June 18, 1935. H. SHORE 2,005,111

AMPLIFIER

Filed April 9, 1931

Fig. 1

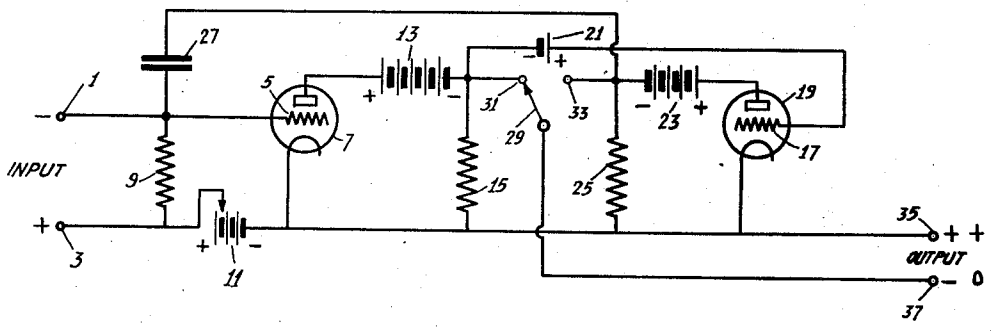


Fig. 2

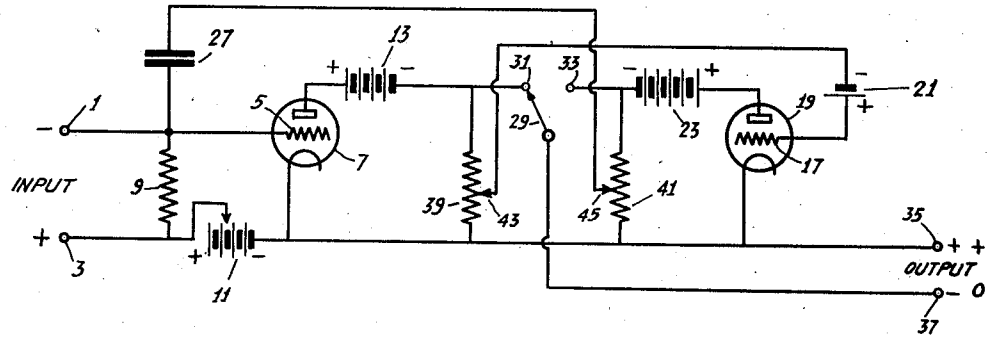
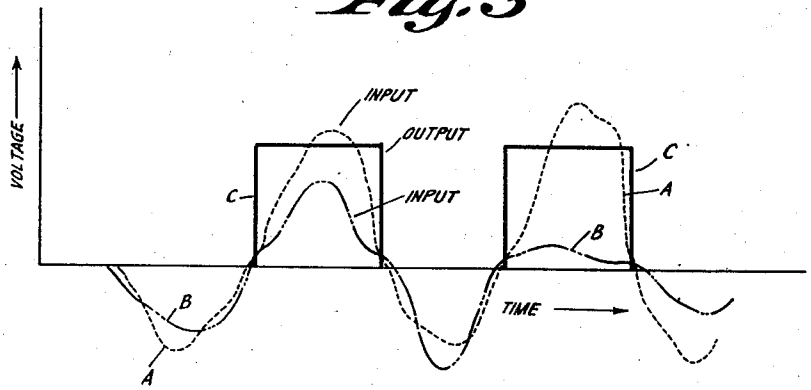


Fig. 3



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AMPLIFIER

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10 Claims. (Cl. 178—70)

The present invention relates in general to amplifying systems, and particularly to amplifying systems which are suitable for converting distorted waves into what may be termed "square-waves".

In communication systems, and particularly at points in the system where it is necessary or desirable to utilize land lines to connect a point at which a signal originates and a transmitting point, or to connect a point where signals are originally received to a second point at which the signals thus received will be utilized, difficulties are frequently encountered from distortion and line attenuation. This distortion effect which may be either amplitude or phase distortion, of which amplitude distortion produces a reduction in magnitude of some of the signal components in greater proportion than others while phase distortion causes certain of the components of the signal to travel at a greater rate than others so that the time of arrival of all signal components is not the same at any predetermined point, must be corrected. Attenuation, above referred to, tends to cause a reduction in the magnitude of the signal without changing its shape so that all portions are reduced proportionately. This system is intended also to overcome this difficulty.

It has been found that by the use of an arrangement of the type to be herein described and disclosed these detrimental effects of distortion and attenuation may be avoided, so that the signals upon a line connecting transmitting or receiving points to points at which the signals originate or are used can be converted into a squared, desirable and useful formation to avoid difficulties in the translating apparatus produced from a badly distorted original signal. Thus, it is possible to take a slowly building up wave and make it build up fast, and, in this manner, compensate for the detrimental effects produced by the line attenuation. Under such conditions, it will readily be seen that it is possible to use a system of the type herein disclosed most efficiently for keying tones as, for example, in a system for transmitting picture records where a tone is used as a carrier for the picture modulated current developed by the photoelectric light converting element.

Also, a system of the type to be herein disclosed has particular advantage for keying a transmitter where the transmitter is either to be on or off completely, and thus during the change-over periods the transmitter is controlled in a most definite and sharply discernible manner. The amplifier system disclosed by the present invention is also most desirable for use with black and white facsimile apparatus, where black, for example, may indicate an interruption in the transmission and white may indicate a period of transmission.

Furthermore, due to detrimental effects of fading in radio transmission or attenuation in line transmission, the case frequently rises where a signal never reaches the value which it should ultimately have, and, therefore, by the design of appropriate means, a signal of materially reduced strength may be transformed into a signal of constant and limited strength as will hereinafter become apparent. It is frequently the case that some signals received over the line have greater amplitude than other signals, and it is most desirable to limit all signals to a constant amplitude. Therefore, according to the present invention, arrangements have been provided for limiting the signal amplitude to a common value irrespective of whether the signal be a greater or lesser amplitude than the common value which is to be obtained for all signals. In this manner, the amplifying system herein disclosed finds particular application in a diversity combining unit and may serve as a radio frequency limiter, or what might better be termed perhaps a "fading compensator".

In addition to the above uses, a system of the type to be hereinafter disclosed finds particular application in tone keying, as above stated, so that it is possible to use alternating current and immediately square all of the peaks produced. Therefore, the invention has, as will be above seen, many and varied objects, with the principal viewpoint being to obtain a square wave formation irrespective of the wave formation reaching the amplifying system.

A further object of the invention is to provide a circuit arrangement for an amplifying system so arranged that the amplifier may act as a limiter, and such that the amplifying system will be one which has a very high gain and, at the same time, be capable of working with either alternating current supply or a pulsating direct current supply.

As a further object of my invention, I have sought to provide a system which will permit "reverse keying" operation. By this I mean that the system shall work to supply an output voltage when no signal is on the line as well as to provide normal operation of supplying an output potential when there is a signal on the input line. Other objects of the invention are, of course,

to provide an amplifying system which is free from the usual complications of amplifiers tending and aiming to produce these desirable results; to provide an amplifying system which is formed from the minimum number of separate elements combined and constructed to accomplish the desirable purposes set forth above; and to provide an amplifying system which is simple in its construction, arrangement, operation, and which will be efficient in its use.

Still other and further objects and advantages will, of course, become apparent and suggest themselves to those skilled in the art to which the invention relates by reading the following specification and claims in connection with the accompanying drawing, wherein:

Fig. 1 shows one form of circuit arranged to accomplish the aims and objects of this invention;

Fig. 2 shows a slight modification of the arrangement of Fig. 1; and,

Fig. 3 is a graphical representation indicating the wave form output from the system of either of Fig. 1 or Fig. 2 as contrasted to the wave form input.

Now making reference to the accompanying drawing, signals from an external source, such as a telegraph key, a facsimile system, a television amplifier, an automatic tape transmitter, or the like, may be impressed upon the input terminals 1 and 3 in such a manner that a negative potential will be supplied at terminal 1 and a positive potential supplied at terminal 3. Signals thus impressed upon the terminals 1 and 3 are supplied to the grid electrode 5 of a vacuum tube amplifier 7 across resistor 9. The grid 5 of the tube 7 is normally biased positively by the adjustable battery 11 connected in the grid circuit of this tube, so that in the absence of signals upon the input terminals 1 and 3 plate current supplied from a suitable source 13 will normally flow in the output circuit of the tube 7.

As plate current is drawn by the tube 7, a drop in potential is produced in the resistor 15 connected directly in the said plate circuit. This drop in voltage in the resistor 15 acts on the grid 17 of the tube 19 through the bias battery 21 connected in the input circuit of the tube 19, so as to counteract the effect of the positive bias supplied to the grid 17 by the battery 21, and brings the tube 19 to cut-off position so that no current will flow in the output circuit thereof during periods when the tube 7 is drawing current.

From the above it is seen that the negative potential supplied to the grid 17 of the tube 19 is a function of the current drawn by the tube 7, the drop in the resistor 15, and the potential of the battery 21.

However, upon impressing signals across the input terminals 1 and 3, in such a manner that the grid electrode 5 of the tube 7 is carried slightly negative, there is a reduction in the current output of the tube 7, and consequently there is less voltage drop in the resistor 15 than with maximum current being drawn by the tube 7 for a condition when no signals are impressed. Due to this decreased voltage drop in the resistor 15, the grid 17 of the tube 19 is carried slightly positive with respect to the potential which it originally assumed and the tube 19 at once begins to draw plate current from the plate potential source 23 through the resistor 25 and a voltage drop will be produced across the resistor 25. This voltage drop produced in the resistor 25 then causes the capacity element 27 to become charged negatively, and thus charged it tends to carry the grid electrode 5 of the tube 7 still more negative, so that there is a still less voltage drop in the resistor 15 and the grid 17 becomes even more positive. The voltage drop in the resistor 25 is thus increased as is the negative charge of the capacity 27, and the system continues to work in this manner until the grid 5 reaches cut-off potential when no further change in current can take place through resistor 15.

Now, suppose that the signal is removed, so that there is a tendency for the grid of the tube 7 to become positive, the charge which has been supplied to the capacity 27 commences to leak off and the grid 5 of the tube 7 becomes less negative with a corresponding reversal of the operation above outlined, so that as the tube 7 starts to draw current, the current which may be drawn by the tube 19 is decreased most rapidly until a position of equilibrium is established, where the system will remain until the next disturbance in the nature of an input signal reaches the system, after which the same cycle of operation is repeated.

In this manner it will be seen that the arrangement functions as a sort of regenerative system in that as soon as a signal reaches the tube 7 the effect thereon is accentuated and increased due to the fact that the tube 19 commences to draw plate current and the tube 7 is almost immediately blocked, while the tube 19 tends to draw a maximum amount of current.

By making reference now to Fig. 3 of the drawing, it will be seen from the curves A and B, indicating assumed input signal values, that almost immediately upon receipt of a signal having a negative potential to effect the grid of the tube 7, and irrespective of the amplitude of the signal at the particular point, there will be an output, indicated by the curve C, which may be derived from the system. As has been shown graphically by Fig. 3, the assumed signal designated as A rises to a value greater than the liminal value of the curve C whereas the curve B never reaches the value of the curve C. However, irrespective of whether the input signal strength is greater or lesser than the limited output value, this limited value is assumed almost immediately and continues for a time period substantially corresponding to the entire duration of the signal.

The output energy from the system may be utilized by connecting the switch 29 with either terminal 31 or 33, and the useful output is then taken from the terminals 35 and 37. It is immaterial whether the switch 29 be positioned upon the contact 31 or 33 so far as the operation is concerned, but by suitably choosing which of the terminals 31 or 33 will be used determines whether or not there will be zero potential or a difference in potential derived from the circuit when it is in a position of equilibrium, or, in other words, during the absence of signals.

For square wave action in the system, the capacity element 27 and the grid leak resistor 9 should preferably be small so that the time constant will be negligible, since it is necessary to supply a definite voltage before the action commences and a small loss in time only should be experienced. However, in order to overcome the difficulties which may be occasioned by the arrangement shown and described in connection with Fig. 1, a slight modification of the arrangement may be made, as has been indicated by Fig. 2, in order to make the starting voltage necessary for operation extremely small. This

modification of the circuit consists in the substituting for resistors 15 and 25 of Fig. 1 the voltage dividers 39 and 41 from which the input to the tube 19 may be taken from the terminal 43 connected to the resistor 39 and from which resistor 41 the negative charge placed upon the capacity 27 may be taken by means of the terminal tap 45. The arrangement shown by Fig. 2 utilizing the voltage dividers is intended to facilitate the adjustment of the system but in no way changes the operation from that set forth and described in connection with Fig. 1. Therefore, further description of the modification shown by Fig. 2 is believed to be unnecessary.

From the above description it will, of course, be obvious that the system has use as a distortion correcting device in all cases where, for example, the input signal while intended to be of square formation in some manner became changed, and a squared wave form output is desired for keying a transmitter for transmission or, for example, a local oscillator in receiving. However, the system will also work as a distortion producing device. A typical use of this function would be in a case where the input energy is in the form of the usual alternating current wave and the output energy converts the alternating current wave form into a square wave form.

From the above description, it, of course, will be apparent that many and varied modifications of the invention may be made without departing from the general principles described and outlined hereinabove, and I, therefore, believe myself to be entitled to make any and all of these modifications such as would suggest themselves to those skilled in the art to which the invention relates, provided, of course, that such modifications and changes fall fairly within the spirit and scope of the invention as set forth in the hereinafter appended claims.

Having now described my invention, what I claim and desire to secure by Letters Patent is the following:

1. An electronic relay system comprising a plurality of independent thermionic devices, means to supply signals to one of the thermionic devices, and means connected with the output circuit of one of the thermionic devices and the input of the signal controlled thermionic device to trigger the signal controlled thermionic element to produce from the relay system a constant amplitude and wave shape output irrespective of the wave shape and amplitude of the supplied energy.

2. In an amplifying system, an amplifying audion, means for connecting a source of signals thereto, a second audion connected with the output of said first audion, and means connecting the output of the second audion and the input of the amplifying audion operable in accordance with the current flow through the second audion for triggering the first audion, and a load circuit connected with the output of one of the audions.

3. An amplitude limiting system comprising a vacuum tube amplifier, means for impressing signals upon the input circuit of said amplifier for controlling the output energy therefrom, a second amplifier connected with the output of said first amplifier and having its output energy increase and decrease in opposite relation to the increase and decrease of output energy from the first of said amplifiers, and means connected with the output of said second amplifier for accentuating the response of said first amplifier to signals above a predetermined threshold amplitude value impressed thereon.

4. In an amplitude controlling system, a vacuum tube amplifier, means for impressing signals across the input circuit of said amplifier for controlling the output energy therefrom, a second amplifier directly connected with the output of said first amplifier, means associated with the output circuit of said first amplifier and with the input circuit of said second amplifier for controlling the output current of said second amplifier in inverse relationship to said first amplifier, and capacity means connecting the output circuit of said second amplifier and the input circuit of said first amplifier for accentuating the response of said first amplifier to signals impressed thereon, whereby the output energy from the system comprising the two amplifiers rises to a maximum at substantially the instant that signals are initially impressed upon said first amplifier and continues to remain at constant amplitude during substantially the entire period during which signals are impressed upon the system.

5. In an amplifying system for producing substantially constant voltage output for impressed signals, a first triode arranged normally to pass current in the absence of impressed signals, means for impressing signals upon said triode and decreasing the current flow therefrom, a second triode connected with the output of said first triode, said second triode being normally biased to cut off potential by said first triode, means operable by the decrease in current flow through said first triode upon the impression of signals thereon for increasing the current flow through the second of said triodes, and means connecting the output of said second triode with the input of said first triode for accentuating the decrease in current from said first triode at periods when signals are impressed thereon and an output circuit for each of said triodes for utilizing the output energy from the amplifying system.

6. In a distortion reducing or producing system, a vacuum tube amplifier, means for connecting the input of said amplifier with a line source of input signal energy, means for normally biasing said triode positively to produce a current output therefrom in the absence of impressed signals thereon, means responsive to impressed signals for decreasing the current flowing through said amplifier, a second amplifier having its input circuit connected directly with the output from said first amplifier, a resistor in the output circuit of said first amplifier for controlling the biasing potential upon said second amplifier, a resistor connected in the output circuit of said second amplifier, and means connecting the output of said second amplifier and the input of said first amplifier for utilizing the resistance drop through the output resistor of said second amplifier for accentuating the rate of decrease of current in said first amplifier upon receipt of signal impulses, whereby the output current from the second of said amplifiers is increased, and a load circuit for utilizing the output energy from each of said amplifiers.

7. In an electronic relay system, a first thermionic relay, means for connecting a source of signals to the input circuit of the thermionic relay, a second thermionic relay having its input circuit connected with the output circuit of the first thermionic relay, a capacity means connecting the output of the second thermionic relay with the input of the first thermionic relay to trigger the first thermionic relay, and a load circuit con-

nected with the output of one of the thermionic relays.

8. A wave-shaping device comprising in combination a pair of thermionic relays, means for supplying signals to the input of one of the thermionic relays, means for supplying the output energy of the signal controlled thermionic relay to the input circuit of a second thermionic relay, means for biasing the second thermionic relay in accordance with the current flowing in the first relay, a capacity coupling between the output of the second thermionic relay and the input of the first thermionic relay for triggering the first thermionic relay to accentuate response therefrom to impressed signals above a predetermined limiting value, and a load circuit connected with the thermionic relays.

9. A relay system comprising an input circuit and an output circuit, a pair of cascade amplifying devices connected between the input and output circuits, means to supply signal energy from the input circuit to one of the amplifying devices, and means for feeding back energy from the second of said amplifying devices to the first of said amplifying devices in phase with the supplied signals from the input circuit during time periods when the supplied signal exceeds a predetermined threshold value, whereby the resulting signals in the output circuit vary abruptly in both directions between minimum and maximum amplitude for each change in intensity of the supplied signal from the said predetermined threshold intensity value.

10. The method of producing signals of constant amplitude and wave shape in the output of an amplifying system including a plurality of thermionic relay tubes which comprises the steps of impressing amplitude modulated signalling impulses upon the input circuit of one of the thermionic relay tubes, amplifying the supplied signalling impulses, feeding back to the input of the relay tube a portion of the amplified signal energy in phase with the signal impulses supplied thereto during time periods when the intensity of the signal energy exceeds a predetermined amplitude value and producing thereby an abrupt change in the output energy from the relay tube system each time the amplitude of the signal impulses supplied to the input varies from the predetermined value.

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