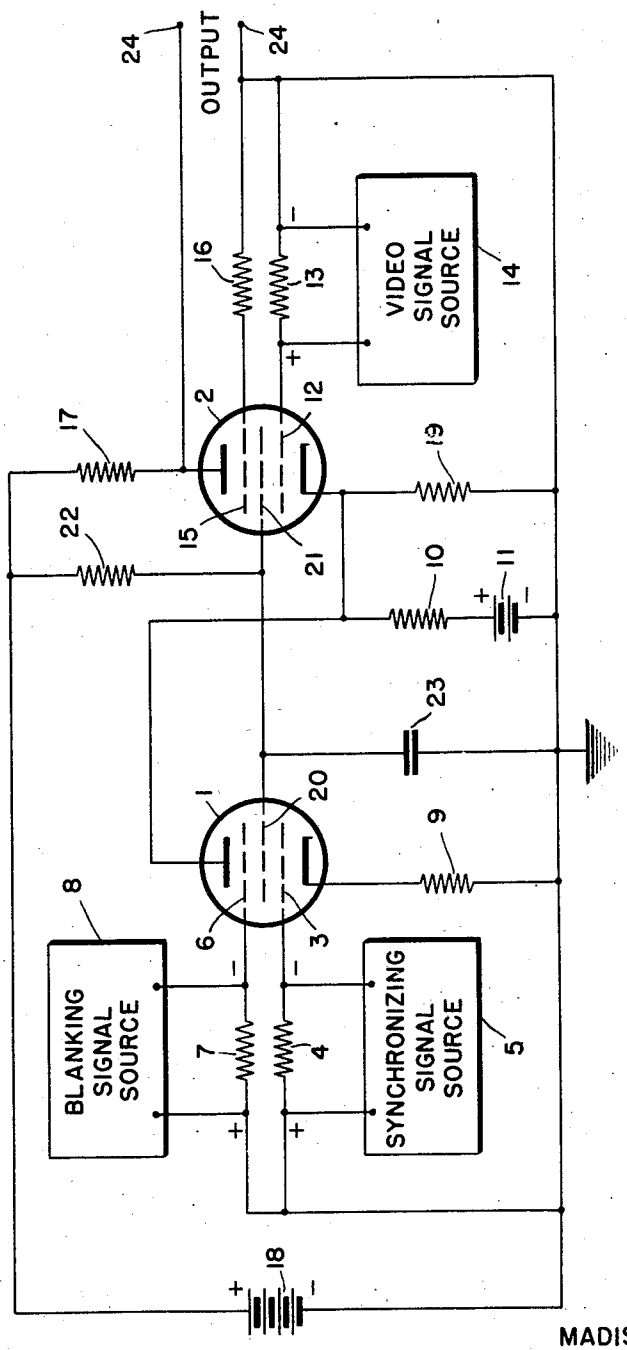
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SIGNAL MIXING AMPLIFIER

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SIGNAL MIXING AMPLIFIER

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This invention relates to mixing amplifiers and particularly to amplifiers of this character for mixing a plurality of intelligence signals to form a composite television signal.

Conventionally, in the operation of television transmitting and receiving apparatus, a composite signal is transmitted from the transmitting station to the receiving station. This composite signal includes, in addition to the video signals, other intelligence signals such as blanking and synchronizing signals for controlling the receiving device. The composite television signal is formed at the transmitter by a process commonly called signal mixing, whereby the blanking and synchronizing impulses are interspersed suitably with the video signals. This signal mixing, or more particularly the injection of the blanking and synchronizing impulses into the generated video signals, usually is accomplished in the video amplifier chain. Heretofore it has been customary to accomplish the signal mixing by either the so-called grid injection method or the so-called plate injection method.

When using the grid injection method of signal mixing, at the end of each scanning line and also at the end of each scanning field, the grid of one of the video amplifier stages is biased sufficiently negative with respect to its associated cathode to effect the complete cut-off of space current for a period equal at least to the retrace time of the scanning apparatus. In this manner any disturbance signal created by the retrace of the scanning apparatus is rendered ineffective. In some cases the biasing of the video amplifier is only sufficient to shift the reference axis about which the video signal voltages alternate. In this latter case the disturbance voltage is superimposed upon the biasing voltage and therefore is reproduced in the output circuit of the amplifier. In either case, however, the modification of the grid bias of the amplifier in the direction of plate current cutoff develops an impulse of substantial magnitude in the output circuit.

A commonly used arrangement for carrying out the plate injection method of signal mixing is one in which the anode of an injector tube is directly connected to the anode of one of the video amplifier tubes so that a common load resistor may be employed in which the mixed signal is developed.

As is well known in the art, however, a signal limiter must also be used in connection with a signal mixing amplifier operated by the grid injection method so that the amplitude of the impulses developed in the output circuit of the amplifier may be suitably reduced. In limiting the amplitude of these impulses there also is eliminated any disturbance effect which may be superimposed on the impulses. It is desirable, in the interest of utilizing the tube complement of a television transmitter at maximum efficiency, to accomplish signal mixing in a manner which will not require the use of signal limiters. While a mixer employing the plate injection method accomplishes such a result, it is not frequently used for the reason that it increases the capacitance in shunt with the common load resistor. The interelectrode capacitances of both the amplifier and injector tubes are connected in shunt across this resistor. When operating electronic amplifiers at the relatively high frequencies necessary in television systems, it is desirable to maintain this shunt capacitance at a minimum value in order not to detrimentally affect the gain of the amplifier.

There are arrangements which have been proposed to couple the anodes or plates of the amplifier and injector tubes in such a manner that the interelectrode capacitances of the tubes are not additive across the load resistor. However, these arrangements make use of additional coupling elements which require very careful adjustment. Consequently, they have met with little favor and are not widely used.

An object of the present invention, therefore, is to provide a novel mixing amplifier for forming a composite signal of two or more intelligence signals which is capable of utilizing the tube complement at maximum efficiency without reducing the amplifier gain substantially from the maximum realizable amplification.

Another object of the invention is to provide a novel mixing amplifier for forming a composite signal of two or more independent intelligence signals wherein the amplifier shunt capacitance is minimized and whereby the use of additional signal limiting devices is obviated.

In accordance with the invention there are provided in the amplifier two vacuum tubes, each having at least one space control grid. The anode circuit of one tube is coupled to the cathode circuit of the second tube so that the anode-to-cathode potential of the second tube may be modified suitably by space current amplitude changes in the first tube in a manner to disable the second tube for the reproduction in its output circuit of signal voltages impressed upon its control grid. The composite signal is developed in the anode circuit of the second tube.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, the single figure is a schematic circuit diagram of a mixing amplifier embodying the invention.

The amplifier comprises two multigrid vacuum tubes 1 and 2. As illustrated herein, these tubes are pentodes, each having, in addition to

a screen grid, the usual control and suppressor grids, either of the latter two being adapted to control the amplitude of space current conduction in the tube. It is contemplated to be within the scope and spirit of the invention that other types of tubes may be employed with equal facility in accordance with the teaching of the instant disclosure. The control grid 3 of the injector tube 1 is connected by a resistor 4 to ground. The terminals of the resistor 4 are connected to a source of synchronizing signal 5. The polarity of the voltage developed across the resistor 4 under the control of the synchronizing signal source is negative as indicated in the drawing so as to decrease the conduction of space current in the tube by an increase in the amplitude of the synchronizing signal. The suppressor grid 6 of the tube 1 also is connected by a resistor 7 to ground. The terminals of this resistor are connected to a source of blanking signal 8. The polarity of the voltage developed across the resistor 7 also is negative so as to decrease the conduction of space current in the tube by an increase in the amplitude of the blanking signal. The cathode of the tube 1 is connected by a resistor 9 to ground. The anode of this tube is connected through a load impedance device such as a resistor 10 to the positive terminal of a source of space current such as a battery 11 of which the negative terminal is connected to ground.

The control grid 12 of the mixer tube 2 is connected by a resistor 13 to ground. The terminals of this resistor are connected to a source of video signal 14. The polarity of the voltage developed in the resistor 13 is positive as indicated in the drawing so as to increase the conduction of space current in the tube 2 by an increase in the amplitude of the video signal. The supressor grid 15 of the tube 2 is connected by a resistor 16 to ground. The anode of the tube 2 is connected through a load resistor 17 to the positive terminal of a source of space current such as a battery 18, of which the negative terminal is connected to ground. The cathode of the tube 12 is connected to the anode of the tube 1 and also through an impedance device such as a cathode resistor 19 to ground.

The screen grids 20 and 21 respectively, of the tubes 1 and 2 are connected together and through a resistor 22 to the positive terminal of the battery 18. The screen grids also are bypassed to ground by a condenser 23.

The output terminals 24 of the mixing amplifier are connected respectively, to the anode of the tube 2 and to ground.

If desired, the resistors 9 and 16 may be shunted with by-pass condensers in a manner and for a purpose well known in the art. In order to simplify the drawing as much as possible such by-pass condensers have not been shown. Also, the sources of space current illustrated by the batteries 11 and 18 may be derived from a single source in any well known manner.

Referring now to the operation of the illustrative embodiment of the invention, the voltage developed across the grid resistor 13 represents the video signal during a scanning period and also represents any disturbance effect created during the retrace period of the scanning apparatus. During a scanning period the voltages developed in the grid resistors 4 and 7, associated with the tube 1 are at their minimum negative values so that grids 3 and 6 are biased with respect to the cathode of this tube in a manner to effect the conduction of space current in the tube of substantial amplitude. The potential of the anode of this tube then has a relatively low positive value with respect to ground. Consequently, the cathode of the tube 2 also has a low positive value with respect to ground.

If it is assumed that the minimum positive voltage developed in the resistor 13 by the video signal source 14 represents black in the picture to be reproduced, the conduction of space current through the tube 2 will be at a minimum value. Consequently, the potential of the anode of this tube is at its maximum positive value with respect to ground to represent picture black at the time when tube 1 is conducting maximum space current during a scanning interval. As the voltage across resistor 13 increases to represent whiter portions of the picture the space current conduction in the tube 2 increases correspondingly. Thus, the positive anode potential of this tube with respect to ground decreases in like manner.

At the end of each scanning line and again at the end of each scanning frame a blanking signal and a sychronizing signal are generated by their respective sources 8 and 5. In accordance with well known practice the blanking signal is of somewhat longer time duration than the synchronizing signal. Consequently, the blanking signal is the first and also the last of these two signals to alter the conduction of space current in the tube 1. The synchronizing signal is effective to additionally alter the space current conduction in this tube while the blanking signal is still effective.

As soon as the negative voltage developed in the resistor 7 increases in response to the blanking signal source, the suppressor grid 6 is rendered more negative with respect to the cathode of this tube to decrease the magnitude of space current conduction. The voltage drop through the resistor 10 thereby is decreased by a predetermined amount to increase the positive potential of the anode of tube 1 and the cathode of tube 2 with respect to ground. In this manner the effective anode-to-cathode voltage of the tube 2 is decreased in sufficient amount to effect plate current saturation for all voltages of the control grid in excess of those representing black in the picture to be reproduced. Consequently, regardless of any disturbance voltages developed in the resistor 13 during the retrace period of the scanning apparatus, the magnitude of the space current conduction in the tube 2 is unaffected. The magnitude of this current is appropriate to develop a positive impulse at the output terminals 24 of a predetermined amplitude desired to represent a blanking signal.

When, subsequently, as increased negative voltage is developed in the resistor 4 under the control of the synchronizing source 5, the conduction of space current in the tube 1 is reduced further. As a consequence, the potential of the anode of tube 1 and the cathode of tube 2 is increased positively with respect to ground. The increased positive potential of the cathode of tube 2 still further decreases the effective anode-to-cathode potential of this tube. The tube, of course, is still operated at saturation so that the voltages developed in the resistor 13 are ineffective to alter the magnitude of the space current. The space current in the tube, however, is less than that permitted to flow under the sole control of the blanking signal. Consequently, there is effected an additional increase in the positive

potential of the anode with respect to ground. This increased potential produces another impulse at the output terminals 24 which is superimposed upon the blanking impulse. Also, by suitably controlling the degree of modification of the space current of tube 1 by the synchronizing signal source 5, the amplitude of the superimposed impulse developed at the output terminals may be made proper to represent a synchronizing signal.

The synchronizing signal impulse is terminated as soon as the voltage developed across the resistor 4 is permitted by the source 5 to return to normal. Similarly, the blanking signal impulse is terminated when the voltage developed in the resistor 7 is permitted to return to normal by the source 8. The control of the space current in tube 2 is then returned to the video signal source 14, whereby it is caused to fluctuate by variations of the voltage impressed upon the control grid 12.

By reason of the described interconnection of the anode of tube 1 and the cathode of tube 2, the anode potential of the tube 1 is maintained at all times at a relatively low value. Consequently, the tube 1 is driven into the space current saturation region by relatively small changes in the magnitude of either of the control grid voltages derived from the synchronizing and blanking signal sources 5 and 8 respectively. Thus, this arrangement affords a convenient and effective device for limiting the amplitude of the blanking and synchronizing signal components of the developed composite television signal. The limiting levels for the blanking and synchronizing signals may be determined as desired by suitably adjusting the amplitude of the voltage derived from the battery 18.

While it will be understood that the circuit specification of a mixing amplifier embodying this invention may vary according to the requirements of the particular television system in which it is employed, the following circuit specifications for the illustrative embodiment of an amplifier of this character are included, by way of example only:

Vacuum tube 1		6AC7
Vacuum tube 2		6AC7
Resistor 4	ohms	10,000
Resistor 7	do	100,000
Resistor 9	do	50
Resistor 10	do	10,000
Battery 11	volts	300
Resistor 13	ohms	3,000
Resistor 16	do	1,000
Resistor 17	do	3,000
Battery 18	volts	300
Resistor 19	ohms	440,000
Resistor 22	do	15,000
Condenser 23	microfarads	20

It is evident that an amplifier in accordance with this invention provides a means for inserting blanking and/or synchronizing signals into a video signal in a manner in which the capacitance connected across the load resistor 17 is limited to the interelectrode capacitance of the mixer tube 2. The interelectrode capacitance of the injector tube 1 is connected across the cathode resistor 19 where it does not affect the load resistor 17. Also, it is apparent that the connection of the output circuit of the tube 1 to the cathode circuit of the tube 2 renders the amplifier susceptible of operation in a manner to effect any desired limiting of the amplitude of the blanking and synchronizing signals.

It will be obvious to those skilled in the art that the invention may be practiced by the connection of the various types of signals to space current control circuits of the respective amplifier tubes other than those illustrated. For example, either the blanking or synchronizing source 8 or 5 respectively, may be connected in proper polarity across the resistor 16, in which case the suppressor grid 15 of the tube 2 would be effective to control the space current in this tube in accordance with the signal impressed thereon.

In practicing the instant invention it is not essential that both the vertical and horizontal synchronizing signals be derived from a single source such as the synchronizing signal source 5. The present invention makes it possible to insert the vertical and horizontal synchronizing signals separately. For example, the vertical synchronizing signal may be impressed upon the control grid 3 of the tube 1 in the manner illustrated and the horizontal synchronizing signal may be impressed in proper polarity upon the suppressor grid 15 of the tube 2. A similar arrangement with respect to the two usual types of blanking signals also is contemplated to be within the scope of the present invention.

It, therefore, should be apparent, in view of the described embodiment of the invention, that the invention also is susceptible of embodiment in an amplifier using other familiar types of multi-grid tubes to effect the mixing of any predetermined number of different signals for the formation of a single composite signal. For example, five such signals may be combined in the manned described, the five signals representing respectively, horizontal and vertical blanking signals, horizontal and vertical synchronizing signals and the video signals.

While there has been described what, at present, is considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An amplifier for forming a composite signal consisting of a plurality of different types of intelligence signals comprising, a first vacuum tube having an anode, a second vacuum tube having an anode and a cathode, means including a source of a first type of intelligence signal for varying the amplitude of the space current of said second tube, means including a source of a second type of intelligence signal for varying the amplitude of the space current of said first tube, means coupling the anode of said first tube with the cathode of said second tube for varying the potential of the cathode of said second tube in correspondence with the space current amplitude variation of said first tube in a manner to effect a corresponding space current amplitude variation of said second tube and to render the source of said first type of signal ineffective to produce space current amplitude variations of said second tube, and an output circuit connected to the anode of said second tube for the development therein of said composite signal.

2. An amplifier for forming a composite signal consisting of a plurality of different types of intelligence signals comprising, a first vacu-

um tube having an anode, a second vacuum tube having an anode and a cathode, means including a source of a first type of intelligence signal for varying the amplitude of the space current of said second tube in correspondence with said first type of signal, means including a source of a second type of intelligence signal for effecting a first variation in the amplitude of the space current of said first tube in correspondence with said second type of signal, means including a source of a third type of intelligence signal for effecting a second variation in the amplitude of the space current of said first tube in correspondence with said third type of signal, means including a conductive coupling between the anode of said first tube and the cathode of said second tube for varying the potential of the cathode of said second tube in correspondence with the space current amplitude variations of said first tube in a manner to effect corresponding space current amplitude variations of said second tube and to render the source of said first type of signal ineffective to produce space current amplitude variations of said second tube, and an output circut connected to the anode of said second tube for the development therein of said composite signal.

3. An amplifier for forming a composite signal consisting of two different types of intelligence signals comprising, a first vacuum tube having an anode and a space current control grid, a second vacuum tube having an anode, a cathode and a space current control grid, means including an impedance device common to the anode of said first tube and to the cathode of said second tube for causing variations of the space current conduction in said first tube to vary the cathode voltage of said second tube, means for impressing said two types of intelligence signals upon the respective control grids of said vacuum tubes, and an output circuit connected to the anode of said second tube for the development therein of said composite signal.

4. An amplifier for forming a composite signal consisting of two different types of intelligence signals comprising, a first vacuum tube having an anode and a space current control grid, a second vacuum tube having an anode, a cathode and a space current control grid, an impedance device connected to the anode of said first tube and to the cathode of said second tube in series with said second tube, means for impressing said two types of intelligence signals upon the respective control grids of said vacuum tubes, and an output circuit connected to the anode of said second tube for the development therein of said composite signal.

5. An amplifier for forming a composite signal consisting of two different types of intelligence signals comprising, a first vacuum tube having an anode and a space current control grid, a second vacuum tube having an anode, a cathode and a space current control grid, a load impedance device connected to the anode of said first tube in series with said first tube, an impedance device connected to the cathode of said second tube in parallel with said load impedance device, means for impressing said two types of intelligence signals upon the respective control grids of said vacuum tubes, and an output circuit connected to the anode of said second tube for the development therein of said composite signal.

6. An amplifier for forming a composite television signal consisting of video, blanking and synchronizing signals comprising, two vacuum tubes each having a space current control grid, a cathode and an anode, and one of said tubes having a second space current control grid, a blanking signal source connected to a first one of said control grids, a synchronizing signal source connected to a second one of said control grids, a video signal source connected to the third one of said control grids, an impedance device connected to the anode of one of said tubes and to the cathode of the other of said tubes in series with said other tube, and an output circuit connected to the anode of said last named tube for the development therein of said composite television signal.

7. An amplifier for forming a composite television signal consisting of video, blanking and synchronizing signals comprising, two vacuum tubes each having two space currents control grids, a cathode and an anode, a blanking signal source and a synchronizing signal source connected in like polarities to the respective control grids of one of said tubes, a video signal source connected to a control grid of the other of said tubes in opposite polarity to said blanking and synchronizing signal connections, a resistor connected to the anode of one of said tubes and to the cathode of the other of said tubes in series with said other tube, and an output circuit connected to the anode of said last named tube for the development therein of said composite television signal.

8. An amplifier for forming a composite television signal consisting of video, blanking and synchronizing signals comprising, a first vacuum tube having two space current control grids and an anode, a blanking signal source and a synchronizing signal source connected in like polarities to the respective control grids of said first tube, a second vacuum tube having an anode, a cathode and a space current control grid, a resistor connected to the cathode of said second tube and to the anode of said first tube in series with said first tube, a video signal source connected to the control grid of said second tube in opposite polarity to said blanking and synchronizing signal connections, and an output circuit connected to the anode of said second tube for the development therein of said composite television signal.

9. An amplifier for forming a composite television signal consisting of video, blanking and synchronizing signals comprising, a first vacuum tube having two space current control grids and an anode, a blanking signal source connected in negative polarity to one of the grids of said first tube, a synchronizing signal source connected in negative polarity to the other of the grids of said first tube, a source of space current connected to the anode of said first tube, a second vacuum tube having an anode, a cathode and a space current control grid, a resistor connected to the cathode of said second tube and to the anode of said first tube, a video signal source connected in positive polarity to the grid of said second tube, a source of space current connected to the anode of said second tube and to said cathode resistor, and an output circuit connected to the anode of said second tube for the development therein of said composite television signal.

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