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WIDE BAND AMPLIFIER

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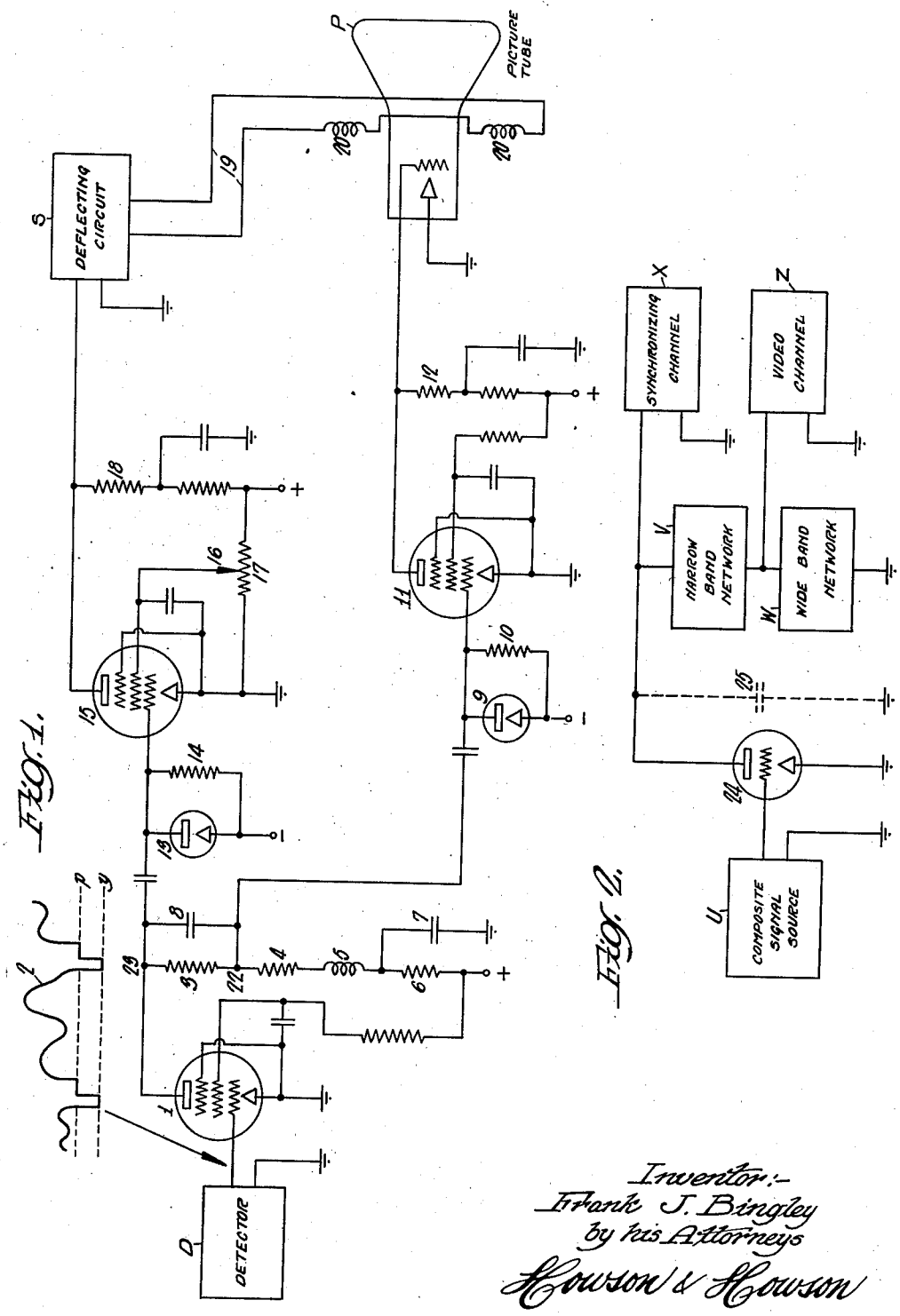


Fig. 1.

Fig. 2.

Inventor:-
Frank J. Bingley
by his Attorneys
Howson & Howson

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WIDE BAND AMPLIFIER

Frank J. Bingley, Philadelphia, Pa., assignor, by mesne assignments, to Philco Radio and Television Corporation, Philadelphia, Pa., a corporation of Delaware

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10 Claims. (Cl. 178—7.3)

This invention relates to wide-band amplifiers for use in high-frequency circuits and, in particular, for use in television systems. More specifically, the invention relates to a method of and means for obtaining both wide-band and narrow-band output signals from a single stage. The desirability of achieving such result may readily be seen by reference to a portion of a television receiver circuit.

It is customary in a television system to employ a signal which comprises a very wide range of frequency components which it is necessary to transmit through the system intact in order to attain the desired fidelity and definition in the reproduced image at the receiver. This signal may include not only the intelligence relating to instantaneous and average picture brightness but also that necessary to maintain the receiving apparatus in synchronism with the transmitter. These components are commonly referred to as the video and synchronizing components of the composite television signal, the latter of which may comprise a series of time spaced pulse signals superposed on the video component.

In the receiver, following the detection of the signal, it may be amplified in one or more stages of a wide-band amplifier and supplied finally to the grid of the picture tube or reproducing device. At some point in this video amplifier it is customary to derive a signal which is supplied by a separate channel to the deflecting circuits where, in response to the synchronizing component, are generated the necessary voltages for deflecting the electron beam of the picture tube. In general, it is not essential to transmit as wide a band of frequencies to the deflecting circuits as to the picture tube in order to obtain the desired results. Hence the transmission means to the deflecting circuit may be designed to pass a narrower band of frequencies whereby certain other advantages obtain such, for example, as increased amplification per stage. Nevertheless, it has been customary to derive the signal for the synchronizing channel across the load impedance in one of the stages of the video amplifier which is designed to give a suitably wide band response for video purposes but which is wasted so far as concerns the synchronizing channel.

Accordingly one of the objects of this invention is to provide a novel video amplifier stage which includes separate wide band and narrow band output circuits for the video and synchronizing signals respectively.

Another object of the invention is to provide such a system wherein a higher gain is obtained in the narrow band output circuit than in the wide band circuit.

Still another object of the invention is to provide such a system wherein the narrow band output circuit cooperates with the wide band circuit so as to maintain, or even to raise, the response of the latter at high frequencies.

A further object of the invention is to provide a system of the stated character wherein the separate output circuits cooperate with each other and with the stray capacities of the circuit to give the desired response.

A still further object of the invention is to provide a means for supplying to the synchronizing channel of a television receiver a signal which is free from spurious low frequency components which tend to vary the amplitude level of the synchronizing pulses.

Other objects and advantages of the invention will appear from the following description.

The invention may be clearly understood by referring to the drawing in which:

Fig. 1 is a diagrammatic illustration of a preferred embodiment of the invention; and

Fig. 2 is a generalized representation showing the fundamental parts of the system.

Referring first to Fig. 1, there is shown a portion of a television receiving system wherein signal from the detector D is to be transmitted to the picture tube P and to the deflecting circuit S. The signal from D, shown at **2**, is supplied to the grid of the tube **1** which is shown as a pentode, although any other suitable form of tube may be employed. This tube is connected as illustrated and has a load impedance which comprises the resistors **3** and **4**, the inductor **5**, and the condenser **8** shunting the resistor **3**. There are also provided the resistor **6** and the condenser **7** which cooperate to filter the power supply and which may be regarded as forming a part thereof.

The signal for the picture channel may be taken across the combination of the resistor **4** and the inductance **5**. This signal may first be leveled on its peaks by means of a peak leveling circuit comprising the diode **9** and the resistor **10**. The operation of such a leveler is fully explained in a co-pending application of A. R. Applegarth, Serial No. 219,643, which relates to an automatic gain control system. Since the leveler forms no part of the present invention, there is no need to describe it further herein. The leveled signal is supplied to the grid of the tube **11**, here shown as a pentode but replaceable by any other suitable type. This tube is loaded, as shown, by

means of the resistor 12, the signal obtained thereacross being supplied to the grid of the picture tube P as shown. Of course any required number of stages of amplification might be interposed at this point in order to raise the signal level, it being necessary however to use care that the number of stages is such as to give the required polarity of picture signal on the grid of the picture tube.

The signal to be supplied to synchronizing channel is derived across the total load impedance of the tube 1 which, as mentioned above, includes the resistors 3 and 4 and the inductor 5 as well as the shunting condenser 8. In like fashion this signal may be leveled by means of the circuit comprising the diode 13 and the resistor 14, the leveled signal being applied to the grid of the tube 15 whose load impedance is the resistor 16. The signal developed across this resistor may be supplied to the deflecting circuit S which generates the necessary waveforms which, when properly employed, serve to deflect the beam of the cathode ray tube P in a manner familiar to those skilled in the art. For purposes of simplicity, only one of the two deflecting means customarily employed in electronic television is shown in the figure, namely the coils 20 which are connected by means of the line 19 to the deflecting voltage generator. It will, of course, be understood that electric deflection might be used in place of magnetic as shown.

The tube 15 is so operated as to pass only the peaks of the signal supplied to its grid and may be referred to as the "synchronizing pick-off tube." Its purpose is to select only the synchronizing component from the composite television signal. The nature of this component and the manner in which amplitude selection may be used to separate it from the rest of the composite signal will be seen clearly by reference to the signal representation 2. The synchronizing component may be regarded as that portion of the signal between the levels p and y. This signal will appear in reversed phase in the output of the tube 1 and hence the synchronizing component can readily be selected by properly adjusting the cut-off level in the tube 15. A convenient way of doing this is by means of the adjustable tap 16 on the potentiometer 17 whereby the screen grid voltage of the tube 15 may be varied and the cut-off level determined. It is also possible, of course, to vary this level by adjusting the control grid bias or the plate voltage.

Returning now to the load impedance used in conjunction with the tube 1, wherein lies the principal feature of the invention, it will first be desirable to point out the difficulties which arise in the design of a conventional wide band amplifier and the manner in which they are avoided. A purely resistive load is not suitable for use in such an amplifier because of its tendency to be by-passed by the fortuitous tube and circuit capacities whereby the high frequency response is lowered. One way of compensating for this is to use a smaller load resistor in series with a small inductor which is commonly referred to as a peaking coil. This inductor may be of such size as to resonate the fortuitous tube and circuit capacities at a frequency outside the band to be amplified. Thus the high frequency response may be raised or peaked as is desirable in such wide band amplifiers. Such a circuit would be obtained in Fig. 1 if the points 22 and 23 were to be short-circuited so that the load impedance for the tube 1 comprised merely the resistor 4 and the inductor 5. Signal for both the picture and synchronizing channels would, in this case, be derived from the same output circuit and would contain the same wide band of frequency components. As has been observed, however, the wide band signal is wasted on the synchronizing channel since only a comparatively narrow band of frequencies need be passed in order to obtain satisfactory synchronization. This suggests the possibility of obtaining a narrower band signal of correspondingly higher level from the output of the tube 1 to be supplied to the synchronizing channel. This generally involves increasing the load impedance, which at first glance appears to be repugnant to the obtaining of a wide-band signal for the picture channel since, as has been noted, it is desirable to keep the resistor 4 small in order that the peaking coil 5 may be effective.

According to the present invention, this difficulty is circumvented by inserting an additional load impedance which varies with frequency in such a manner as to form in conjunction with that already present, a relatively high combined load impedance for frequency components within the range necessary to be supplied to the synchronizing channel but which becomes negligible by comparison with the original load impedance at frequencies outside of this range. In the embodiment of Fig. 1 this additional impedance takes the form of the parallel combination of the resistor 3 and the condenser 8. At low frequencies, the condenser is ineffective appreciably to by-pass the resistor 3, and the load from which the synchronizing signal is derived consists essentially of the series combination of the resistors 3 and 4 with the inductor 5. Thus a relatively large signal is supplied to the synchronizing channel. At higher frequencies, however, the effect of the condenser 8 becomes more pronounced, the resistor 3 is effectively shorted out, and the load from which the signal is derived comprises the series combination of the resistor 4, the inductor 5, and the condenser 8 operating in conjunction with the various fortuitous tube capacities to give the desired high frequency response. As shown, the signal for the picture channel may be taken at the point 22.

Thus, there are provided in the output circuit of tube 1 a pair of load impedances, one comprising the parallel combination of resistor 3 and condenser 8, and the other comprising the series-connected resistor 4 and inductor 5; and the signal for the synchronizing channel is derived from across the total or combined load impedance while the signal for the video channel is derived from across the second load impedance.

For purposes of illustration, suitable values of the principal circuit elements are given below but these should not be regarded as restricting the scope of the invention:

Tube 1—Type 1231, high mutual conductance pentode.
Resistor 3—5000 ohms.
Resistor 4—500 ohms.
Resistor 6—5000 ohms.
Condenser 7—8 microfarads.
Condenser 8—250 micro-micro-farads.

The estimated values of the fortuitous capacities introduced by the various tubes and circuit elements are:

Between the point 23 and ground due to the interelectrode capacity of the tube 1—12 micro-micro-farads.

Between the point 23 and ground due to the

input capacity to the synchronizing channel—25 micro-micro-farads.

Between the point 22 and ground due to the input capacity to the picture channel—15 micro-micro-farads.

It may be well to note another important reason for the use of a high value of load impedance in conjunction with the tube 1 for the synchronizing channel output. This obtains by reason of the fact that there is a tendency for the composite signal to develop across the impedance of the power supply a spurious low frequency component which adds to the signal tending to cause variations in the amplitude of the synchronizing pulses. These variations are such as not to be removable by the action of the leveling tube 13 and are very objectionable as regards the function of synchronizing pick-off performed in the tube 15. The spurious component comprises fundamentally a voltage of substantially sawtooth form occurring at the vertical scanning frequency of the television system. According to the present television practice, the vertical synchronizing pulses (not shown in Fig. 1) which actuate the vertical scanning apparatus and the accompanying blanked-out portions of the video signal are of longer duration than those used to actuate the horizontal scanning equipment. They represent appreciable variations of fairly long duration from the average signal and may be effective, in the case of the embodiment of Fig. 1, to cut off the tube 1 throughout the duration of each vertical pulse. This permits the condenser 7 in the power supply to discharge. It then recharges until the next vertical pulse is received and the result is that the above-mentioned sawtooth is developed across the condenser and is included in the output signal. This action cannot be eliminated without making the condenser 7 prohibitively large, but its effect may be reduced by employing a large value of load impedance so that the amount of sawtooth appearing in the output signal will be proportionately small. This is one of the results obtained by the invention.

Rather than to attempt to illustrate and describe a number of specific embodiments of the invention it is deemed better to point out the general features of a system in accordance with the method of the invention and its fundamental constituents. In so doing it will be convenient to refer to Fig. 2 of the drawing where the essential components of the device are represented generally. A signal comprising a wide band of frequency components is supplied from a source U to the grid of a space discharge device 24 the output circuit of which includes the two impedance elements V and W and which, also, is shunted by the fortuitous capacity of the tube itself represented at 25. These impedances are most generally described by saying that they cooperate in such a manner with each other and with the fortuitous capacity of the tube to produce a high-impedance, narrow-band output circuit from which signal is supplied to the synchronizing channel X and a wide band relatively lower impedance output circuit from which signal is supplied to the video channel Z. Thus, it will be seen that the impedance W is characterized by being such as will cooperate with the tube capacity to give a suitable wide band load impedance while the impedance V must be such as to supplement the impedance W for low frequencies, but to become negligible by comparison with it for high frequencies. Impedances with the desired characteristics for these purposes may be obtained in a number of ways familiar to those skilled in the art and may be built up in accordance with well established principles of network theory from the fundamental circuit elements. Thus V and W might take the form of suitable low pass filters terminated in the proper impedances, the embodiment of Fig. 1 being simply a simplified example of this.

It will be seen, therefore, that the invention is not to be restricted to the specific embodiment here shown but is subject to considerable variation within the scope of the appended claims.

I claim:

1. In combination with a source of a composite signal including a signal component requiring transmission of a wide band of frequencies and a signal component requiring transmission of only a narrow band of frequencies, and a pair of signal channels adapted respectively to receive said signal components, the provision of frequency-selective signal-transfer apparatus interposed between said signal source and said channels, said apparatus comprising signal transfer means arranged to receive said composite signal, a plurality of serially-connected impedance means shunted across the output of said transfer means, one of said impedance means having an impedance variable with frequency, means for deriving one of said signal components from across another of said impedance means, and means for deriving the other of said signal components from across both of said impedance means.

2. In combination with a source of a composite signal including a signal component requiring transmission of a wide band of frequencies and a signal component requiring transmission of only a narrow band of frequencies, and a pair of signal channels adapted respectively to receive said signal components, the provision of frequency-selective signal-transfer apparatus interposed between said signal source and said channels, said apparatus comprising signal transfer means arranged to receive said composite signal, a plurality of serially-connected impedance means shunted across the output of said transfer means, one of said impedance means comprising shunt-connected resistive and reactive elements having an impedance variable with frequency, another of said impedance means comprising series-connected resistive and reactive elements, means for deriving one of said signal components from across said other impedance means, and means for deriving the other of said signal components from across both of said impedance means.

3. In a television system employing a composite signal comprising video and synchronizing components, in which separate video and synchronizing channels are provided for the utilization of the respective components and wherein it is necessary to transmit a signal comprising a wider range of frequency components to said video channel than to said synchronizing channel; a space discharge device having an input circuit and an output circuit, said space discharge device having a fortuitous capacity shunting its output circuit; a source of said composite signal coupled to the input circuit of said space discharge device; a pair of serially-connected impedances in said output circuit, said impedances cooperating with said fortuitous capacity to form a wide band low impedance output across one of said impedances and a narrow band relatively high impedance output across both of said impedances; means for deriving a signal across

said one impedance and for supplying it to said video channel; and means for deriving a signal across both of said impedances and for supplying it to said synchronizing channel.

4. In a television system employing a composite signal comprising video and synchronizing components, in which separate video and synchronizing channels are provided for the utilization of the respective components and wherein it is necessary to transmit a signal comprising a wider range of frequency components to the video channel than to the synchronizing channel; a space discharge device having an input circuit and an output circuit, said space discharge device having a fortuitous capacity shunting its output circuit; a source of said composite signal coupled to the input circuit of said space discharge device; a pair of serially-connected load impedances in said output circuit, one of said load impedances varying with frequency in such a manner as to form in conjunction with the second of said load impedances a relatively high combined load impedance for frequency components within the range necessary to be supplied to said synchronizing channel, but becoming negligible by comparison with said second load impedance at frequencies above said range, and said second load impedance being such as to present an inductive component at high frequencies, said inductive component cooperating with said fortuitous tube capacity to raise the response across said second load impedance for the higher frequencies within said video range; means for supplying the signal developed across said combined load impedance to said synchronizing channel; and means for supplying the signal developed across said second load impedance to said video channel.

5. In a television system employing a composite signal comprising video and synchronizing components, in which separate video and synchronizing channels are provided for the utilization of the respective components and wherein it is necessary to transmit a signal comprising a wider range of frequency components to said video channel than to said synchronizing channel; a space discharge device having an input circuit and an output circuit, said space discharge device having a fortuitous capacity shunting its output circuit; a source of said composite signal coupled to the input circuit of said space discharge device; a pair of serially-connected load impedances in said output circuit, one of said load impedances comprising a low-pass filter network terminated in a relatively high impedance and having a pass-band corresponding to the range of frequencies necessary to be supplied to said synchronizing channel, and the other of said load impedances comprising a four-terminal network terminated in a relatively low impedance and adapted to form in conjunction with the input impedance of said first filter and said fortuitous tube capacity a filter having a pass-band corresponding to the said video frequency range; means for supplying the signal developed across said both load impedances to said synchronizing channel; and means for supplying the signal developed across said second load impedance to said video channel.

6. In a television system employing a composite signal comprising video and synchronizing components, in which separate video and synchronizing channels are provided for the utilization of the respective components and wherein it is necessary to transmit a signal comprising a wider range of frequency components to said video channel than to said synchronizing channel; a space discharge device having an input circuit and an output circuit, said space discharge device having a fortuitous capacity shunting its output circuit; a source of said composite signal coupled to the input circuit of said space discharge device; a pair of serially-connected load impedances in said output circuit, one of said load impedances comprising a relatively large resistance shunted by a condenser, said condenser being of such magnitude as substantially to bypass said resistor for frequency components outside said synchronizing range, and said second load impedance comprising a serially-connected combination of a resistance and an inductance, said inductance being adapted to cooperate with said fortuitous capacity to improve the response across said second impedance for frequency components within said video range; means for supplying the signal developed across said both load impedances to said synchronizing channel; and means for supplying the signal developed across said second load impedance to said video channel.

7. In an electrical signal system wherein it is desired to provide for a given signal a relatively wide band low gain output to one channel and a relatively narrow band high gain output to another channel, a space discharge device having a fortuitous capacity shunting its output circuit, a load impedance for said space discharge device, said load impedance comprising a plurality of serially-connected impedances, one of said impedances cooperating with said other impedances and with said fortuitous capacity to provide a wide band low gain output across said one impedance, and all of said impedances mutually cooperating to provide a narrow band high gain output thereacross, means for supplying the signal developed across said one impedance to said one channel, and means for supplying the signal developed across all of said impedances to said other channel.

8. In an electrical signal system wherein it is desired to provide for a given signal a relatively wide band low gain output to one channel and a relatively narrow band high gain output to another channel, a space discharge device having a fortuitous capacity shunting its output circuit, a load impedance for said space discharge device, said load impedance comprising a pair of serially-connected impedances, one of said impedances comprising serially-connected resistive and reactive elements cooperating with said other impedance and with said fortuitous capacity to provide a wide band low gain output across said one impedance, and said two impedances mutually cooperating to provide a narrow band high gain output thereacross, means for supplying the signal developed across said one impedance to said one channel, and means for supplying the signal developed across both of said impedances to said other channel.

9. In an electrical signal system wherein it is desired to provide for a given signal a relatively wide band low gain output to one channel and a relatively narrow band high gain output to another channel, a space discharge device having a fortuitous capacity shunting its output circuit, a load impedance for said space discharge device, said load impedance comprising a pair of serially-connected impedances, one of said impedances cooperating with said other impedance and with said fortuitous capacity to provide a wide band low gain output across said one impedance, and

said other impedance comprising shunt connected resistive and reactive elements cooperating with said first impedance to provide a narrow band high gain output across both of said impedances, means for supplying the signal developed across said one impedance to said one channel, and means for supplying the signal developed across both of said impedances to said other channel.

10. In an electrical signal system wherein it is desired to provide for a given signal a relatively wide band low gain output to one channel and a relatively narrow band high gain output to another channel, a space discharge device having a fortuitous capacity shunting its output circuit, a load impedance for said space discharge device, said load impedance comprising a pair of serially-connected impedances, one of said impedances comprising a serially-connected resistance and inductance cooperating with said other impedance and with said fortuitous capacity to provide a wide band low gain output across said one impedance, and said other impedance comprising a shunt-connected resistance and capacitance, said two impedances cooperating to provide a narrow band high gain output thereacross, means for supplying the signal developed across said one impedance to said one channel, and means for supplying the signal developed across both of said impedances to said other channel.

FRANK J. BINGLEY.