Feb. 25, 1941. P. J. KONKLE 2,233,317

AMPLIFIER FOR TELEVISION SYSTEM

Filed May 25, 1937

Fig. 1.

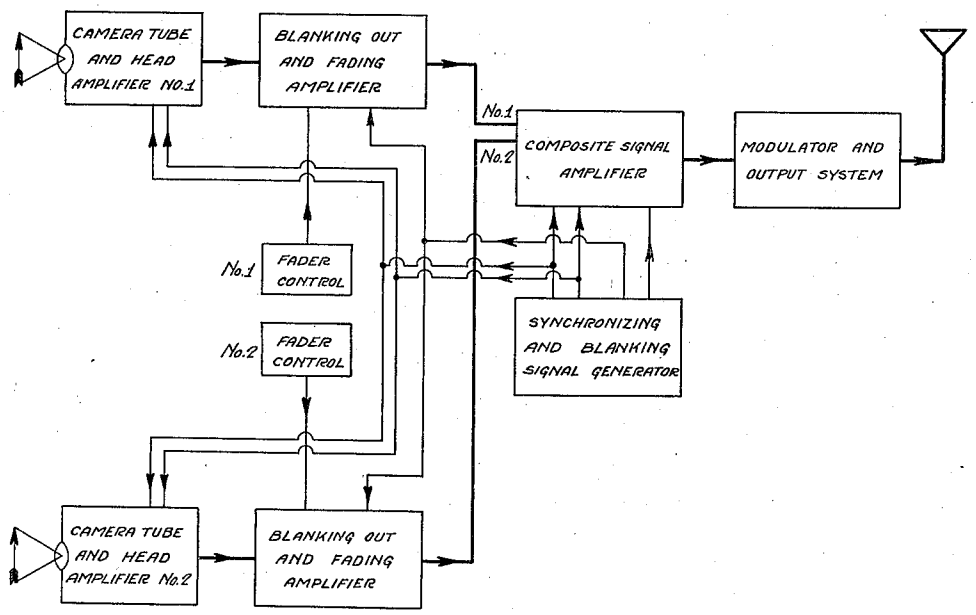
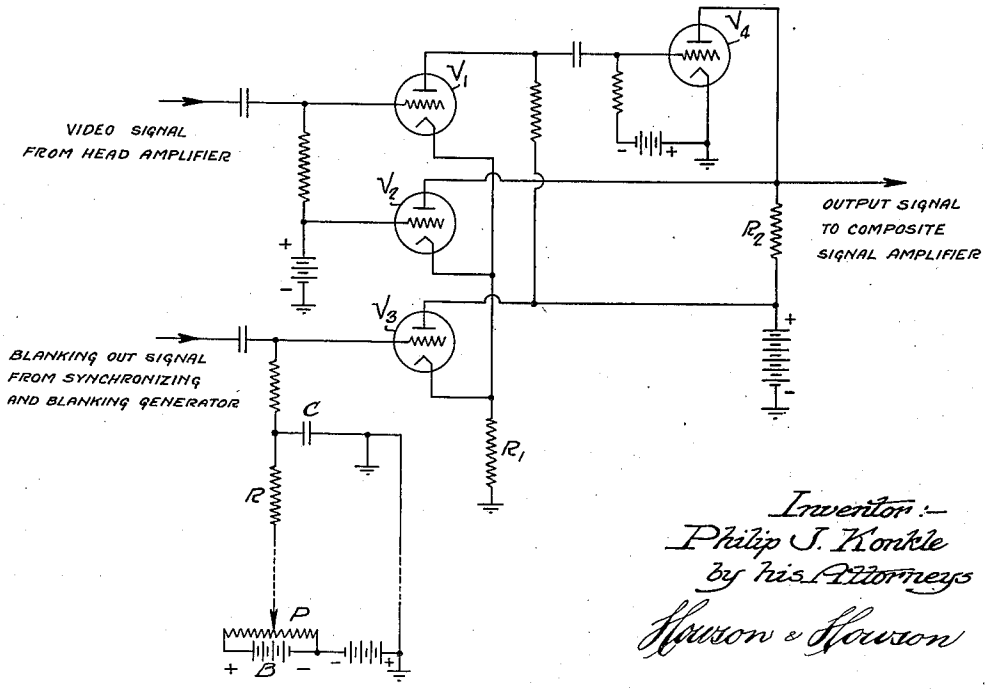


Fig. 2.



Inventor:—
Philip J. Konkle
by his Attorneys
Howson & Howson

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2,233,317

AMPLIFIER FOR TELEVISION SYSTEM

Philip J. Konkle, Cincinnati, Ohio, assignor, by mesne assignments, to Philco Radio and Television Corporation, Philadelphia, Pa., a corporation of Delaware

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7 Claims. (Cl. 178—7.1)

This invention relates to a variable gain amplifier which may be used in a television system to "fade" a television signal in or out. By "fading" is meant to gradually diminish or increase the light intensity of the reproduced image by means provided in the electrical signal channel at the transmitter. The invention is particularly adapted for use where it is desired to fade out the signal from one channel and subsequently or concurrently fade in the signal from another channel. The invention might be used, for example, to fade out the signal from a studio camera tube and to fade in a signal from another studio pick-up device.

The primary object of the invention is to provide an amplifier whose gain may be manually or automatically controlled from a remote point without affecting the frequency response characteristic of the amplifier as its gain is changed.

Another object of the invention is to provide a television system in which the video signal may be faded in or out completely without deleteriously affecting the transmission of the signals required to keep a receiver synchronized with the transmitter.

A further object of the invention is to provide a "fader" in which the rate of "fade" may be determined by electrical circuits requiring a minimum of attention on the part of the operator.

Still another object of the invention is to provide a system for television in which the transmitted picture may be quickly and easily changed from one produced by a signal obtained from one source to one produced by a signal obtained at another source, by the use of means which may be located at a common control point.

These and other objects of the invention will be more readily apparent from the following description and accompanying drawing in which:

Fig. 1 is a schematic illustration of a dual channel television transmitter system embodying the invention; and

Fig. 2 is a circuit diagram of a preferred form of the fading amplifier employed according to the invention.

In the transmission of audio signals as, for example, in conventional radio broadcast or public address systems, it is the usual practice to provide several incoming signal channels which are adapted to be connected to a common output channel, and in each channel there is provided a simple potentiometer or T-pad by which the amplitude of the signal transmitted may be controlled. In changing from one program to another, it is customary to gradually diminish the gain of the signal in the channel being faded out and to then gradually increase the gain of the signal in the channel which is to be faded in. In the art of television, it is desirable to be able to accomplish the same results, but conventional audio circuits now available are not suited to the particular requirements of a television system. In sound transmission systems no synchronizing signals are required, but in television systems it is necessary that each receiver be at all times synchronized with respect to the transmitter, which requires that certain synchronizing signals be transmitted continuously while the accompanying video or picture signal is changed. Moreover, the frequency requirements of an audio signal channel are relatively simple and an ordinary potentiometer or T-pad may be used as a gain control device without difficulty. In a television system, however, the gain control must have a uniform frequency response which extends over a very appreciable frequency range, for example, from about 40 cycles to about 2½ to 4 megacycles. None of the potentiometers now available are capable of handling such a wide frequency range, and due to the inherent inter-element capacities ever present in mechanical devices of this nature, it appears to be improbable that audio gain control devices could ever be adapted for television purposes.

In accordance with the present invention, an electrical circuit is provided which may be actuated by a potentiometer in such a way as to provide the desired variation in gain, without variation of the frequency response and without the introduction of any extraneous and undesired transient signals. It has been found that if the frequency response varies as the gain varies in a television system, the picture takes on grotesque and unpleasant appearances. By maintaining the frequency response substantially uniform the invention enables the gradual fading in or out of the picture without varying the relative illumination between the high lights and other parts of the transmitted image, thus eliminating the grotesque and unpleasant appearances obtained heretofore.

In my Patent No. 2,081,127, issued May 18, 1937, there is described and claimed a variable gain amplifier comprising a unit having two input circuits and an output circuit. As described in the patent, the signal supplied to one input circuit is transferred to the output circuit and is amplified by an amount determined by the signal in the other input circuit, which will be

called the gain control input circuit. However, in the absence of any input signal in the first circuit, a variation of the signal in the gain control input circuit will not cause any response in the output circuit. Furthermore, in the presence of an input signal, a variation of the signal in the gain control input circuit will not cause any transient or other extraneous signal in the output circuit. The present invention utilizes an amplifier of this general type, as described more particularly hereinafter.

As indicated in Fig. 1, in a conventional television system a video or picture signal as obtained from a camera tube, is amplified in a head amplifier, and is then transmitted to the blanking out and fading amplifier. The camera tube is energized by suitable signals for the purpose of obtaining the required deflection of the scanning system. Generally speaking, where electronic means are used to convert the light image into an electrical video signal, a transient signal is introduced during the time intervals between different lines and different frames of the transmitted image. These extraneous signals are sometimes of considerably larger amplitude than the desired video signal, and consequently, would overload subsequent stages in the video signal channel were they not removed. These extraneous signals may be removed by supplying the signal obtained from the camera tube to a blanking out amplifier, which comprises a variable gain amplifier whose gain is reduced to zero during the intervals between line and frame scans when the extraneous signals are present. The output signal then comprises a video signal during the time intervals when the image is being scanned and no signal during the intervals when the scanning means change from one line to the next line, and from one frame to the next frame. At a subsequent point in the system, blanking and synchronizing signals occurring during the time intervals between video signals are combined with the video signals to form a composite signal, which is applied to a modulator and transmitted in the usual manner to a receiver. The receiver contains circuits for distinguishing between the video signal and synchronizing signals, and after being separated, the synchronizing signals are used to control and maintain synchronization of the receiver scanning system with that of the transmitter, while the video signal is supplied to a picture tube which forms a visible image corresponding to the picture being transmitted. Where the video signal may be obtained from one of a plurality of sources, fading preferably takes place ahead of the composite signal amplifier, and the same synchronizing signals are supplied to all of the several camera tubes. In this way, when the picture signal is faded in or out, transmission of the synchronizing signals is not deleteriously effected, and hence the receivers may be maintained in synchronism with the transmitter.

A suitable blanking out and fading amplifier capable of transmitting signals over the above-mentioned frequency range, for the purpose of the invention is shown in Fig. 2. The amplifier comprises a variable gain amplifier of the type disclosed in my aforementioned patent, which, however, according to the present invention, is employed in combination with other elements as hereinafter described. The amplifier comprises the four tubes V_1, V_2, V_3 and V_4. As disclosed in the said patent, tubes V_1 and V_2 have identical characteristics and the mutual conductance of each tube is determined by the voltage in its input circuit. An input signal to be transmitted is supplied to the input circuit of tube V_1, while a bias voltage including the voltage across resistor R_1 is applied to both of the tubes V_1 and V_2. A gain control signal is established across resistor R_1 by means of the tube V_3, which control signal determines the operating voltage of the tubes V_1 and V_2. The circuit of V_3 is likewise adapted to transmit a wide range of frequency components. The tube V_4 inverts the phase of the signal transferred by tube V_1, and the output signals from tubes V_2 and V_4 are combined to form an output signal across the common resistor R_2. It will be seen, therefore, that the gain control signal is balanced out and does not appear in the output circuit. The input signal, however, whose amplification is controlled, is transferred to the output circuit. Obviously, the input signal may be supplied to either of the tubes V_1 and V_2 or opposite phase signals may be supplied to these tubes in which case, the output signal will be proportional to the vector difference between or arithmetic sum of the input signals.

When the device is used as a blanking out amplifier, the video signal may be supplied between the grid either V_1 or V_2 and ground. The signal supplied to tube V_3, which determines the voltage across resistor R_1, may be in the form of a blanking out signal obtained from the synchronizing and blanking signal generator. In accordance with the invention, controllable bias is supplied to the tube V_3 by means of the potentiometer P, the battery B, and the resistance R, as shown in the drawing. The grid leak for V_3, across which the blanking out signals are formed, is by-passed to ground at the blanking amplifier by means of the blocking condenser C. By suitably proportioning the relative values of R and C, only very slow changes in voltage may take place in this circuit and hence, the potentiometer may be positioned at a remote point without danger of the introduction of extraneous signals due to inductive or capacitive pick-up and the like by the control line to the amplifier. Furthermore, the characteristics of the amplifier are such as to prevent the transmission of any such signals, should they be introduced in the input circuit of tube V_3, as well as the transient signal caused by the fading operation.

When the potentiometer arm is positioned at the negative end of the battery, the tube V_3 will draw only sufficient amount to build up a suitable biasing voltage across R_1 for tubes V_1 and V_2 so that signals will be transferred through the amplifier and it will operate as a blanking out amplifier in normal manner. However, when the potentiometer arm is moved to the other end of the battery, so as to supply a positive voltage, the tube V_3 will draw sufficient current to build up a large voltage across R_1. The biasing voltage may be sufficient to bias off tubes V_1 and V_2 completely and the gain of the amplifier will thus be reduced to zero, in spite of the signal variations in the input circuit of tube V_3 due to the normal blanking out signal. The time constant of the circuit RC should preferably be so adjusted that an appreciable time interval, say $\frac{1}{10}$ second is required for the gain of the amplifier to be reduced from its normal value to zero and vice versa.

It will be understood, of course, that various modifications may be made in the circuit. For example, the fading voltage might be inserted in

the grid circuits of V_1 and V_2 replacing the battery shown in the figure. In this case, making the bias more positive would make the amplifier conducting, whereas making it more negative would make it non-conducting. Furthermore, by inserting an additional resistance in either end of the potentiometer and adjusting the battery voltage accordingly, the rate at which pictures are faded out may be made different from the rate at which they are faded in. In addition, while preferably a potentiometer is used so that the gain of the amplifier may not only be changed from zero to some maximum value but also may be adjusted to some predetermined value, nevertheless, if desired, the potentiometer may be removed and in lieu thereof, a simple single-pole double-throw switch may be inserted and adapted to change the bias of tube V_3 so as to either set the gain of the amplifier at its normal value or reduce it to zero. Under these circumstances, the rate at which the picture fades in and out would be determined completely by the decay period of the time delay circuit RC.

Referring again to Fig. 1, it will be apparent that any number of camera tubes and a corresponding number of blanking out and fading amplifiers may be provided, and each of the several camera tubes may be energized by synchronizing signals from a common source. Each blanking out amplifier may be provided with a fader circuit such as that shown, and each fader circuit control may be located at a point remote from the blanking out amplifier. In Fig. 1, two camera tubes #1 and #2 and their associated signal channels are shown, and the respective fader controls #1 and #2 are located at a remote control point. The outputs of the several blanking out amplifiers may be all connected to the input circuit of the composite signal amplifier, and thus the change from one channel to another may be readily accomplished by fading out the then existing signal and fading in the desired new signal by appropriate manipulation of the fader controls.

While a specific form of the wide-band variable gain amplifier has been illustrated in Fig. 2, the invention is not thus limited but contemplates the use of any such wide-band amplifier having the characteristic that the amplification of one signal may be controlled by a second signal which is prevented from appearing in the output circuit and which serves only to control the amplification of the first signal without varying the frequency response. The illustration of Fig. 2 is intended simply as a preferred representative form of such an amplifier.

It will be apparent that various embodiments of the invention, other than that specifically disclosed herein, are possible and, therefore, the invention is not to be limited by the disclosure but is to be given a scope commensurate with the appended claims.

I claim:

1. In a television system, a video signal amplifier, means responsive to a control signal for varying the gain of said amplifier, means for preventing said control signal or any component thereof from appearing in the output circuit of said amplifier, and manually operable means associated with said first-mentioned means for varying the gain of said amplifier from a normal value to substantially zero and vice versa, whereby said video signal may be faded in or out, said last-mentioned means comprising a source of biasing potential and a time delay circuit connected between said source and said amplifier for applying a varying bias potential to the amplifier.

2. In a television system, a video signal amplifier, means responsive to a control signal for varying the gain of said amplifier, means for preventing said control signal or any component thereof from appearing in the output circuit of said amplifier, and manually operable means associated with said first-mentioned means for varying the gain of said amplifier from a normal value to substantially zero and vice versa, whereby said video signal may be faded in or out, said last-mentioned means comprising a source of biasing potential and a time delay circuit including a resistance and a condenser connected between said source and said amplifier for applying a varying bias potential to the amplifier.

3. In a video signal amplifier for a television system, a plurality of space discharge devices each having an input circuit, an output circuit, and an effective mutual conductance, the mutual conductance of each of said space discharge devices being dependent upon the voltage in the input circuit of the respective discharge device, means for deriving an output signal from said amplifier, another space discharge device having an input circuit and an output circuit, a common impedance in said input circuits and said output circuits, means for applying a control signal to the input circuit of said other space discharge device, to establish a control voltage across said impedance, and manually operable means associated with said other space discharge device for varying the gain of the amplifier from a normal value to substantially zero and vice versa, whereby the video signal may be faded in or out, said last-mentioned means including a source of biasing potential and a time delay circuit connected between said source and said amplifier for applying a varying bias potential to the amplifier.

4. In a wide-band amplifier for a television system, an input circuit, an output circuit, video signal amplifying means connected between said input circuit and said output circuit for transferring signals therebetween, means including an auxiliary vacuum tube for controlling the gain of said amplifying means in response to a gain control voltage, said voltage being applied to the input circuit of said tube, means for preventing said gain control voltage or any part thereof from appearing in said output circuit, manually-operable means electrically connected to said gain-control tube for varying said gain-control voltage whereby said video signal may be faded in or out, and means for automatically limiting the rate of gain variation by said manual means.

5. In a television system, a plurality of video channels, an amplifier in each of said channels, means including an auxiliary vacuum tube associated with each of said amplifiers for controlling the gain of the associated amplifiers in response to gain control voltages, said voltages being applied to the input circuits of the respective control tubes, means for preventing said gain control voltages or any parts thereof from appearing in the output circuits of the respective amplifiers, manually operable means electrically connected to each gain-control tube for varying said gain-control voltages whereby the video signal of one channel may be faded out and the video signal of another channel faded in, and vice versa, and means for automatically limiting

the rate of gain variation by said manual means.

6. In a television system, a video signal amplifier, means responsive to a control signal for varying the gain of said amplifier, means for preventing said control signal or any component thereof from appearing in the output circuit of said amplifier, manually operable means associated with said first-mentioned means for varying the gain of said amplifier from a normal value to substantially zero and vice versa, whereby said video signal may be faded in or out, and means for automatically limiting the rate of gain variation by said manual means.

7. In a television transmitter wherein it is desired to control the video signal transmission from a location other than that at which the transmitting apparatus is located, a video signal amplifier included in said transmitting apparatus and positioned at one location, means for controlling the gain of said amplifier in response to a gain-control voltage, means for preventing said gain-control voltage, or any part thereof, from appearing in the output of said amplifier, and manual control means positioned at a location spaced substantially from the location of said amplifier and electrically connected to the amplifier for varying the gain-control voltage through a sufficient range to enable fading of the video signal in or out.

PHILIP J. KONKLE.