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2,337,399

ATTENUATION EQUALIZER

Filed Sept. 27, 1941

FIG. 1

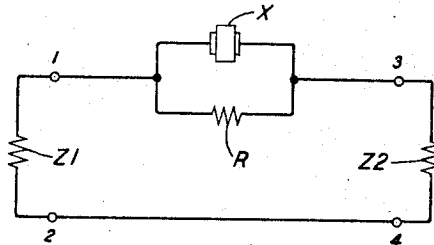


FIG. 2

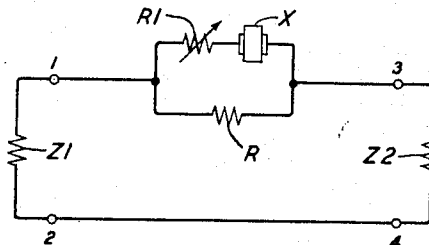


FIG. 3

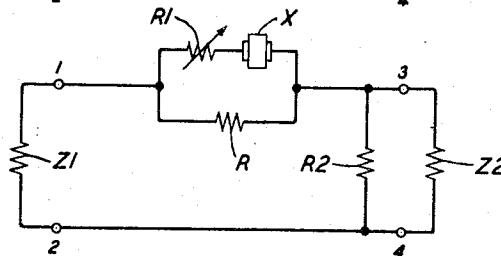


FIG. 4

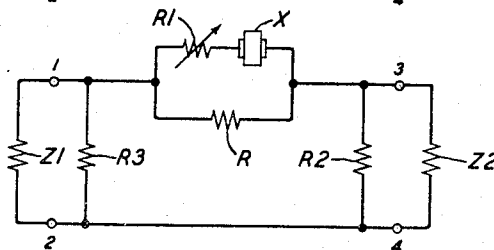
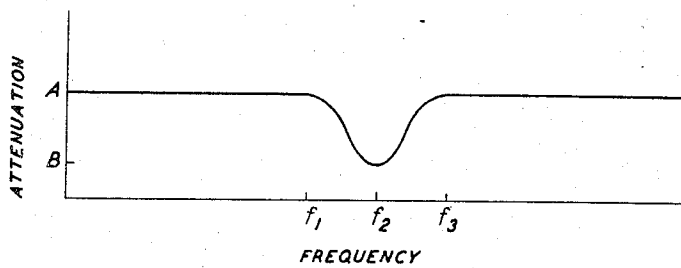


FIG. 5



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ATTENUATION EQUALIZER

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3 Claims. (Cl. 178—44)

This invention relates to wave transmission networks and more particularly to attenuation equalizers.

An object of the invention is to equalize the attenuation in a wave transmission system.

Another object is to compensate for attenuation distortion which occurs in a comparatively narrow percentage frequency range without introducing appreciable distortion outside of that range.

In a multichannel carrier telephone system, for example, where a pilot channel is used in connection with automatic regulation the transmission loss in the pilot channel must be the same as the loss in the other channels to ensure proper operation of the regulator. When the pilot channel is taken off by means of a high impedance shunt, including a narrow band filter, connected across the transmission line attenuation distortion in the band of the pilot channel filter is introduced. This distortion is usually small, extends over a comparatively narrow percentage frequency range and has a maximum value at some frequency within this range.

In accordance with the present invention this distortion is compensated for by means of a simple but efficient attenuation equalizer which has the required inverse loss characteristic over the distortion band but has a flat loss outside of this band.

The equalizer comprises a resistor associated with a piezoelectric crystal impedance element which has a resonance in the neighborhood of the maximum attenuation distortion. If the resistor is connected in series with the transmission line the crystal element is connected in shunt with the resistor. In order to provide the required impedance for the crystal a second resistor may be connected in series therewith, and this latter resistor may be made variable to allow for manufacturing variations in the crystal and to permit an adjustment of the attenuation characteristic. In order to improve the impedance match between the equalizer and its terminal loads a shunt resistor may be connected across the line at one or both ends of the series impedance branch.

The nature of the invention will be more fully understood from the following detailed description and by reference to the accompanying drawing, in which like reference characters refer to similar parts and in which:

Fig. 1 is a schematic circuit of one embodiment of an attenuation equalizer in accordance with

the invention, connected between two load impedances;

Fig. 2 shows a modification of the circuit of Fig. 1 in which a resistor is added in series with the piezoelectric crystal;

Fig. 3 is a modification of the circuit of Fig. 2 in which a shunt resistor is connected at the right of the series impedance branch to improve the impedance match at the left end of the equalizer;

Fig. 4 shows a modification of the circuit of Fig. 3 in which a shunt resistor is connected at the left of the series branch to improve the impedance match at the opposite end; and

Fig. 5 gives the type of attenuation-frequency characteristic obtainable with the equalizer circuits shown in the other figures.

Taking up the figures in more detail, Fig. 1 shows one embodiment of the attenuation equalizer comprising a piezoelectric crystal element X and a resistor R connected in parallel between terminals 1 and 3. Since the unbalanced form is shown there is a direct connection between terminals 2 and 4, which may be grounded or otherwise fixed in potential. If the balanced form is desired the impedance branch between terminals 1 and 3 is reduced to half the value shown and a second branch of the same impedance is substituted for the strap between terminals 2 and 4. The terminal loads are represented by the impedances Z1 and Z2, one of which is assumed to include the source of signal voltage.

It is assumed that the attenuation distortion to be corrected occurs between the frequencies f_1 and f_3 and has a maximum value K at the intermediate frequency f_2 . The magnitude of the resistor R is therefore so chosen that the flat loss A introduced by its insertion between the load impedances Z1 and Z2 exceeds K. The crystal X is now designed to resonate at or near the frequency f_2 and to have a resistance at resonance which is low enough that the insertion loss of the parallel combination of X and R is equal to B, where

$$B = A - K$$

The crystal X is further designed to have a reactance characteristic so steep that at the frequencies f_1 and f_3 the impedance of the crystal is so high that the insertion loss of the equalizer ceases to be appreciably affected thereby. The equalizer will then have an attenuation characteristic of the type shown in Fig. 5, with a flat loss A below f_1 and above f_3 and a minimum value B at f_2 , which will compensate for the

assumed attenuation distortion. It should be pointed out that in Fig. 5 neither the frequency scale nor the attenuation scale starts at zero.

In order to build the resistance at resonance of the crystal X out to the required value a resistor R_1 may be added in series therewith as shown in Fig. 2. This resistor may be made variable, as indicated, to allow for manufacturing variations in the resistance of the crystal and also to permit an adjustment of the attenuation characteristic of the equalizer. As the resistor R_1 is increased in value the minimum attenuation B of the attenuator at the frequency f_2 is raised, and vice versa.

In either Fig. 1 or Fig. 2 the impedance match between the load Z_1 and the equalizer may be improved if the impedance of the load Z_2 is so chosen that the sum of the impedance Z_2 and the impedance of the series branch is equal to the impedance Z_1 .

If the impedance Z_2 cannot be made smaller than Z_1 then an impedance match with Z_1 may be obtained by adding the resistor R_2 in shunt with Z_2 , as shown in Fig. 3, to form an L-type attenuator.

The impedance of the equalizer may be matched to the load at both ends by adding another shunt resistor R_3 at the left of the series impedance branch as shown in Fig. 4, to form a π -type attenuator.

What is claimed is:

1. An attenuation equalizer adapted to compensate for attenuation distortion which occurs in a comparatively narrow percentage frequency range and has a maximum value at a certain frequency comprising two shunt resistors, an interposed series resistor and a piezoelectric crystal, said crystal being connected in parallel with said series resistor and having a resonance in the neighborhood of said certain frequency.

2. An attenuation equalizer comprising two shunt resistors, an interposed series resistor and an impedance branch connected in parallel with said series resistor, said impedance branch including a piezoelectric crystal and an additional resistor connected in series.

3. An attenuation equalizer in accordance with claim 2 in which said additional resistor is variable.

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