

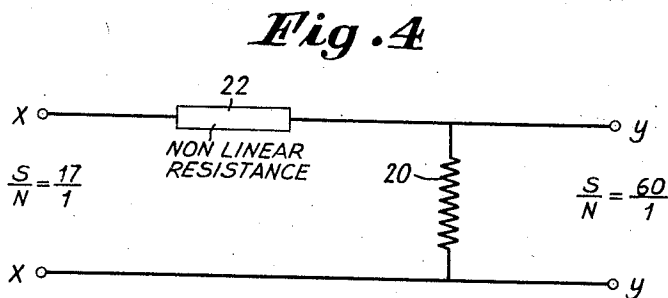
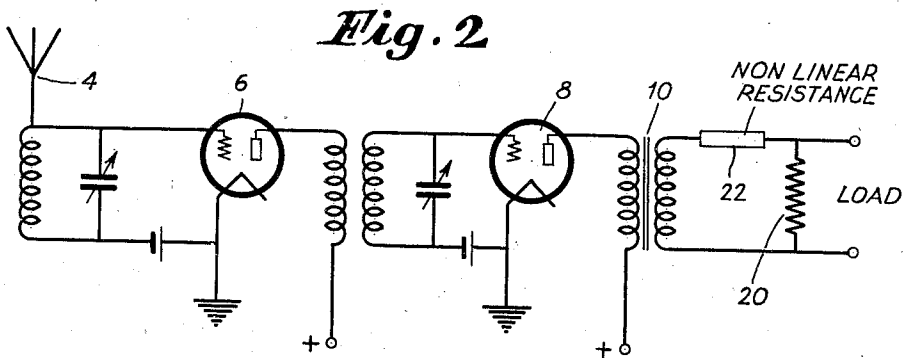
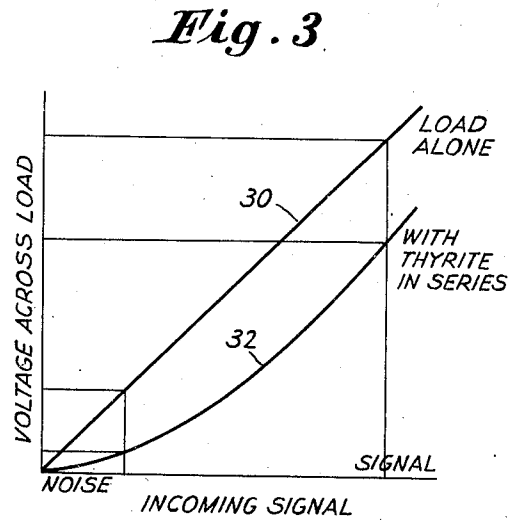
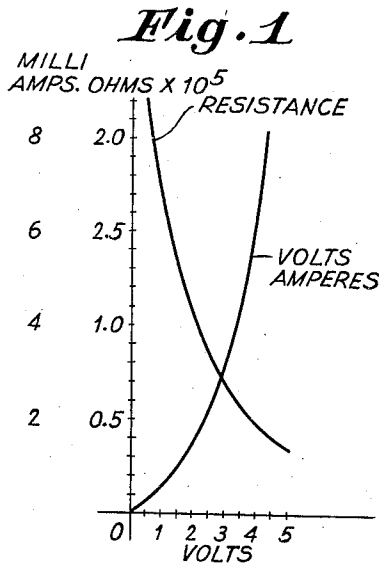
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NOISE SUPPRESSION

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NOISE SUPPRESSION

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2 Claims. (Cl. 250—20)

This invention relates to noise suppression which is based on the action of a non-linear resistance in series with a load circuit.

Heretofore, noise suppressors have been devised which require rather complicated circuits and make use of vacuum tubes in addition to the said complicated circuits. This invention makes use of a non-linear resistance element, acting as a passive resistance in series with the load and thereby overcomes maintenance costs, high initial costs and has the advantage of being exceedingly simple. Any non-linear resistance known may be used provided it has the necessary characteristics. The characteristics of the non-linear resistance used in my novel circuit must be such that increasing the voltage applied to the resistance will decrease its resistance at a rapid rate. This decrease in resistance causes an increase in the current flow through the resistance. If the non-linear resistance is placed in series with a load resistance it will use up a relatively large amount of small impressed potentials and small amount of large impressed potentials. These characteristics may be used in accordance with my novel concept to reduce the noise heretofore present in the outputs of potential or wave amplifiers of all types.

As pointed out above, any non-linear resistance having the proper characteristics may be used. One substance particularly adapted to the present invention is that known in the art as Thyrite. The characteristics of Thyrite have been described in detail by Mr. K. B. McEacheron in the General Electric Review of February, 1930, volume 33, No. 2, page 92. For a detailed description of this type of non-linear resistance reference is made for those interested, to said publication. The character of Thyrite is such that doubling the voltage applied to it will decrease its resistance to less than one-sixth its initial value. This decrease in resistance is obviously accomplished by a rapid increase in current flow through the Thyrite. Another characteristic of Thyrite is that it conducts currents equally well in either direction of the conductive path through its resistive material. A Thyrite resistor may, therefore, be regarded as unbiased with respect to the polarity of the currents traversing the same. The composition of Thyrite and the process of making it is of no consequence in the disclosure of my invention since this resistive material is one which is commercially obtainable for a great many different purposes. It may be said, however, that Thyrite has mechanical properties somewhat similar to

those of dry-process porcelain, but possesses the remarkable property of being substantially an insulator at one potential and a good conductor at certain higher potentials. The process of making Thyrite is said to involve the very accurate control of a large number of variables. The material can be moulded in any desired shape and its consistency can be depended upon as being held within close limits so that, for example, a disc of a given thickness may be depended upon as having a predetermined resistance value in relation to the applied voltage.

When considering the application of Thyrite it should be noted that the constant varies directly as the thickness of the piece but not inversely with the area as does the ordinary resistance. For instance, with an exponent of one, the constant for the piece depends on the length but is independent of the area. To make this clear, we may consider the effect of doubling the area, remembering that the constant is defined as the resistance at one ampere, which, with an exponent of one, is inversely proportional to the current. By doubling the area, the current in the original area is reduced to one-half, but the resistance of each half is thereby doubled and so the total resistance remains unchanged. It should be noted that these relationships are dependent upon the definition of the "constant" as the resistance at one ampere. As the exponent approaches zero as a limit these relationships approach those of the ordinary resistor.

Although my invention has been described clearly to those skilled in the art, additional description thereof will be made and in said additional description reference will be made to the drawing attached hereto.

In the drawing,

Figure 1 shows curves illustrating the volt amperes and volt ohms, characteristics of a non-linear resistance such as Thyrite;

Figure 2 illustrates somewhat diagrammatically the essential elements of an amplifying or relaying system including the noise suppressing feature of the present invention;

Figure 3 shows curves illustrating the manner in which the non-linear resistance acts in the relaying or amplifying circuit to suppress, reduce, or eliminate the noise so that a more favorable signal to noise ratio is obtained in the energy reaching the load circuit as has been the case heretofore; while

Figure 4 is a simplified diagram used in illustrating values of resistances necessary to obtain a specified noise reduction;

Referring to the drawing and in particular to Figure 1, it will be noted that the resistance value of the non-linear resistor decreases rapidly with an increase in voltage applied to the terminals thereof. This decrease in resistance value is accompanied by a rapid increase in current which may flow through the non-linear resistor. The curves of Fig. 1 hold true both for a rising voltage and a falling voltage, thus indicating that there is no appreciable time lag in the resistive characteristic of the preferred non-linear resistor which I have adopted, namely, Thyrite. The curves of Figure 1 are characteristic of a low resistance piece of non-linear resistance. Increasing the length of the non-linear resistance increases the resistance as does decreasing the diameter.

In Figure 2 I have shown a source of wave energy or potentials or modulated wave energy in the form of an aerial system 4 connected with the input electrodes of a thermionic amplifier 6 having its output electrodes coupled to a rectifier 8, in turn coupled by a low frequency transformer 10 to a load circuit 20. A non-linear resistance 22 is connected as shown in series with the load circuit. The load circuit may be any utilization device or additional amplifiers but is preferably a final utilization device such as a recorder or a loudspeaker, etc. The source 4 may be replaced by incoming lines or the source 4 and the amplifier 6 and the demodulator 8 may be replaced by any source of low frequency potentials or wave energy or modulated wave energy. By modulation it is intended to include keyed wave energy or tone keyed energy.

In Figure 2 it will be noted that the non-linear resistance element 22, preferably composed of Thyrite, is placed in series with the load 20. The load in this case is simply the device which is to work from an incoming signal. It may, for example, be a relay or an amplifier or a loudspeaker. Due to the non-linear characteristics of the non-linear device 22 decreasing current through it increases its resistance very, very rapidly. Consequently, when a fixed value of resistance such as a load is placed in series with the non-linear resistance, as the incoming wave signal voltage decreases, a greater and greater portion of the available voltage is used up across the non-linear resistance. In other words, the voltage drops across the non-linear resistance for very low applied voltage values constitutes by far the greater portion of the total drop in the circuit including the load. This means that for low applied voltages very little of the applied voltage is impressed across the load. As the applied voltage, which may carry a signal, increases however, more and more of said voltage appears across the load. This being so, since the noise level of the amplifying or relaying system is generally much lower than the useful voltage or signal, the non-linear resistance has a tendency to suppress the noise voltage coming in without materially attenuating the received useful voltage. This effect of the circuit is illustrated graphically in Figure 3 wherein the voltage across a load is plotted against the incoming applied voltage or signal, the straight line 30 denotes the relation between the voltage across the load and the applied voltage when no non-linear resistance is used in series with the load circuit. The curved line 32 denotes the relation between the voltage applied across the load and

the incoming voltage or signal when a non-linear resistance is, in accordance with my invention, placed in series with the load. As will be seen, little or no voltage resulting from noise, reaches the load circuit in the latter case.

More specifically, the reduction of noise ratio by the use of my novel network is obtained in practice as follows:

Assume that wave energy or varying potentials are applied to the terminals X of the network of Figure 4 and it is desired to obtain potentials or wave energy of improved signal to noise ratio from the terminals Y. For purposes of illustration, also assume that the non-linear resistance has a value of 10,000 ohms so that when one milli-ampere current is passed through said non-linear resistance a drop of potential of 10 volts will be produced therein. This one milli-ampere of current is also flowing through the substantially linear resistance 20 and, if this resistance is given a value of 10,000 ohms, it will produce a drop of 10 volts. Thus, in an example given we will see that the voltage impressed across the terminals X is equal to the sum of the potential drops in 22 and 20, which is 20 volts. With a one volt drop across the non-linear resistance 22 the resistance is equal to substantially 60,000 ohms (due to the non-linear characteristic of said resistance) and consequently a current of .0167 milli-ampere flows in the said non-linear resistance. This means that across the series output resistance there is produced a drop of 1.67 volts. This means that the total voltage impressed across the terminals X is the sum of the potential drops in 22 and 20 or 1.167 volts.

Thus, if the 20 volts impressed represented signal voltage and the 1.167 volts represents the noise, the signal to noise ratio impressed on the input terminals X is about 17 to 1. On the other hand, the ratio of output voltages at the terminals Y is 10 to .167 or a signal to noise ratio of about 60 to 1. Hence my network insures considerable improvement of increase of the signal to noise ratio in signals passed thereby.

In usual signalling practice for radio the minimum output signal to noise ratio in practice is considered to be about 20 to 1. Obviously, the arrangement of the present invention enables me to use a signal ratio (17 to 1, and less) heretofore considered not usable.

I claim:

1. In a wave amplifying system, means for receiving and amplifying wave energy, a load circuit, a resistor in series with said load circuit, said resistor being constituted by a substance having bilateral conductivity and a non-linear voltage current characteristic, and means coupling said load circuit and non-linear resistance to said amplifying means.

2. A radio receiving circuit having an antenna, a detector, an amplifier, and means for attenuating the noise component of signalling energy impressed upon said circuit, said means comprising a single resistor whose conductivity is independent of the direction of current flow there-through, and whose impedance value is an inverse logarithmic function of the voltage applied thereacross, and a utilization circuit of substantially linear impedance characteristics to which said signalling energy is fed through said attenuating means.

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