March 8, 1949. A. V. BEDFORD 2,463,735

SPLIT CHANNEL DIRECT-CURRENT INSERTION NETWORK

Filed March 17, 1945

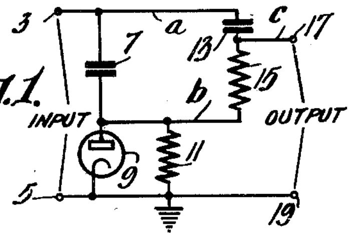


Fig. 1.

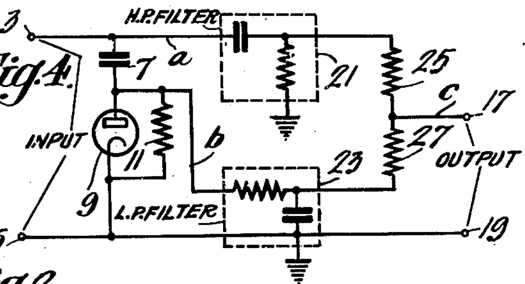


Fig. 4.

Fig. 2.

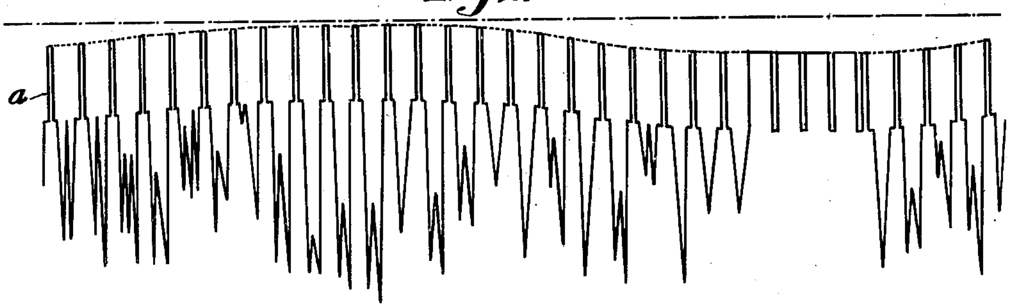


Fig. 3.

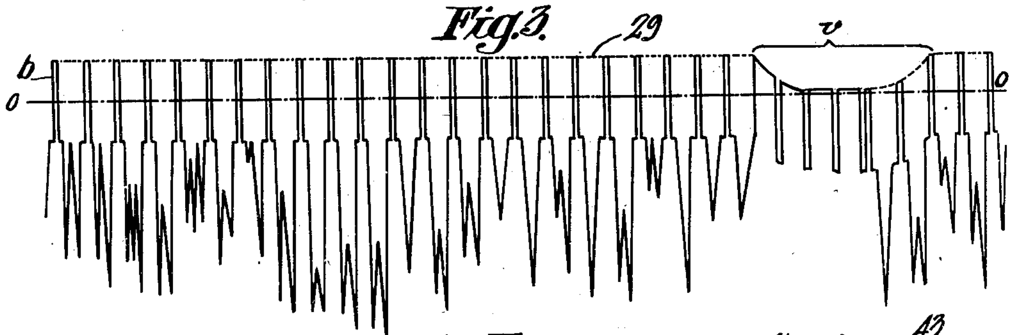
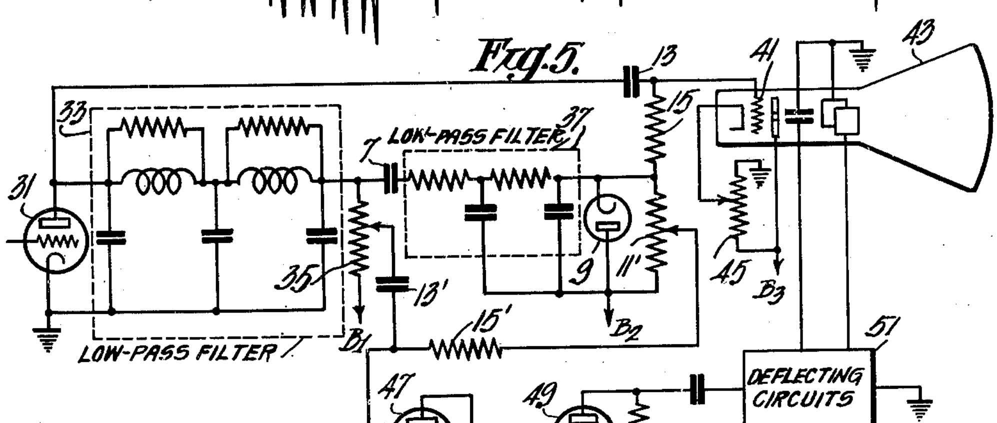


Fig. 5.



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Patented Mar. 8, 1949

2,463,735

UNITED STATES PATENT OFFICE

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SPLIT CHANNEL DIRECT-CURRENT INSERTION NETWORK

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Application March 17, 1945, Serial No. 583,343

3 Claims. (Cl. 178—7.3)

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This invention relates generally to signal correction networks and more particularly to an improved method of and means for correcting for spurious low frequency modulation components in a signal communication system and for substantially eliminating spurious high frequency signal components normally introduced by D.-C. insertion networks.

The invention will be described by reference to circuits suitable for use in a television receiving system wherein D.-C. insertion is required for the received video signals to compensate for spurious low frequency modulation and low frequency infidelity of the received signal to provide an accurate value of the mean brightness of the received picture.

It is well known that the D.-C. and low frequency components of a television picture which are lost or distorted in transmission may be reconstructed at the receiver by means of a capacitor serially interposed between the video amplifier and the television kinescope tube in combination with a diode peak detector connected in shunt with the kinescope circuit. In this combination the diode draws current during the peaks of the synchronizing signals, thereby creating a control bias for the control electrode of the kinescope which provides the desired D.-C. signal component. However, noise peaks also cause the diode to draw current, thereby providing false values of D.-C. insertion. Also, since the vertical synchronizing pulses of the television signal are of substantially longer time duration than the horizontal synchronizing pulses, the control bias values for the different types of synchronizing signals vary substantially. The longer duration vertical synchronizing signal tends to depress abruptly the control signal level. Hence, in conventional circuits the vertical synchronizing pulses even may not properly actuate the vertical synchronizing circuits.

The instant invention contemplates the use of a split-channel D.-C. restoring network wherein the low frequency or D.-C. spurious components of the received signal are effectively restored, and at the same time the spurious high frequency components normally introduced by the D.-C. restoring circuit are substantially eliminated from the picture signal employed to modulate the intensity of kinescope tube cathode ray. This feature is accomplished by combining, through complementary filter systems, only the low-frequency components of the restored picture signal with complementary high-frequency components of the initial signal to form therefrom a complete, substantially accurate, video signal which may be employed to modulate the kinescope tube and to actuate the synchronizing circuits. The complementary filtering is such that the sum of the signal response from the two filter systems is uniform for all frequencies in a selected frequency band. Thus, in operation the vertical synchronizing pulses tend to maintain the same signal level as the horizontal synchronizing pulses, since the variations in the levels of the synchronizing pulses in conventional systems comprise spurious components which are predominately high frequency in character.

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The instant invention is an improvement upon the system described in applicant's copending U. S. application, Ser. No. 583,342, filed March 17, 1945, and now abandoned, wherein a low-pass filter is serially interposed between the series capacitor and the shunt-connected diode peak detector of a conventional D.-C. insertion network, in order that the D.-C. insertion signal may be substantially independent of the noise signals.

Three embodiments of the present invention are described and illustrated herein. The first embodiment comprises a conventional D.-C. insertion network and a single resistive-capacitive filter network for providing complementary filtering of the received and the restored signal components. A second embodiment of the invention utilizes separate high-pass and low-pass complementary resistive-capacitive filter networks for the received and the restored signal components respectively, and a coupling network for combining the complementarily filtered signal components.

The third embodiment of the instant invention combines the novel features of applicant's copending application, identified heretofore, with the novel features of the first embodiment of the instant invention in a circuit for providing restored video signals for both modulation and synchronization of the deflection of a kinescope tube in response to television signals.

Among the objects of the invention is to provide an improved method of and means for correcting for spurious low-frequency modulation of communication signals. Another object is to provide an improved method of and means for reconstructing the low-frequency components in a communication signal. Another object is to provide an improved method of and means for D.-C. insertion in a signal communication system. A further object of the invention is to provide an improved method of and means for reducing the effect of noise signals in a D.-C. insertion circuit for a signal communication system. An additional object of the invention is to provide an improved D.-C. insertion split-channel network for a signal communication system, wherein the D.-C. insertion circuit and the received signal circuit are coupled through complementary filter systems to provide a substantially restored communication signal. A further object of the invention is to provide an improved split-channel D.-C. insertion network wherein the correcting signal components and the received signal components are combined through separate complementary high-pass and low-pass filter systems to provide a restored communication signal. Another object of the invention is to provide an improved D.-C. insertion network for a signal communication system, wherein the restoring signal components and the received signal components are combined through a plurality of complementary filter systems to provide restored communication signals for modulating and deflecting the cathode ray beam of a television kinescope tube.

The invention will be described in greater detail by reference to the accompanying drawing of which Figure 1 is a schematic circuit diagram of a first embodiment thereof, Figure 2 is a graph of a typical television signal having spurious low-frequency signal components or improper low-frequency response, Figure 3 is a graph of said television signal wherein the spurious low-frequency components have been substantially eliminated, but additional spurious high frequency components have been introduced by a conventional D. C. restoring network, Figure 4 is a schematic circuit diagram of a second embodiment of the invention, and Figure 5 is a schematic circuit diagram of a third embodiment of the invention. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figure 1 of the drawing, signals from a television receiver or other signal source are applied to input terminals **3**, **5**. A small capacitor **7** and a diode peak detector **9** are connected in series between the input terminals **3**, **5**. A high value shunt resistor **11** is connected across the diode **9**. A filter network comprising a serially-connected small filter capacitor **13** and filter resistor **15**, are connected across the first capacitor **7**. Output terminals **17**, **19** are connected to the junction of the filter capacitor **13** and filter resistor **15** and to ground, which corresponds to the input terminal **5**.

In operation, received signals *a*, as shown in the graph of Figure 2, are applied, through a high-pass filter comprising the series filter capacitor **13** and the effectively shunt-connected filter resistor **15**, to the output terminals **17**, **19** whereby the low-frequency components of the received signal are deleted. Also, due to the normal action of the D. C. inserting network comprising the first capacitor **7**, the diode **9** and the shunt resistor **11**, low-frequency restoring

signal components are provided at the point *b*, which correspond to the signals shown in the graph of Figure 3. These signals are a substantially true replica of the original signal except that the average maximum signal level is depressed at the region *v* corresponding to the occurrence of the vertical synchronizing pulses, as explained heretofore. The signal *b* thence is applied to the output terminals and combined with the signal *a* by passing it through the series filter resistor **15** and the effectively shunt-connected filter capacitor **13**. Thus, substantially only complementary high-frequency components of the received signal *a* may be combined at the output terminals to provide a substantially restored communication signal *c*.

The partially restored signal *b* is produced as follows: Only the high-frequency and medium-frequency components of the received signal *a* are transmitted through the small first capacitor **7** to the diode peak detector **9** since the load provided by the shunt resistor **11** greatly attenuates the low-frequency components of the signal *a*. However, the diode peak detector **9** draws current on each peak of the synchronizing signals when the anode of the diode becomes positive with respect to ground. This current generates a bias voltage wherein the received wave is depressed below the zero axis in a manner wherein the peak values of the signal exceed zero by a relatively small amount which is determined by the value of the shunt-resistor **11**. This action tends to provide uniform peak signal level as shown by the envelope **29** of the signal wave of Figure 3. Absolute uniformity of the signal pulse levels would indicate ideal restoration of the low-frequency components of the transmitted signal.

However, as indicated at the portion *v* of the graph of Figure 3, the vertical synchronizing pulses being many times longer than the horizontal synchronizing pulses, the diode conducts for a much greater percentage of the time during the interval of the vertical synchronizing pulse. Therefore, additional bias is generated by the diode **9**, which tends to depress the signal peak values below the maximum level of the horizontal synchronizing pulses. This condition implies that the wave is given a spurious component which although repeated sixty times per second is comprised principally of much higher harmonic frequency characteristics.

Since the spurious signal component caused by the vertical synchronizing pulses is essentially of relatively high frequency character, this high frequency spurious component may be effectively eliminated by means of the low-pass filter interposed between the diode and the output circuit. Also, since the spurious low-frequency components of the received wave are substantially eliminated by the high-pass filter interposed between the input and output circuits, the combination of the output signals derived from the low-pass and high-pass filter action tends to reproduce the originally transmitted signal since the filters are complementary in character.

The action of the filter comprising the filter capacitor **13** and filter resistor **15** in providing complementary response to the signals applied to the outer terminals thereof, may be explained as follows: By considering the point *b* as temporarily grounded, it is evident that signals reaching the point *c* from the point *a* will have their low frequencies greatly attenuated. Similarly, by considering the point *a* temporarily grounded, signals transmitted from *b* to *c* will have their high frequency components greatly attenuated. By the inherent nature of the circuit, the filtering action for the two signals is actually complementary. Hence, a substantially perfect correction of the received video signal will be provided.

The circuit of Figure 4 is similar to the circuit of Figure 1 except that separate high-pass and low-pass filter networks **21**, **23** are substituted for the common filter network **13**, **15** of the circuit of Figure 1. The output of the high-pass filter **21** is coupled to the output terminal **17** through a first isolating resistor **25**. Similarly, the output of the low-pass network **23** is coupled to the output terminal **17** through a second isolating resistor **27**. The frequency characteristics of the high-pass and low-pass filters **21** and **23**, respectively, are made complementary by proper selection of the filter parameters. The operation of the circuit of Figure 4 is substantially identical to the operation of Figure 1 described heretofore.

As explained heretofore, the third embodiment of the invention illustrated in Figure 5 combines the novel features of the instant invention with those of applicant's copending application identified heretofore. Video signals derived from one of the tubes **31** of a conventional television radio receiver are applied, through a low-pass filter network **33** for attenuating noise components, to a voltage divider **35**. Signals applied to the voltage divider **35** also are coupled through a small capacitor **7** and a second low-pass filter network **37** to the diode detector **9** across which is shunted a second high resistance voltage divider **11'**. The output circuit of the tube **31** also is coupled through a first series filter capacitor **13** to the control electrode **41** of a conventional kinescope television receiving tube **43**. The cathode of the diode peak detector **9** is coupled through a first series filter resistor **15** to said control electrode **41** of the kinescope tube **43**. Hence, received video signals are applied to the control electrode **41** of the kinescope tube **43** by passing them through the high-pass filter **13**, **15**.

Also the received signals derived from the ouput of the first low-pass filter **33** are coupled through the capacitor **7** and the second low-pass filter **37** to the cathode of the diode peak detector **9**, in the same manner as described in said copending application, whereby the D.-C. insertion circuit including the diode **9** is substantially unaffected by noise signal components. The low-frequency components of the D.-C. insertion signal thence are coupled to the control electrode **41** of the kinescope tube **43** through the low-pass filter comprising the filter resistor **15** and capacitor **13**, as explained heretofore with respect to the circuit of Figure 1.

Thus, the control electrode **41** of the kinescope tube **43** receives complementary high frequency and low frequency signal components from the received signal circuit and the D.-C. insertion network, respectively.

The cathode and first anode of the kinescope tube **43** are supplied with operating potentials from a third voltage divider **45** which is connected across a source of operating potential, not shown.

The desired high-frequency components of the received signal are applied to the control electrode of a first limiter amplifier tube **47** through a small coupling capacitor **13'** which is connected to an adjustable contact on the first voltage divider **35**. Similarly the low-frequency components of the D.-C. insertion signal are derived from an adjustable contact on the second voltage divider **11'** and applied to the control electrode of the first limiter amplifier **47** through a second filter resistor **15'**. Thus, the second filter capacitor **13'** and second filter resistor **15'** comprise a second complementary filter system for applying restored signals to the control electrode of the first limiter-amplifier **47** in the same manner as described heretofore with respect to the signals applied to the control electrode **41** of the kinescope tube **43**, except that said signals are filtered by the first low-pass filter **33**.

The limited signals derived from the first limiter-amplifier **47** are further limited and amplified in a second limiter-amplifier tube **49**. The latter tube actuates conventional kinescope deflecting circuits **51** which are connected to the deflecting elements of the kinescope tube **43** to accomplish the required synchronization of the cathode ray deflection in the kinescope tube. The tap on the second voltage divider **35** usually should be adjusted to a somewhat lower level than the tap on the third voltage divider **11'** to provide optimum waveform for the signals which are applied to the first limiter-amplifier tube **47**. Simultaneous adjustment of the taps on both of the voltage dividers provides selection of the proper synchronizing signal level. Since the cathodes of the triode limiters are coupled together, the grid-cathode bias on the first tube **47** determines one limiting level, and the grid-cathode bias on the second tube **49** determines the other limiting level for the synchronizing signal pulses, in a manner well known in the art. Thus, the circuit provides D.-C. restoring action for both the modulating and deflecting signals actuating the kinescope tube.

The various embodiments of the invention disclosed herein comprise a novel split-channel D.-C. restoring network for television or other complex signal systems wherein complementary filter systems are employed for combining complementarily signal components derived from the signal receiving circuits and the D.-C. insertion circuits for providing a substantially perfect replica of the transmitted signal.

I claim as my invention:

1. A D.-C. inserting network for connection between a communication signal source and utilization means, said network including a first capacitor serially interposed between said signal source and said utilization means, a second capacitor, a low-pass filter and a unilaterally conducting circuit serially connected with said second capacitor, said serially connected second capacitor, low-pass filter and unilaterally conducting circuit being connected in shunt with said signal source, a resistor connected between said unilaterally conducting circuit and said utilization means, said unilaterally conducting circuit providing a bias voltage for said utilization means responsive to peak signal magnitude, and said first capacitor and said resistor comprising elements of a complementary filter system for substantially eliminating spurious high frequency signal components introduced by said bias voltage circuit, a second utilization means, and second complementary filter means connecting said signal source and said unilaterally conducting circuit to said second utilization means.

2. The network as set forth in claim 1 including a low-pass filter interposed between said second capacitor and said signal source, said second complementary filter means comprising a resistor

and a condenser, said resistor being serially connected from said unilaterally conducting circuit to second utilization means, and said last named condenser being serially connected from said signal source through said last named low-pass filter to said second signal utilization source.

3. The network of claim 2 in which said last named resistor is connected through a potentiometer to said unilaterally conducting circuit, and said last named condenser is connected from said signal source through a second potentiometer.

ALDA V. BEDFORD.

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