8 an actuating bushing 10 is used formed with an internal helical groove 11 into which a pin 12 projects, the pin 12 being rigid with, and projecting outwardly from, an insulating ring support 13 through which extends and to which is secured the piston rod 7 of piston 8. The bushing 10 is movable in rotation but is prevented from axial movement by means of an abutment flange 14 around the output guide 5. As shown, the output guide 5 is formed with a longitudinal slot or groove 15 through its wall to allow the actuating pin 12 to extend therethrough. It is to be observed that this slot 15 is at all times sealed by the surrounding bushing 10 so that there is no risk of outside dirt penetrating through the slot into the guide 5.

Between the input and output wave-guides 1 and 5 and extending generally perpendicularly thereto is a tube member 16 axially of which is disposed a rod 17 which is connected with the fixed or input coupling piston 3. The tube 16 is retained in position relatively to the guides 1 and 5 by any suitably-designed means. Over the rod 17 a slider 19 is displaceable which provides the short-circuiting means serving to adjust the input energy into the attenuator. Displacement of the slider 19 is effected by means of a rotatable actuating bushing 20 surrounding the tube 16, through the medium of a pin 21 projecting at one end thereof into an inner helical groove 22 of the bushing 20 and secured at its other end to the shorting member 19. The tube 16 is of course formed with a slot 23 through its wall for passage of the pin 21, and this slot is at all times sealed by the surrounding bushing 20. Suitable abutment means such as the nut 18 engaging a threaded end portion of the rod 17 are provided to prevent axial displacement of the rotatable bushing 20.

In order to fix the energy level of the high-frequency input energy, thereby to be assured of the fact that, in two successive measurements effected with a device connected with the output 5 of the attenuator the input energy remains the same, it is necessary to be able to measure said input energy. For this purpose according to the invention a measuring probe member is used comprising a crystal rectifier or diode 24 one terminal of which is imbedded in the fixed coupling piston 3 and the other terminal for instance in threaded engagement as shown with a de-coupling element 25 housed in a tube member 26 secured in any suitable way to the input and output tubes 1 and 5 on the side opposite that at which the tube member 16 is supported. Thus it may be seen that the rectifier 24 is in series with the short-circuiting means 17—19.

The decoupling element 25 is mounted on the rod 24 in a readily removable manner in order to enable it to be replaced by a similar element of different diameter depending on the particular range of wavelengths in connection with which the attenuator is to be used. For this purpose the element 25 is shown as retained in position by means of an internally threaded bushing or cap 27 screwed over the externally threaded end of the tube member 26, with the interposal of an insulating washer 28 of "Trolitul" or the like. A socket 29 rigid with the decoupling element 25 is provided for plugging connection with a suitable measuring instrument.

The attenuator assembly just described makes it possible to adjust the power transmitted therethrough over a range extending from a predetermined maximum down to a value of about 10^{-15} or 10^{-20} watt by varying the spacing from the movable piston 8 to the fixed piston 3. According to the invention, the desired attenuating action is produced by the setting up of vibratory energy in the mode E_{0_1} within the guide 1 and absorbing a greater or less amount of said energy depending on the adjusted spacing between the movable output and fixed input coupling pistons 8 and 3.

It will be noted from the foregoing description that in the device shown no particular means are provided for averting impedance-mismatchment shock effects, and no special load resistances are included, as a result of which an extremely simple attenuator construction is achieved. Experience has shown that the absence of such means while affording great simplicity at the same time does not detract from the operating efficiency of the attenuator of the invention, as the defects due to mismatched impedance are greatly reduced as the amount of power transmitted through the attenuator is itself reduced, to such an extent that when for instance the spacing adjustment in the device is 1 centimeter, the impedance mismatchment shock effect already has a negligible value.

An important advantage of the attenuator described is the possibility of adjusting the input energy to any desired value by actuating the short-circuiting member 17—19, said value of the input energy being at all times ascertainable owing to the rectifier or probe member 24. Thus any high-frequency oscillation-generator may be applied to the attenuator and the input energy may be adjusted with the short-circuiting means 17—19 to any desired value as indicated by the measuring instrument plugged in at 29.

By way of indication, the operating wavelength range of the above-described attenuator is from about 20 centimeters to about 3 centimeters. It will be understood of course that many modifications may be made in the details of the exemplary device illustrated and described within the purview of the ensuing claims. Thus among other possible variations, the actuating means for producing the adjusting displacements of the movable piston 8 and the short-circuiting member or slider 19 may be provided in forms other than those shown. The mounting for the rectifier or "probe" member 24 may also differ from that illustrated.

What I claim is:

1. In an attenuator in combination an input and an output wave-guide in coaxial alignment and in energy-transmitting relationship with each other at their inner ends, an axial rod through the input guide and a telescopable axial rod through the output guide, means at the outer ends of each of said rods cooperating with the adjacent ends of the related guides for connection thereof with an energy-transmitting and receiving means respectively, a fixed input coupling element at the inner end of said first rod and an output coupling element at the inner end of said telescopable rod movable towards and away from said input coupling element for transmitting a variable fraction of the available amount of input energy on said input coupling element, adjustable short-circuiting means in series with said input coupling element for varying said available amount of input energy thereon, a rectifier member connected at one end with said input coupling element and a de-coupling means connected with the other end of said rectifier, and an indicating instrument connected with said de-coupling means.

2. Attenuator as in claim 1 wherein said de-coupling element is interchangeable and removably secured to the outer end of said rectifier.

3. In an attenuator in combination an input and an output guide in axial alignment and in energy-transmitting relationship at their inner ends with each other, an energy-transmitting space defined at the inner ends of said guides, a pair of tubes extending in opposite directions from said space normally to said guides, a fixed axial rod through the input guide and a slidable axial rod through said output guide, connector means at the outer ends of said respective rods cooperating with the adjacent ends of the related guides for connection with an energy-transmitting and receiving means respectively, a fixed input coupling element at the inner end of said input guide in said space and an output coupling element at the inner end of said output guide and means for adjusting said slidable rod in axial position to move said output towards and away from said input coupling element to transmit a desired fraction of the amount of input energy available on said input coupling element to said output coupling element, short-circuiting means for abstracting a variable amount of input energy

from said input coupling element to leave only a desired amount of available input energy thereon, said short-circuiting means comprising a rod connected to said input coupling element and extending axially through one of said pair of tubes, a short-circuiting slider slidable on said rod and adjusting means for adjusting said slider in axial position on said rod, and means for indicating the said available amount of energy on said input coupling element, said indicating means comprising a rectifier connected at its inner end with said input coupling element and extending therefrom through the other one of said further tubes axially thereof, a replaceable de-coupling element in said other tube removably connected

at its inner end with the other end of said rectifier, and means for plugging an indicating instrument to the outer end of said de-coupling element.

HERBERT FRANÇOIS MATARÉ.

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