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Maier

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[54] **ADJUSTABLE ATTENUATOR WITH P-I-N DIODES**

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[51] **Int. Cl.** **H03h 7/24**, H01p 1/22

[58] **Field of Search** ..... 333/81 R, 81 A; 323/80

[56] **References Cited**

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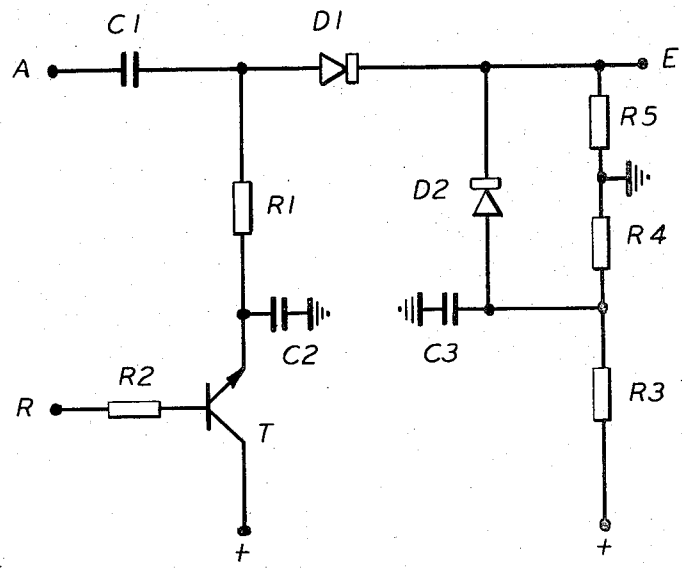
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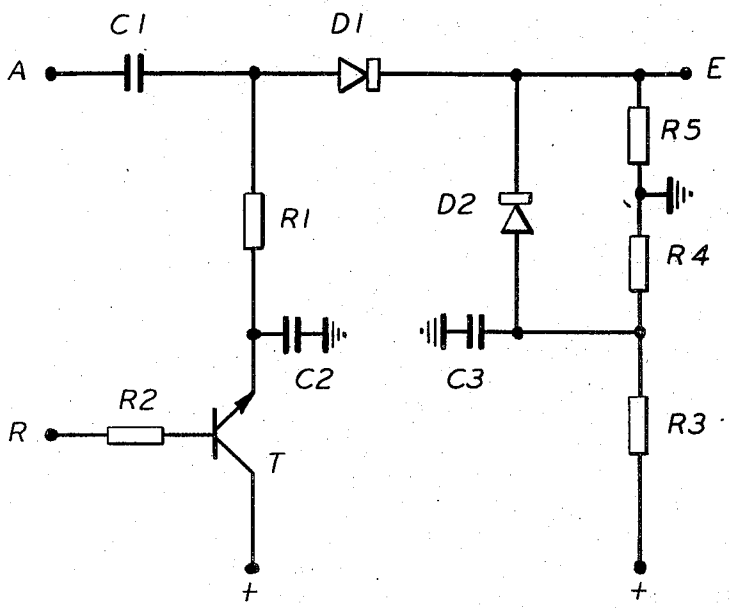
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[57] **ABSTRACT**

An antenna and television receiver are interconnected by an adjustable attenuator in the form of a π network having a longitudinal branch with a p-i-n diode, an antenna cross branch with high frequency short-circuiting and adjustable control means, and a receiver cross branch with high frequency short-circuiting means and a second p-i-n diode coupled to a positive bias source whereby variable attenuation is accompanied by substantially constant input and output impedances.

2 Claims, 1 Drawing Figure




C1
D1
A
E
R5
R1
D2
R4
C2
C3
R2
R
R3
T
+
+

ADJUSTABLE ATTENUATOR WITH P-I-N DIODES

BACKGROUND OF THE INVENTION

The present invention relates to an adjustable attenuator with p-i-n diodes.

In order to match input signals of different strengths, for instance antenna signals, to the input amplifier of a high frequency receiver, attenuators are connected between the antenna and the input of the amplifier. These attenuators are adjustable and their attenuation can be varied continuously or stepwise without the input and output impedances being changed. The attenuators were first of all constructed with resistors in π or tee networks.

The semiconductor technique created a new component, the p-i-n diode. It constitutes an electronically adjustable attenuator which, due to its special construction, has the property of changing its HF forward resistance as a function of the direct current flowing through it with a falling characteristic. It therefore represents an ideal component for the completely electronic control of attenuation.

It is already known to arrange p-i-n diodes, similar to the corresponding attenuators with resistors, in π as well as tee networks (Radio-Elekronik-Schau, Issue 9, page 497). π networks are particularly preferred in order to maintain equal impedances at the input and at the output independently of the attenuation of the attenuator. In practice, however, it was found that the match at the antenna input changes very greatly upon misadjustment and thus extensive reflections can occur.

It is found in an attenuator constructed with p-i-n diodes that as a result of the p-i-n diode installed in the antenna-side cross branch of the π member, the antenna is more and more short-circuited upon adjustment of the attenuator, since the diode connected in the cross branch is adjusted so as to be more conductive and the diode connected in the longitudinal branch more highly ohmic. This has the result that upon increased misadjustment of the attenuator, one operates more and more in the antinode at the antenna jack, as a result of which ghosts appear in the television picture.

A controllable attenuator member for high-frequency signals using p-i-n diodes is also known (German Patent 2,105,747). The object of this known arrangement is to avoid nonlinearities of the p-i-n diodes operated in this case in the region of the lower cutout frequency. The linearity of the p-i-n diodes for this low-frequency range is improved in the manner that two p-i-n diodes connected in opposition to each other are connected in the cross branch parallel to a load resistor. A control current is fed via a common connection to a connecting line between the two p-i-n diodes and removed via the outer connections facing away from the connecting line of the two p-i-n diodes. With such an arrangement, however, it is not possible to obtain high values of attenuation, since the diodes connected in the cross branch have their forward resistances connected in parallel, in which connection the attenuation can be adjusted in only one cross branch. Furthermore, such networks do not satisfy the requirement for matching.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide an enhanced signal attenuation circuit. Another object of the invention is to provide an attenuation circuit for improved antenna to signal receiver matching. Still another object of the invention is to provide a substantially constant antenna match with relatively high values of attenuation of signals having a relatively wide range of frequencies.

These and other objects, advantages and capabilities are achieved in one aspect of the invention by an attenuation circuit in the form of a π network with a first p-i-n diode in a longitudinal branch interconnecting an antenna and a signal receiver, an antenna cross branch having high frequency shortcircuiting and adjustable control means, and a receiver cross branch having high frequency shortcircuiting and a second p-i-n diode coupled to a positive bias source.

BRIEF DESCRIPTION OF THE DRAWING

The sole FIGURE illustrates a preferred embodiment of an attenuation circuit for an antenna and signal receiver.

PREFERRED EMBODIMENT OF THE INVENTION

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the accompanying drawing.

Referring to the drawing, a first p-i-n diode D1 is connected in the longitudinal branch of a π network intermediate an antenna terminal A and a signal receiver terminal E. An antenna cross branch includes a resistor R1 coupling the junction of the diode D1 to circuit ground by way of a high frequency short-circuiting capacitor C2. The resistor R1 and capacitor C2 are coupled to the emitter electrode of a transistor T having a collector coupled to a potential source + and a base coupled by a resistor R2 to a variable amplifier signal source R.

A receiver cross branch includes a second p-i-n diode D2 coupled to the first p-i-n diode D1 and to the receiver terminal E. The second p-i-n diode D2 is coupled to circuit ground by a high frequency shortcircuiting capacitor C3 and to the junction of a pair of resistors R3 and R4 connected intermediate a potential source + and circuit ground. Another resistor R5 couples the junction of the p-i-n diodes D1 and D2 and the receiver terminal E to the potential reference level or circuit ground.

As to operation, an input signal available at the antenna input terminal A is fed via a capacitor C1 and first p-i-n diode D1 to receiver terminal E. Depending upon the control voltage applied to the base of the transistor T, a corresponding current flows from the potential source + via the collector-emitter path of the transistor T, the resistor R1, the p-i-n diode D1, and the resistor R5 to circuit ground. Thus, a positive bias voltage is established at the cathode of the p-i-n diodes D1 and D2.

When the current flow through the resistor R5 becomes so small that it drops below the fixed bias of the voltage divider consisting of the resistors R3 and R4, the p-i-n diode D2 will open and, with increasing current flow, its resistance will be reduced whereupon attenuation is thus increased. Moreover, the resistor R1 in the antenna cross branch of the attenuator is so di-

mensioned that the ratio of the characteristic impedance of the connected antenna to the value of the resistor R1 is in a ratio of approximately 1:4. Obviously, other ratios can be selected.

By the measures of the invention of connecting only one p-i-n diode D1 in the longitudinal branch of one p-i-n diode D2 in the receiver-end cross branch, the attenuation in the critical frequency range at the upper end of the UHF band is only 4 db less than in the case of an attenuator constructed in the customary manner with three p-i-n diodes. This small difference is due to the fact that sucking effects can easily be utilized at these high frequencies. In other words, the term "sucking effects" relates to the fact that the diode D2 and capacitor C3 tend to form a series resonant circuit having a very low impedance at a frequency in the UHF range. Thereupon, the junction of the diodes D1 and D2 is essentially grounded and short circuits any signal present at the junction of the diodes D1 and D2.

Thus, the inductance of the p-i-n diode D2 as well as that of the line with the capacitor C3 can form a "wide" series resonance at any desired frequency portions of the UHF range. In absolute value, the attenuation at a frequency of 800 megacycles is of the order of magnitude of > 30 db.

Additionally, a maximum mismatch of only 1:4 is obtained with the larger attenuation of the antenna input signal. In many tuners, this maximum mismatch is by no means reached in normal operation. Thus, the indicated mismatch is to be considered merely as a most unfavorable value when the tuner has a standing wave ratio of $m = 1$.

While there has been shown and described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined by the appended claims.

What is claimed is:

1. An adjustable π network form of attenuator comprising:

a longitudinal branch including a first p-i-n diode interconnecting antenna and signal receiver terminals;

an antenna cross branch including a resistor coupled to said antenna terminal and a transistor coupled to said resistor, to a potential source, and to a variable amplifier source, said antenna cross branch including a high frequency short circuiting capacitor coupling said resistor and transistor to a potential reference level; and

a receiver cross branch including a second p-i-n diode coupling said receiver terminal to a positive potential source.

2. An adjustable π network form of attenuator comprising:

a longitudinal branch including a first p-i-n diode interconnecting antenna and signal receiver terminals;

an antenna cross branch including a resistor coupled to said antenna terminal and a transistor coupled to said resistor, to a potential source, and to a variable amplifier source; and

a receiver cross branch including a second p-i-n diode coupling said receiver terminal to a positive potential source, said receiver cross branch including a resistor coupling said receiver terminal to circuit ground and said positive potential source is in the form of a voltage divider having a pair of resistors series connecting a potential source to a potential reference level.

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