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K. R. WENDT

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TELEVISION APPARATUS

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FIG. 1.

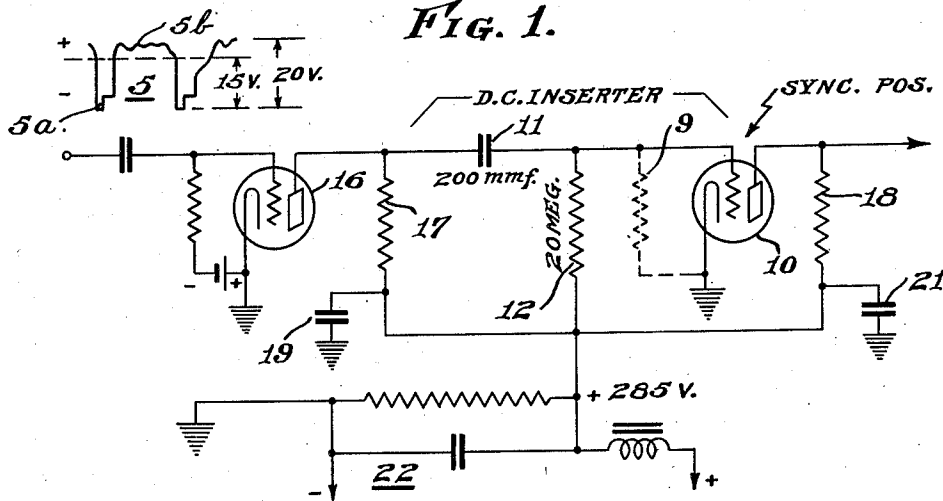


FIG. 2.

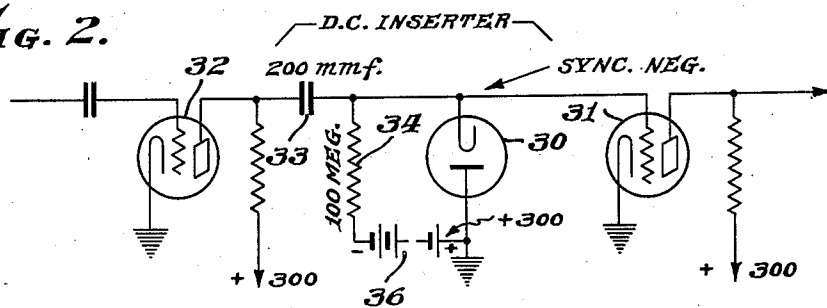
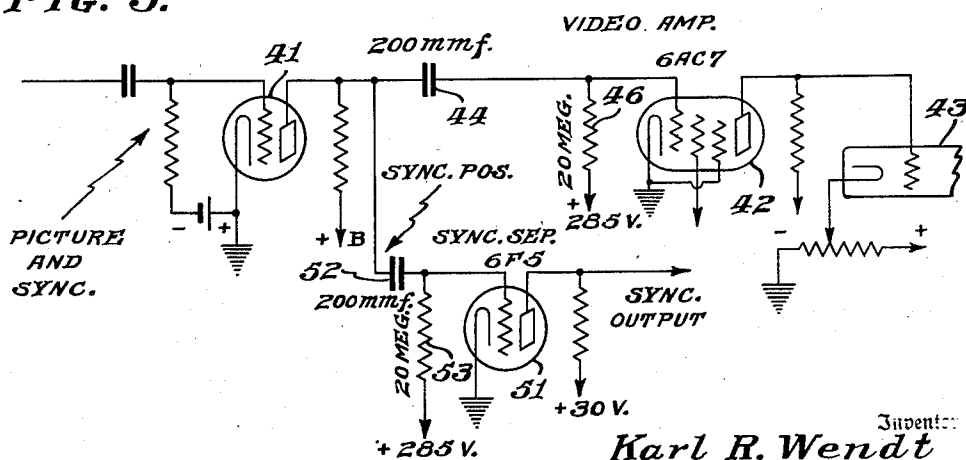


FIG. 3.



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8 Claims. (Cl. 178—7.1)

The present invention is a continuation in part of my application Serial No. 350,477, filed August 3, 1940, entitled Television system. It relates to television apparatus and particularly to circuits for inserting the direct current and/or low frequency components of a signal. These circuits also function to correct for the presence of undesired hum or the like and may be utilized for various purposes such as signal amplification or synchronizing pulse separation.

In television transmitters and receivers, it usually is desirable to reinsert D.-C. and/or low frequency components of the television signal after the signal has passed through an alternating current amplifier. One of the circuits frequently employed for this purpose comprises a grid-leak biased tube in which the grid is driven positive periodically by the synchronizing pulses to produce pulses of grid current. The time constant of the grid circuit is such that only a slight amount of the charge put on the grid condenser by the grid current leaks off between successive synchronizing pulses. A D.-C. insertion circuit of this design is described in Patent No. 2,194,514, issued March 26, 1940, to Willans et al.; a similar circuit for separation of synchronizing pulses from picture signals is described in Tolson Patent 2,207,839, issued July 16, 1940.

While the above-described circuit has been found very useful and has been widely used both because of its good operation and because of its simplicity, it cannot operate as perfectly as desired under some operating conditions. For example, if the grid circuit time constants are adjusted to give good restoration of the D.-C. and very low frequency components, the circuit may be too slow acting to insert any missing higher frequency components or to remove undesired 60 cycle or 120 cycle hum or the like. Also, the circuit used by Willans et al. and Tolson has a tendency to remove or clip off differing amounts of the top portion of the synchronizing pulses for differing amplitudes of applied signal, the amount clipped off representing the amount of power dissipated in the circuit—principally in the grid leak resistor.

It is an object of the present invention to provide an improved direct current and/or low frequency insertion or signal correction circuit of the general character described above.

A further object of the invention is to provide an improved means for and method of reinserting lost frequency components of a signal having periodically recurring control pulses or

otherwise providing corrections in a signal of this character.

A further object of the invention is to provide an improved circuit of simple design for direct current insertion, low frequency signal correction, synchronizing pulse separation, or the like.

A still further object of the invention is to provide an improved synchronizing pulse separation circuit.

In one of the preferred embodiments of the present invention a grid-leak biased tube is employed, but the grid leak resistor, instead of being connected to ground or to cathode potential, is connected to a positive bias voltage. Also, the resistance of grid-leak resistor preferably is increased enough to hold the current flowing through it to about the same value as in the design with the resistor going to cathode potential.

In another embodiment of the invention, a diode having its plate connected to the positive terminal of a bias source is employed in place of an amplifier tube. This circuit may be desirable if the synchronizing pulses happen to be of negative polarity at the desired point of D.-C. insertion.

The invention will be better understood from the following description taken in connection with the accompanying drawing, in which

Figures 1 and 2 are circuit diagrams of two different embodiments of the invention applied to television apparatus for direct current insertion or the like, and

Figure 3 is a circuit diagram illustrating the application of my invention to a television receiver both for direct current insertion (background control) and for synchronizing pulse separation.

Referring to Fig. 1, there is shown an embodiment of the invention which may be employed either in a radio transmitter or in a radio receiver. This circuit comprises an amplifier tube 10 of the high vacuum type having in its input circuit a grid condenser 11 and a grid leak resistor 12. In accordance with the present invention, the grid leak resistor 12 has an unusually high resistance, 20 megohms, for example, and is connected to a positive biasing voltage instead of to ground.

Because of the very high resistance of the grid leak resistor 12, the leakage resistance (indicated at 9) in the tube socket, etc., is not negligible. It is, of course, a variable quantity since it depends upon humidity and other variable conditions, but, as explained hereinafter, this variation is

accompanied by a compensating voltage variation whereby stable operation results.

Preferably, the resistance of the grid leak resistor 12 is made high enough to keep the current flow therethrough about the same in this positively biased circuit as it would be if the circuit without positive bias, as described by Willans et al., were used. Although the grid leak resistor 12 is connected to the positive plate voltage of 285 volts in the example illustrated, the actual bias on the grid of the tube 10, when there is no incoming signal, is about 1 volt negative, just as in the case where the grid leak resistor goes to cathode potential. This negative voltage is due to initial electron velocity and contact potential. Obviously, if the grid resistor current is kept the same for both cases, the grid voltage must be the same.

The television signal indicated at 5 may be supplied to the D.-C. inserter or signal correction circuit through an alternating current amplifier such as a resistance coupled amplifier 16. Both the amplifier tube 16 and the tube 10 are supplied with plate voltage through plate resistors 17 and 18, respectively. The usual by-pass condensers are shown at 19 and 21.

The plate voltage source may be a conventional rectifier-filter unit 22, this source being used also for the positive bias on the grid of the D.-C. inserter tube 10 in this particular example of the invention.

It will be understood from the foregoing description that the circuit of Fig. 1 operates on the same general principle as the circuit described in the Willans et al. patent, where the grid leak resistor is connected to cathode potential instead of to a positive bias voltage. Specifically, the control or line synchronizing pulses indicated at 5a are of positive polarity on the grid of the tube 10 and drive the grid slightly positive with respect to its cathode to produce a flow of grid current which puts a direct current charge on the grid condenser 11.

At the end of each synchronizing pulse the condenser 11 discharges slightly through the plate resistor 17 and the grid leak resistor 12, the current flow through resistor 12 being in the direction to apply a negative bias to the grid of the tube 10 between synchronizing pulses. When the tube 10 is being employed for D.-C. insertion, as in the case of Fig. 1, this negative bias between synchronizing pulses is such as to bias the tube 10 for operation as a linear amplifier, just as in the Willans et al. circuit, whereby the picture signal itself, indicated at 5b, is amplified without distortion by the tube 10.

It has been found in practice that my improved circuit has certain advantages over the above-mentioned Willans et al. circuit. These advantages may be noted as follows: In the Willans et al. circuit, in which the grid leak resistor is returned to cathode potential, the total direct current voltage appearing across the grid leak resistor is rectified from the signal. In the example illustrated in Fig. 1, this signal voltage is assumed to be 15 volts, this being the peak voltage of the synchronizing pulses measured from the A.-C. axis of the signal. Since the signal voltage commonly varies as much as 10:1, and since the power dissipated varies as the square of this voltage, the variation in power dissipation under these circumstances varies 100:1. This means that the area of that peak portion of each synchronizing pulse extending into the conduction region to produce grid current flow would

also vary 100:1 if the grid-cathode portion of the tube 10 (which portion functions as a diode) had a linear characteristic. Actually this diode characteristic would not be linear, but there would still be a very large variation in the area of successive synchronizing pulses extending into the conduction region. It follows that successive synchronizing pulses are clipped off varying amounts in the circuit previously used, this being undesirable both in the case where the tube is being employed for synchronizing pulse separation and in the case where it is being employed in an amplifier for A.-C. insertion.

This objectionable feature is largely avoided by the present invention, since the D.-C. voltage appearing across the grid leak resistor that is rectified is the positive bias voltage plus the signal voltage or, in the example of Fig. 1, 300 volts. Therefore, the maximum possible variation is $300^2:285^2$, or 1.1:1. Thus, all synchronizing peaks extend substantially the same amount into the conduction region, and the undesirable variations in synchronizing pulse amplitude are avoided.

With respect to the operation of my improved circuit for direct current insertion or for some other form of signal correction, a more important fact is that the grid condenser 11 can discharge much quicker at the termination of a synchronizing pulse than in the case where the grid leak resistor is returned to cathode potential, because the voltage on this grid condenser approaches ground potential linearly rather than exponentially, as it does when the grid condenser discharges to ground potential as a limit rather than to the positive bias potential as a limit. As a result, the circuit operates faster whereby it recovers from noise and reductions in signal level much faster.

As previously mentioned, the grid leak resistor 12 preferably is given a resistance such that the current flow through it is about the same as in the older circuit where the grid leak resistor is returned to cathode potential. For example, in the older circuit, assuming the signal voltages indicated in Fig. 1 and assuming a grid leak resistance of 1 megohm, the current through the grid leak would be 15 volts divided by 1 megohm, or 15 microamperes. The present invention can be applied to this older circuit as follows: Assuming a positive bias voltage of 285 volts, the grid leak resistance should be 285 volts plus 15 volts, divided by 15 microamperes, or 20 megohms. While the improved circuit may be designed in this manner in terms of the Willans et al. circuit, it should be understood that the grid leak current may be considerably different from that indicated above. For instance, the circuit has been found to give good results with a grid leak resistor of 100 megohms and with the other values the same as indicated in Fig. 1.

The value of the positive bias voltage is not critical and may be a great deal less than 285 volts, providing a corresponding change is made in the value of the grid leak resistor 12. The value of positive bias voltage that should be used also depends to a certain extent upon the voltage swing of the applied signal. However, assuming, by way of example, that there is a total voltage swing of 20 volts, as indicated in Fig. 1, there will be a marked improvement in operation as compared with the operation of the Willans et al. circuit if a positive bias voltage of 10 volts is applied. Increasing the bias voltage to 15 volts will result in an additional marked improvement in circuit operation. As the positive volt-

age bias becomes more than two or three times the peak voltage of the synchronizing pulses as measured from the A.-C. axis, the added improvement in circuit operation is slight. For example, in the circuit of Fig. 1, the bias voltage may be decreased from the 285 volts indicated to 100 volts without much change in the circuit operation, providing the grid leak resistor 12 is decreased in value a substantially corresponding amount—that is, decreased approximately one-third. It will be understood, of course, that a slightly different circuit operation may be found desirable and may be obtained merely by decreasing the bias voltage to 100 volts, for example.

With respect to the value of the grid condenser 11, its value is not critical, but in practice where the circuit is employed for direct current insertion, it usually is desired to give this condenser a small capacity value such as 200 micro-microfarads, as indicated in the drawing. This gives a faster acting circuit which will correct, for example, for the absence of a 60-cycle picture component, for the presence of an undesired 60-cycle hum, or for the absence or presence of other low frequency components. It will also correct for frequencies up to about one-tenth the scanning line frequency or, in the present example, up to about 1000 cycles per second. One of the advantages of the present invention is that it permits the use of a grid condenser 11 of small capacity whereby the circuit is made faster acting to give good correction at frequencies such as 60 cycles and above without making the circuit rather poor in operation for insertion of direct current and of the lower frequency picture components, such as picture components of 6 cycles per second, for example.

It will be understood that, just as in the case of the circuit where the grid leak resistor is returned to cathode potential, it may be desirable to use different grid condenser capacities under different conditions of operation. It may be said, by way of example, that it has generally been found that the capacity of the grid condenser should be somewhere from 200 micro-microfarads to 1000 micro-microfarads. On the other hand, it may be desirable to give the grid condenser a capacity as high as 0.1 microfarad in cases where the circuit is to re-insert substantially only the direct current component and is not required to make any correction for frequencies in the order of 60 cycles or above.

It has already been mentioned that even though the resistance of the grid leak resistor 12 is very high, it has been found that there is very little change in the circuit characteristics as a result of changes in the value of the leakage resistance indicated at 9. The reason for this appears to be that the grid leak resistor 12 and the leakage resistance 9, in effect, are connected across the voltage divider of the power supply 22 whereby the grid of the tube 10 is connected to a point on a potentiometer formed by these two resistors. The result is that any change in the value of the leakage resistance 9 results in a change in the effective positive bias voltage, this change being in the direction to compensate for a change in the leakage resistance.

Referring to Fig. 2, I have shown the invention applied to a direct current inserting circuit of the type utilizing a diode 30 in place of the grid-cathode portion of a triode pentode, or the like. In the previously mentioned Willans et al. patent, there is described a type of circuit employing a diode as well as the other type of circuit oper-

ating by the grid-leak biasing action. However, in both types of Willans et al. circuits, a resistor is connected directly across the electron emitting electrode and its associated electrode—that is, directly across the cathode and the anode, in the case of the diode circuit, and directly across the cathode and the control grid in the case of the grid leak biased circuit.

In accordance with the invention illustrated in Fig. 2, the diode 30 is connected across the input circuit of an amplifier tube 31 and signal is supplied thereto from an alternating current amplifier 32 through a coupling condenser 33. A resistor 34 of very high impedance is connected between the cathode and the anode of the diode 30 and in series with a biasing battery 36 which has its positive terminal connected to the anode of the diode 30.

In the example illustrated, the cathode of the diode 30 is connected to the high potential side of the circuit, since this circuit is designed for operation where the synchronizing pulses are of negative polarity at this point.

The operation of the above-described diode circuit is similar to the operation of the circuit shown in Fig. 1, and the comments made regarding the values of various circuit constants in Fig. 1 apply also to the circuit of Fig. 2.

Referring to Fig. 3, the invention has been applied to a television receiver in which the mixture of picture signal and synchronizing pulse is supplied through video amplifiers 41 and 42 to the input circuit of a cathode ray receiver tube 43. The last video amplifier stage 42 has a grid condenser 44 and a grid leak resistor 46 having capacity and resistance values such as to provide good D.-C. insertion whereby automatic background control of the received picture is obtained. The circuit values and the positive bias voltage indicated on the drawing by way of example are the same as those indicated for the D.-C. inserter shown in Fig. 1.

In Fig. 3, I have also shown the invention applied to a synchronizing pulse separating circuit which is so designed as to exclude picture signals and pass substantially only the synchronizing pulses to the cathode ray tube deflecting circuits (not shown). This separating circuit includes a tube 51 and operates in the same basic manner as the separating circuit described in the previously mentioned Tolson patent, but operates more effectively as a result of the present invention being included.

The mixture of picture signal and synchronizing pulse is fed from the output of the amplifier 41 through a coupling or grid condenser 52 to the control grid of the separating tube 51 with the synchronizing pulses of positive polarity. The grid leak resistor 53 has a very high resistance such as 20 megohms, for example, and has its lower end connected to the positive terminal of a biasing source just as in the D.-C. inserter circuits previously described.

The operation of the synchronizing separator tube 51 is similar to the operation of the D.-C. inserting circuits and is, in fact, itself a circuit which inserts direct current and low frequency signal components and which will, like the previously described circuits, remove certain undesired components, if present, such as undesired 60-cycle hum. The main difference in the operation of the synchronizing separator tube 51 and the previously described circuits is that the tube types and circuit values are so adjusted and the signal is fed to the separator tube with such amplitude

that the separator tube 51 is biased beyond cut-off for the picture signal portion of the applied signal and passes only the more positive synchronizing pulses. In Fig. 3, the separator tube 51 may be a type 6F5 which biases off sooner than does the amplifier 42, which may be of the 6AC7 type. Also, less than normal voltage is applied to the plate of the separator tube to increase this difference in the operation of tubes 51 and 42.

As previously mentioned, the present invention is especially desirable in a synchronizing pulse separating circuit, since it does not clip off the tops of the synchronizing pulses substantially varying amounts in the process of holding the tops of the pulses at a fixed voltage value with respect to ground, or, stated differently, in the process of inserting the D.-C. component and correcting for the absence of desired low frequency components or for the presence of undesired hum frequencies or the like.

From the foregoing it will be seen that my invention substantially improves the operation of certain types of circuits previously employed for producing a picture signal containing only the desired components.

In actual practice, the low frequency and direct current error in a signal may be reduced practically to zero by employing my invention. It may be noted, however, that in a television system employing a slotted vertical synchronizing pulse of long duration, there is an error introduced by the vertical pulse although it is much less with the present circuit than with the older Willans et al. circuit.

This error is generally referred to as a "depressed vertical pulse," since on an oscillograph the vertical pulse appears depressed or below the level of the horizontal synchronizing pulses. The amount of such an error is the difference between the saw-tooth components produced across the grid condenser of the D.-C. inserting circuit during the occurrence of horizontal synchronizing pulses and during the occurrence of a vertical synchronizing pulse, it being understood that a certain saw-tooth is unavoidable because of the slow grid condenser discharge at the end of the positive voltage pulse. At the end of a horizontal synchronizing pulse there is a comparatively long period for discharge, whereas at the end of a portion of the slotted vertical synchronizing pulse and during the occurrence of the slot there is a comparatively short period for discharge. Since the grid condenser never receives full charge in spite of the fast time constant of the charging circuit, the result is that the saw-tooth component is smaller during the vertical pulse than during the preceding time whereby the vertical pulse is depressed some.

With respect to the error introduced by the long duration vertical pulse, the following example may be noted:

According to a preferred standard of television signal transmission, only a short interval is used for the horizontal or line synchronizing pulse. This pulse lasts for 8% of one line or approximately 6 microseconds. During the remainder of the line, which is devoted to the picture signal, the grid condenser 11 (Fig. 1) discharges. This interval lasts for approximately $69\frac{1}{2}$ microseconds. During the vertical blanking interval, several lines are devoted to the actual slotted vertical synchronizing pulse. During this vertical pulse, a pulse portion lasts a long time or approximately 37 microseconds and the slots, which provide the horizontal synchronizing, last for ap-

proximately 6 microseconds. The grid condenser 11 thus has only 16% of the time for discharge during this interval, as compared with 92% of the time during the preceding picture scanning interval. Since the grid condenser 11 discharges at substantially a constant rate, the actual voltage of the saw-tooth during this vertical or return-line interval is much smaller than that occurring during the picture scanning interval. The effect that this will have on the corrected signal will depend on the ratio of the saw-tooth voltage during these intervals to the picture voltage. For practical purposes, the amount which the vertical synchronizing signal is depressed below the peaks of the horizontal synchronizing pulses during the picture scanning interval can be made negligibly small and, at the same time, the circuit may be made fast enough so that it will follow all normal changes in signal levels.

I claim as my invention:

1. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the direction to cause current flow between said electrodes, the polarity of said pulses also being in the direction to cause current flow between said electrodes to charge said condenser, and the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

2. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the direction to cause current flow between said electrodes and having an amplitude greater than the peak to peak amplitude of said signal, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

3. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the

direction to cause current flow between said electrodes and having an amplitude at least twice the maximum peak to peak amplitude of said signal, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, and the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

4. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor having a resistance of at least 10 megohms connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the direction to cause current flow between said electrodes and having an amplitude at least twice the peak to peak amplitude of said signal, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, and the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

5. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor having a resistance greater than 5 megohms connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the direction to cause current flow between said electrodes and having a value of at least 50 volts, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

6. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity

in the direction to cause current flow between said electrodes, the relative values of said bias voltage and said resistor resistance being such that said second electrode remains at a low negative voltage for the condition of no signal input, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, and the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

7. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the direction to cause current flow between said electrodes and having a certain amplitude, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, said resistor having sufficient resistance so that, for a given value or amplitude of biasing voltage, the voltage on said second electrode during the condition of no signal input is due primarily to the initial velocity of electrons from said emissive electrode and to contact potential, the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

8. In a television system in which there is a signal including periodically recurring pulses of greater amplitude than the signal between said pulses, an electric discharge device having an electron emissive electrode and a second electrode associated therewith, a condenser connected for supplying said signal therethrough to one of said electrodes, and a resistor connected from the junction point of said condenser and said one electrode to the other of said electrodes and also connected in series with a source of biasing voltage, said biasing voltage having a polarity in the direction to cause current flow between said electrodes and having an amplitude greater than the peak to peak amplitude of said signal, the polarity of said pulses being in the direction to cause current flow between said electrodes to charge said condenser, said resistor having sufficient resistance so that, with said value of biasing voltage, the voltage on said second electrode for the condition of no signal input is due primarily to the initial velocity of electrons from said emissive electrode and to contact potential, the time constants for the charge and discharge circuits of said condenser being such that its direct current charge holds over a substantial amount between successive pulses.

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