June 12, 1951 E. D. McARTHUR 2,556,881

NEGATIVE ATTENUATION AMPLIFIER DISCHARGE DEVICE

Filed May 24, 1950

Fig. 1.

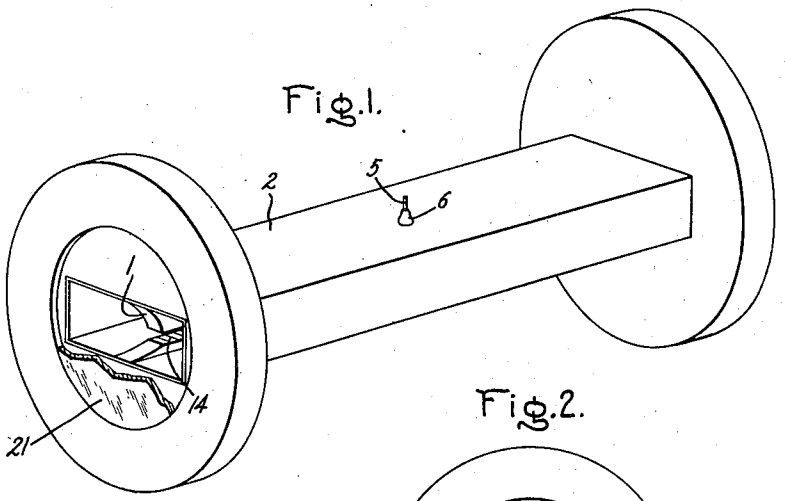


Fig. 2.

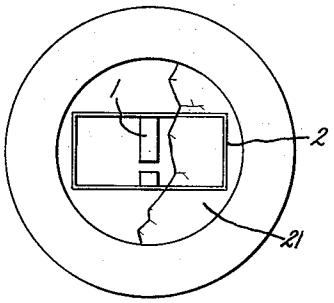


Fig. 3.

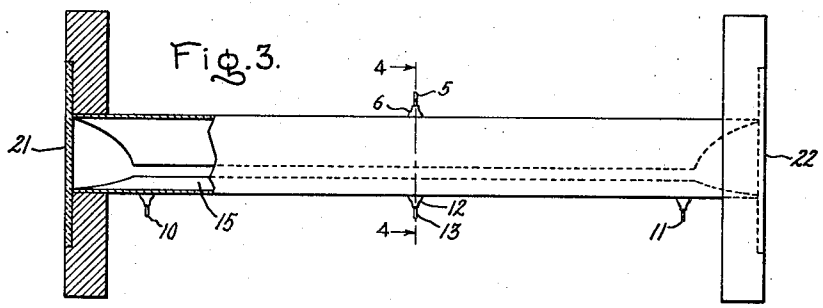
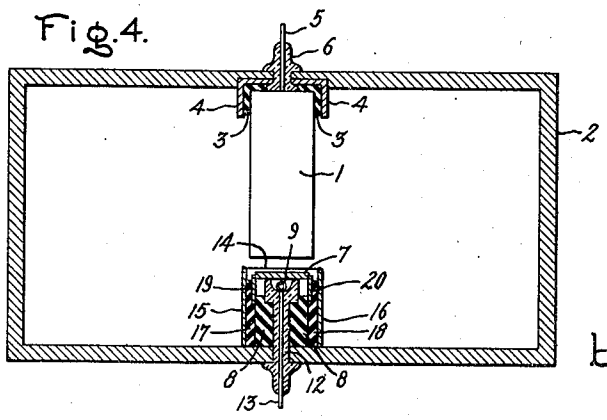


Fig. 4.



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UNITED STATES PATENT OFFICE

2,556,881

NEGATIVE ATTENUATION AMPLIFIER DISCHARGE DEVICE

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1 Claim. (Cl. 315—39)

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My invention relates to electron discharge devices, and more particularly to electron discharge devices employed as amplifiers of high frequency electromagnetic waves.

It is known that an ordinary transmission system, such, for example, as a wave guide or a coaxial cable, has inherent losses which cause an electromagnetic wave to be attenuated upon passing therethrough. All of the sources of loss are commonly lumped into a factor called the attenuation constant which is a measure of how much the wave is decreased in amplitude per unit distance of travel through the system. If this attenuation constant is made negative in sign, a wave passing through the system exhibits an increased amplitude.

It is, therefore, an object of my invention to provide a transmission system which presents a negative attenuation to an electromagnetic wave passing therethrough.

It is another object of my invention to provide a wave guide structure exhibiting a negative impedance to electromagnetic waves having frequencies throughout a wide band width.

It is a further object of my invention to provide a new and improved electron discharge device having a negative impedance.

According to the illustrated embodiment of my invention, an electron discharge device in the shape of a rectangular wave guide is provided with an anode, a cathode, and a grid, each of which extends longitudinally along the guide. The anode is maintained at a higher positive potential than the cathode such that a direct electric field exists between the anode and the cathode. A high frequency electromagnetic wave is introduced at one end of the guide and travels along the guide parallel to the electrode structure. The dyotron principle is disclosed in application, Ser. No. 772,517, filed September 6, 1947, entitled "High Frequency Electric Systems Having High Input Impedance" and Ser. No. 751,358, filed May 29, 1947, entitled "Electric Discharge Devices and High Frequency Systems Therefor," and which has been abandoned, both being assigned to the assignee of the present application. According to the dyotron principle, part of a high frequency electric field established between the anode and the grid extends through the grid structure to the cathode, and may be used with an appropriate circuit arrangement to present a negative resistance to the source of the high frequency field. In my amplifier, the electromagnetic wave introduced into the guide establishes this electric field and,

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therefore, may be amplified by the device. My negative attenuation type amplifier may be likened to a number of dyotron stages in cascade, and as the wave travels to each successive stage as it passes through the guide, it is further amplified. Consequently, the gain of the amplifier is related to the number of stages and hence to the length of the device.

For additional objects and advantages and for a better understanding of my invention, attention is now directed to the following description and accompanying drawing and to the appended claim in which the features believed to be novel are particularly pointed out.

In the drawing, Fig. 1 shows a section of one embodiment of my invention; Fig. 2 shows an end view of the device; Fig. 3 is a semi-transparent view of the device; and Fig. 4 is an end view showing the electrode structure in detail.

Referring particularly to Fig. 4, an anode 1 extending the full length of and supported by one side of a hollow conductor or wave guide structure 2 is insulated therefrom by insulation 3. Metallic plate 4 is mounted between guide 2 and insulation 3 and serves as one plate of a coupling capacitor comprising insulation 3 as the dielectric and anode 1 as the other plate. An electric terminal 5 is connected to anode 1 and insulated from guide 2 by an insulating bushing 6. A cathode 7 extending the full length of guide 2 is located opposite anode 1 and supported by an insulation member 8. A conventional filament type heater 9 extends the full length of cathode 7 and has input terminals 10 and 11 connected at opposite ends thereof. A ceramic bushing 12 is located at the approximate center of the guide and serves as a support for metallic terminal 13 which extends to the cathode 7 inside the guide. A multiplicity of grid wires 14 are mounted parallel to each other between cathode 7 and anode 1 on metallic supports 15 and 16 which extend the full length of the guide. These supports also shield cathode 7 from an electromagnetic wave in the guide except for a portion of the wave which passes through grid wires 14 to it. Insulators 17 and 18 in combination with supports 15 and 16 and metallic strips 19 and 20 capacitively couple grid 14 to cathode 7.

Referring to Figs. 1, 2, and 3, the ends of the guide are hermetically sealed by windows 21 and 22 which are made of a suitable material such, for example, as mica. An electromagnetic wave to be amplified is introduced into the guide through window 21 and establishes an electric

field between grid 14 and anode 1. The intensity of this field is related to the amplitude of the wave, and, therefore, the intensity of the field at any instant of time between any particular grid wire and a portion of the anode adjacent thereto is related to the amplitude of the electromagnetic wave at such particular grid wire at that particular instant of time. Because a negative resistance may be produced between grid 14 and anode 1 by adjusting the phase angle of the current flow between cathode 7 and anode 1 to the proper value as explained in the hereinbefore cited copending applications, a negative conductance will be established across the inter-action space. By controlling the amount of current flow between cathode and anode and other controlling factors such, for example, as the number of grid wires per unit length, and the phase angle of the current with respect to the electric field established by the transmitted electromagnetic wave between grid and the anode, the negative resistance provided by dyotron action per unit length of guide may be made greater than the inherent positive conductance caused by the metal resistivity or other sources, and a wave passing through this guide will be amplified.

This type amplifier has the advantage of simplicity of design, the ability to be readily adapted to wave guide systems, and amplification which is directly dependent upon its length, and no mechanical adjustments which may be disturbed by such external effects as vibration. While my invention has been disclosed by means

of a particular device and construction, it will be understood that those skilled in the art may make many changes and modifications without departing from my invention, and, therefore, by the appended claim I intend to cover any such modifications which fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

An amplifier of high frequency electromagnetic waves comprising a rectangularly shaped wave guide being provided therein with an anode and a cathode mounted on opposite faces of said guide, said anode and said cathode extending the full length of said guide and being insulated therefrom, a pair of flat metallic shielding strips being mounted within said guide and being located on opposite sides of said cathode, a multiplicity of parallel grid wires being mounted on said strips and being disposed transversely to the longitudinal axis of said wave guide between said anode and said cathode.

ELMER D. McARTHUR.

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The following references are of record in the file of this patent:

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