April 21, 1942. D. E. FOSTER 2,280,695

TELEVISION CIRCUITS

Filed June 29, 1940

FIG. 1.

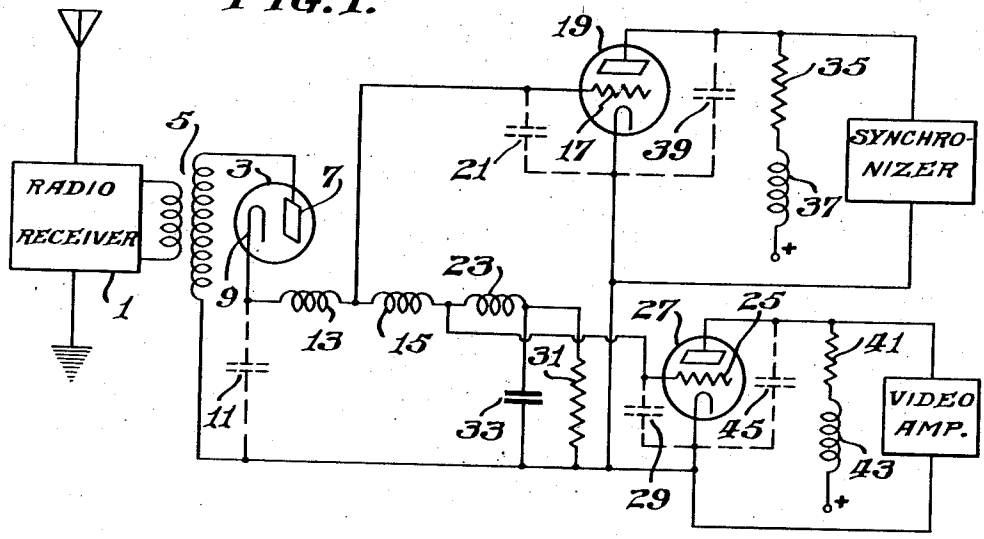
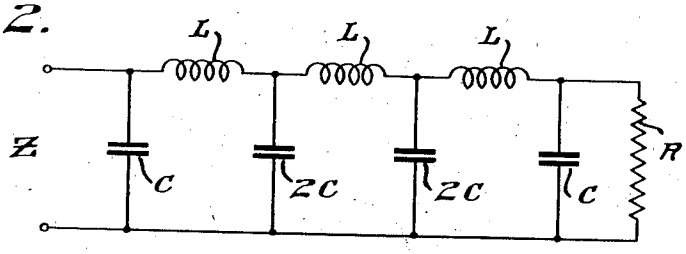


FIG. 2.



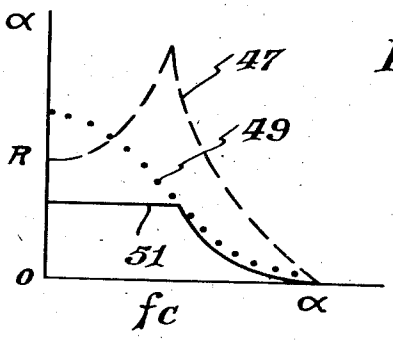


FIG. 3.

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UNITED STATES PATENT OFFICE

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TELEVISION CIRCUITS

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10 Claims. (Cl. 250—27)

This invention relates to television circuits and more particularly to ultra high frequency detector circuits.

Television signaling systems adapted to provide images of high definition cover a relatively wide band of signaling frequencies and they require the use of a carrier in the ultra short regions for their transmission in broadcast.

It is well known that in these ultra high frequency regions, thermionic amplifying tubes experience a falling off in efficiency due to the fact that the interelectrode capacity between the elements of such tubes is of sufficient magnitude to provide a relatively low impedance.

One method of overcoming this decreased efficiency of thermionic amplifiers in the regions of high frequency necessary for television signal transmission is shown in Roberts Patent No. 1,925,340, granted September 5, 1933, in which a resistance-coupled amplifier includes coupling elements comprising a band pass filter with the input capacity of the filter comprising amplifier tube interelectrode capacities.

The detector circuit which is utilized to demodulate the video-modulated carrier is subject to the same decreased efficiency at increased signal frequency. In the patent to Seeley, No. 2,197,024, issued April 16, 1940, it has been proposed to feed the output of the diode detector circuit to a plurality of load circuits, each connected to a different point in the filter network in order to eliminate the relatively high capacity caused by connecting a plurality of load circuits across the output of the filter.

It will be noticed that heretofore it has been customary to follow the filter network with a stage of amplification comprising a thermionic tube operating into a relatively low impedance to maintain a substantially uniform amplification over the desired band width of the signals to be amplified. When a normal load resistance is used in the plate circuit of this amplifying tube following the filter circuit, a falling off in amplification of the higher frequencies results because of the increased effect of the interelectrode capacity of the thermionic tube.

In accordance with this invention, a filter circuit having rising frequency response characteristic is used and it is followed by an amplifier stage having a normal high load resistance to cause a falling off of amplification at high frequency in this stage to compensate for the rising frequency response characteristic of the filter circuit.

The primary object of this invention is to provide an improved detector circuit having a uniform response and high gain over a large range of frequencies.

A further object of this invention is to provide a detector circuit with the improved characteristics to avoid frequency distortion.

A still further object of this invention is to provide a detector circuit having a high impedance to ultra high frequencies.

Other and incidental objects of the invention will be apparent to those skilled in the art from a reading of the following specification and an inspection of the accompanying drawing in which—

Figure 1 is a schematic drawing showing one form of this invention,

Figure 2 shows schematically a multi-section low-pass filter for the purpose of explaining the invention, and

Figure 3 is a graphical representation of the results obtained by the use of this invention.

Figure 2 shows a low-pass filter made up of a plurality of constant K sections with midshunt termination having inductances represented by L, condensers C, and terminating in resistance R. This type filter is well known (see, for example, "Transmission networks and wave filters," by T. E. Shea, D. Van Nostrand & Co., New York, 1929, page 291).

The characteristic impedance of such a filter structure is given by

$$R=\sqrt{\frac{L}{C}} \tag{1}$$

where R is nominal filter resistance (termination value), L is inductance, and C, capacity. When a number of half sections are connected serially, the structure shown in Fig. 2 results. When the filter is terminated by a resistor whose value equals R, the filter will have an input impedance equal to R at frequencies approaching zero.

The image impedance Z in Fig. 2 takes the form

$$Z=\frac{R}{\sqrt{1-\left(\frac{f}{fc}\right)^2}} \tag{2}$$

where R is nominal filter resistance (terminating value), f is any frequency, and fc is cut-off frequency. The image impedance is the same as the actual impedance of an infinitely long filter. The actual impedance of the filter shown in Fig. 2 is substantially the same as its image impedance because image impedance matching is

followed through the filter to the terminating resistor R.

A wave filter, for example, one such as set forth in Fig. 2, is useful in preventing picture intermediate frequency and harmonics thereof from passing through the video amplifier and synchronizer, and for providing through its image impedance a load for the detector diode.

The image impedance of such a filter is purely resistive over the passband but it is not uniform as shown by Formula 2. As f increases towards cut-off value, Z increases. It has been proposed to add more shunt capacity across the input terminals to make more uniform this image impedance. However, this decreases the load impedance into which the detector must operate and consequently lowers the voltage developed. According to this invention, no shunt capacity is used and, furthermore, this irregular characteristic is utilized to aid in securing greater amplification from the following amplifier stage.

Referring now to Fig. 1, a television signal of well-known form, for instance, is received by radio receiver 1 and its associated equipment and transmitted to the diode detector 3 through transformer 5 which has its secondary connected to the anode 7 of the diode detector 3. The output of the diode detector or its cathode 9 is connected to the input of the bandpass filter.

The distributed capacity of the diode cathode 9 to its associated anode 7, wiring, and heater element is used as the filter input capacity represented in Fig. 1 as capacity 11.

A load circuit such as one supplying signals to the synchronizer is tapped on the filter at an intermediate terminal, for example, between inductances 13 and 15 through the control electrode 17 of a discharge device 19. The grid to cathode capacity 21 of the discharge device 19 is approximately twice that capacity 11 representing the interelectrode capacity of the diode 3, so that the relation of capacity $2c$ to c shown in Fig. 2 is satisfied.

A second load circuit supplying signals to the video amplifier is preferably tapped on the filter at another terminal, such as, for example, between inductances 15 and 23 through the control electrode 25 of the discharge device 27. The grid-to-cathode capacity 29 of the discharge device 27 is also approximately twice capacity 11 representing the interelectrode capacity of the diode 3, so that the relation of capacity $2c$ to c, shown in Fig. 2, is again satisfied.

A resistance 31 is added to terminate the filter in a dead end. Condenser 33 has a value approximately the same as capacity 11 in Fig. 2. By terminating the filter in a dead end and having a small auxiliary condenser 33 whose capacity is substantially one-half the grid-cathode capacity of the amplifier tubes such as 19 and 27 supplying the intermediate condensers of the network and represented by capacity 21 and capacity 29, the relation of capacities shown in Fig. 2 of $2c$ and c is satisfied and the condition shown by Equations 1 and 2 result.

The anode voltage supply circuit of the discharge tube 19 includes a resistance 35 and an inductance 37. The inter-electrode capacity of the discharge tube 19 is represented by capacity 39. By using a relatively high value of plate load resistance 35, a greater amplification over the whole pass band is obtained. It is true that the use of a high load resistance causes a falling off in amplification at high frequencies because of the decrease in impedance of anode-to-cathode shunt capacity 39, but, according to this invention, a falling off in amplification at high frequency is desirable so as to compensate for the rising frequency characteristic of the filter circuit. By choosing the proper values of resistance 35 and inductance 37, the response curve of the amplifier stage may be made complementary to the response curve of the filter circuit. This results in a substantially uniform amplification over the entire pass band with the increase in amplification resulting from the higher detector load impedance of the filter circuit and the increase in load resistance of the amplifier tube 19.

Amplifying tube 27 which supplies signals to the video amplifier contains an anode circuit like that described above for amplifying tube 19. The anode voltages supply circuit of the discharge tube 27 includes a resistance 41 and an inductance 43. The interelectrode capacity of the discharge tube 27 is represented by capacity 45. A relatively high value of plate load resistance 41 may be used here also to provide a greater overall amplification. The falling off in amplification at high frequencies is also compensated for by the rising frequency characteristic of the filter.

In Fig. 3, the image impedance of the filter circuit is represented by curve 47. This curve corresponds to Equation 2. The impedance of the anode circuit is represented by curve 49. The overall impedance of the combined detector-filter circuits and amplifier stage is represented by curve 51 which is substantially flat to cut off frequency represented by fc.

While one system for carrying this invention into effect has been indicated and described, it will be apparent to one skilled in the art that this invention is by no means limited to that particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

I claim as my invention:

1. In a signaling system, a multi-section filter having a rising frequency response characteristic, a load circuit having a frequency response characteristic complementary to said first filter response characteristic connected intermediate the ends of said filter.

2. In a signaling system, a detector having an output circuit, a multi-section filter having a rising frequency response characteristic connected in said output circuit, a load circuit having a frequency response characteristic complementary to said filter response characteristic connected intermediate the ends of said filter, and a terminating circuit for said filter comprising a resistance and a condenser whose capacity is less than the capacity of said load circuit.

3. In a signaling system, a source of signal energy, a detector having an input and output circuit, said input circuit being connected with the said signal energy source, a multi-section coupling circuit having a rising frequency response characteristic connected in the detector output circuit, a terminating resistance for said coupling circuit, a load circuit including a filter circuit having a frequency response characteristic complementary to the response characteristic of said coupling circuit connected intermediate the ends of said coupling circuit.

4. In combination, a discharge device having input and output circuits, a coupling circuit connected to said input circuit and having a rising frequency characteristic, and means in the output circuit of said discharge device to impart to

said discharge device a frequency response characteristic complementary to the frequency response characteristic of said coupling circuit.

5. In combination, a discharge device having input and output circuits, a coupling circuit connected to said input circuit and having a rising frequency response characteristic, and means in said output circuit to increase the low frequency response of said discharge device at the expense of its high frequency response and adapted to cause said discharge device to have an over-all frequency response complementary to the response of said coupling circuit.

6. In combination, an electrical coupling circuit comprising a multiple section network having intermediate terminals between sections of said network, a discharge device having an input circuit connected to an intermediate terminal of said network, means for increasing the low frequency response of said discharge device, and means for imparting to said network a frequency response complementary to the response of said discharge device, and a termination for said network comprising a resistance and condenser whose capacity is less than the capacity of the input circuit of said discharge device.

7. In combination, a pair of discharge devices and a coupling circuit therefor whose shunt impedance is made high at the expense of its uniform frequency response, means for imparting to one of said discharge devices an amplification response characteristic complementary to the response characteristic of said coupling circuit.

8. In a signaling system, a multisection filter having a rising frequency response characteristic, a load circuit having a frequency response characteristic substantially complementary to said filter response characteristic connected intermediate the ends of said filter and a terminating capacity for said filter having a value less than the capacity of said load circuit.

9. In a signaling system, a multisection filter having a rising frequency response characteristic, a plurality of load circuits each having a frequency response characteristic substantially complementary to said filter response characteristic, each connected to a section intermediate the ends of said filter, and a terminating capacity for said filter having a value less than the capacity presented to said filter by either of said load circuits.

10. In a signaling system for composite televising signals including both picture signals and synchronizing pulses, the combination of a detector responsive to said composite signals and having an output circuit, a multisection filter having a terminating capacity of relatively low value to cause said filter to have a rising frequency response characteristic, a picture signal channel connected to an intermediate section of said filter, a synchronizing pulse channel connected to another intermediate section of said filter and an amplifying tube in each of said channels having a load resistance sufficiently high to cause said amplifying tube to have a frequency response characteristic substantially complementary to the frequency response characteristic of said filter.

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