June 21, 1932. N. BISHOP 1,863,895

AMPLITUDE LIMITING DEVICE FOR AMPLIFYING SYSTEMS

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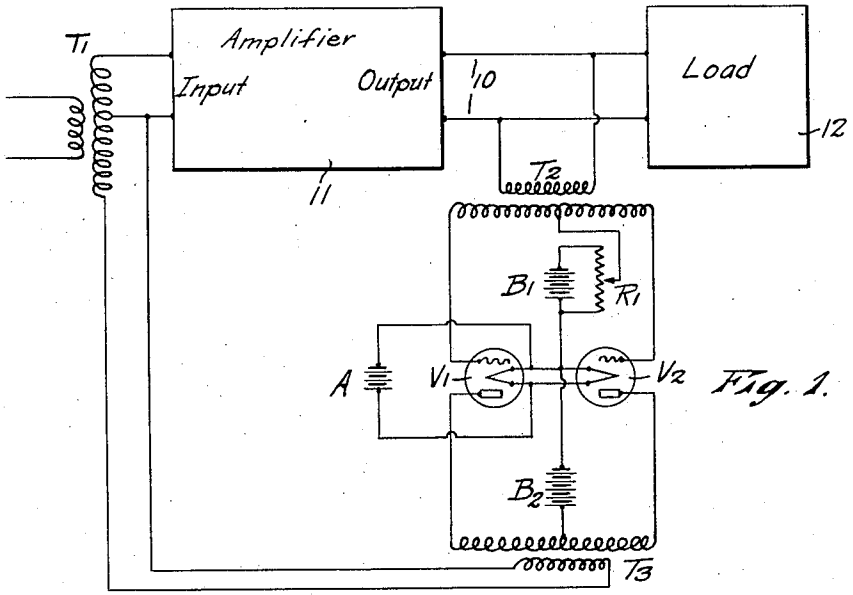

Fig. 1.

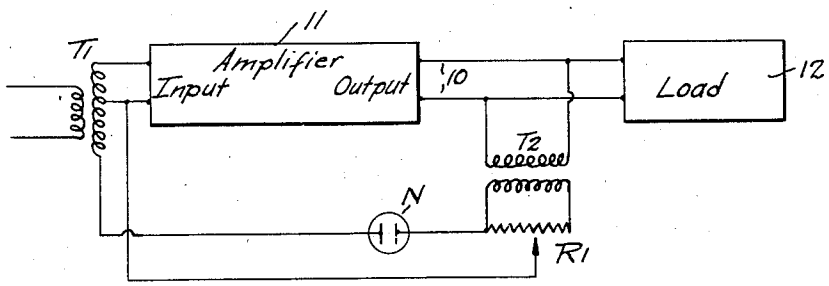

Fig. 2.

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AMPLITUDE LIMITING DEVICE FOR AMPLIFYING SYSTEMS

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This invention relates to amplitude limiting devices for amplifying systems, and has for an object to produce a device whereby the output of any amplifying system may be limited to a predetermined amount so that any undesired interference which produces a greater voltage than the desired output voltage may be limited in amplitude to the same or slightly greater value than the desired output. Thus, for example, when used in a radio receiving system it prevents surges, static, transients in near-by power circuits and similar sources of interference from producing an effect in the output of the amplifier circuit greater than the peaks of the desired signal.

In general, the theory of operation is as follows: Across the output terminals of the amplifier in the amplifying system is connected a transmission network having the characteristic that if an alternating voltage is applied across its input there will be no output from the network until the voltage is increased to a predetermined value. Beyond this predetermined or critical value a voltage will be present across the output of the network which will have a wave shape similar to that portion of each half cycle of the amplifier output voltage which is above this critical value for the network. If, then, this output voltage from the network is introduced into the input of the amplifier a hundred and eighty degrees out of phase with the input voltage to the amplifier, the effect will be to prevent the peaks of the input wave from exceeding a value predetermined by the setting of the constants of the network. In a like manner the output of the amplifying system is limited so as not to exceed a predetermined value.

In the accompanying drawing I have shown two arrangements of devices for securing this operation and effect. In this drawing

Fig. 1 is a diagram of an amplifying system with a limiting network employing vacuum tubes applied thereto, and

Fig. 2 is a similar diagram showing a limiting network employing a neon tube or similar discharge device.

Referring to the first system illustrated in Fig. 1, this method makes use of two three-element vacuum tubes V^1 and V^2 connected in a push-pull arrangement. B^1 is a source of grid bias potential and R^1 is a potentiometer allowing adjustment of the negative grid bias applied to the grids of the tubs V^1 and V^2. A is a source of filament potential for these tubes, and B^2 is a source of plate potential for these tubes. The network includes the input transformer T^2, the primary of which is connected across the output 10 of the amplifier 11, the input impedance of the transformer being high in comparison with the load impedance, the load being represented by the element 12, such for example as a loud speaker. In the plate circuit of the vacuum tubes V^1 and V^2 is connected an output transformer T^3, and the secondary of this output transformer T^3 is connected to the secondary of the input transformer T^1 of the amplifier 11 so that the voltage across the secondary of the transformer T^1 due to the output of the limiting device, will be a hundred and eighty degrees out of phase with the input voltage to the amplifier.

In the operation of this device, the potentiometer R^1 is adjusted so that the peaks of the desired wave fall just below the point where current will flow in the plate circuit of tubes V^1 and V^2. In other words, the bias is made far enough below cutoff so that the strongest desired signal will produce a voltage on the grids of tubes V^1 and V^2 just below the value which will allow plate current to flow. Then, if any interference which produces a greater voltage than the desired signal is introduced into the amplifier, the cutoff voltage in the network will be passed and the network will produce a voltage across the input of the amplifier a hundred and eighty degrees out of phase with and similar to each half of the cycle of the input wave which exceeds the cutoff voltage, thereby limiting the output of the amplifier due to this interference to a value only slightly greater than the desired signal. By adjustment of the grid bias as by varying the setting of potentiometer R^1, it is possible to make the

device operative at any output level of the amplifier which may be desired.

Referring now to Fig. 2 there is illustrated in this figure a method of securing this effect which employs a limiting network making use of a neon tube or similar discharge device having the characteristic that it will pass current in either direction only after the applied voltage has reached the critical value or break-down voltage. In this arrangement, the primary of the step-up input transformer T^2 of the network is connected across the output 10 of the amplifier 11 the same as in the arrangement of Fig. 1. This transformer is designed so that the impedance looking into its circuit is high in comparison to the impedance of the load 12. Across the secondary of this transformer T^2 is connected the potentiometer R^1 which affords means for adjusting the voltage applied to the circuit containing the discharge device N and the secondary of the input transformer T^1 of the amplifier 11. When current flows through the discharge device N, it passes through the secondary of the input transformer T^2 in such a way as to produce a voltage across the input to the amplifier 11 one hundred and eighty degrees out of phase with the input voltage to the amplifier.

The adjustment of this device is similar to that of Fig. 1 in that the potentiometer R^1 is set so that the desired signal just fails to ignite the discharge device N or is set just below the point where distortion is noted on the peaks of the desired signal. Then, if the system is subjected to interference which produces greater voltages across the output of the amplifier 11 than the desired signal, the voltage produced by the peaks of this interference will ignite or break down the discharge device N and it will pass current impulses the wave shape of which will be similar to each half cycle of the output wave which exceeds the break down voltage for which the discharge tube circuit is adjusted. This current is introduced into the input of the amplifier 11 through the secondary of the transformer T^1 one hundred and eighty degrees out of phase with the corresponding peaks of the input voltage to the amplifier, thereby limiting the possible peak voltage across the output of the amplifier, to a value only slightly in excess of the desired signal.

Both of these devices may be used as a "safety valve" on any amplifying system to prevent surges, static, transients from nearby power circuits and similar sources of interference from producing an effect in the output circuit of the amplifier greater than the peaks of the desired signal. As an example, the device has been applied to the power amplifier of several types of radio receivers with success. It has been demonstrated that while attempting to hear a weak station through strong local interference from a spark coal and without this device in the circuit, it was impossible to hear the station at all. With this device in the circuit, it was found possible to understand what the announcer was saying. Such interference as intermittent crackling, etc., of much greater volume than the program giving the effect of a series of deafening crashes when this device was not used, was reduced by the use of this device to a dull clicking.

The second method, employing the discharge tube or device N, is limited in its application to systems where sufficient voltage is available to cause the tube to ignite at the desired voltage level, but due to its extreme simplicity, it is ideally suited for application on modern radio receivers using power amplifiers. With this device it is possible to limit the output of an audio frequency amplifier to a predetermined value, and it is especially adapted to be used in conjunction with radio receivers subjected to intermittent interference which would normally be louder than the signal or program being received. A neon lamp has a characteristic such that its internal impedance is very high at audio frequencies if the voltage applied to the lamp is lower than the value necessary to light it (or the break-down voltage). As soon as this critical or break-down voltage is reached its impedance becomes low enough to pass current during that portion of each one-half cycle of the impressed voltage that the voltage is equal to or greater than the critical voltage.

No claim is made that these devices will in any way affect background interference or noise of lower volume than the desired signal. They will, however, make a marked difference in the effect of high level interference and in such a way as to have no detrimental effect on the quality of the desired signal.

Having thus set forth the nature of my invention, what I claim is:

1. In an amplifying system the combination with an amplifier of a transmission network having its input connected across the output of said amplifier and having an impedance sufficiently great to prevent current flow through said network until a voltage is impressed thereon greater than the voltage of the desired output from the amplifier and means connecting the output from said net work across the input to the amplifier to impress the output thereon 180° out of phase with the input to the amplifier.

2. In an amplifying system the combination with an amplifier of a transmission network having the characteristic that if an alternating voltage is applied across its input there will be no output from said network until the voltage exceeds a predetermined value, means connecting the input of said net-

work across the output of the amplifier, and means connecting the output from said network across the input to the amplifier to impress the output thereon 180 degrees out of phase with the input to the amplifier.

3. In an amplifying system the combination with an amplifier of a transmission network having the characteristic that there will be no output therefrom until the voltage across its input is equal to a predetermined value, means connecting the input of said network across the output of the amplifier, and means connecting the output from said network across the input of the amplifier to impress the output thereon 180° out of phase with the input to the amplifier.

4. In an amplifying system the combination with an amplifier of a transmission network having the characteristic that there will be no output therefrom until the voltage across its input is equal to a predetermined critical value, means for varying the impedance of the net work to vary said critical value, means connecting the input of said network across the output of the amplifier, and means connecting the output of said network across the input of the amplifier to impress the output thereon 180° out of phase with the input to the amplifier.

5. In an amplifying system the combination with an amplifier of a transmission network including an input transformer having its primary connected across the output from the amplifier, means in said network to prevent output therefrom until the voltage on the input to the network reaches a predetermined amount, and means connecting the output of the network to the input to the amplifier to deliver the output from the network to the input to the amplifier 180° out of phase with the amplifier input.

6. In an amplifying system the combination with an amplifier of a transmission network including an input transformer having its primary connected across the output from the amplifier, means in said network to prevent flow of current therethrough when the voltage on the input to the network is less than a predetermined amount, means in the network whereby the said predetermined limit may be varied, and means for delivering the output from the network to the input to the amplifier one hundred and eighty degrees out of phase with the amplifier input.

7. In an amplifying system the combination with an amplifier of a transmission network including an input transformer having its primary connected across the output from the amplifier, a circuit including the secondary of said transformer connected to the input to the amplifier to deliver the output from said net work to the input to the amplifier 180 degrees out of phase with the amplifier input, and a neon tube in said circuit to prevent current flow to the amplifier input when the voltage in the circuit is less than a predetermined amount.

8. In an amplifying system the combination with an amplifier of a transmission network including an input transformer having its primary connected across the output from the amplifier, a circuit including the secondary of said transformer connected to the input to the amplifier to deliver the output from said circuit to the input to the amplifier 180 degrees out of phase with the amplifier input, and a neon tube in said circuit to prevent output therefrom when the voltage in the amplifier output is below a predetermined limit.

9. In an amplifying system the combination with an amplifier of a transmission network having its input connected across the output from the amplifier and its output connected to the input to the amplifier to deliver the output from said net work to the input to the amplifier 180 degrees out of phase with the amplifier input, and a neon tube in said network to prevent current flow therethrough when the voltage on the input to the network is less than a predetermined amount.

10. In an amplifying system the combination with an amplifier of a transmission network having its input connected across the output from the amplifier and its output connected to the input to the amplifier to deliver the output from said net work to the input to the amplifier 180 degrees out of phase with the amplifier input, a discharge device in said network to prevent current flow therethrough when the voltage on the input to the network is less than a predetermined amount, and means to cause the discharge device to pass current at different input voltages.

In testimony whereof I affix my signature.

NATHANIEL BISHOP.