April 16, 1940. S. W. SEELEY 2,197,024

ELECTRICAL CIRCUITS

Filed June 17, 1938

Fig. 1

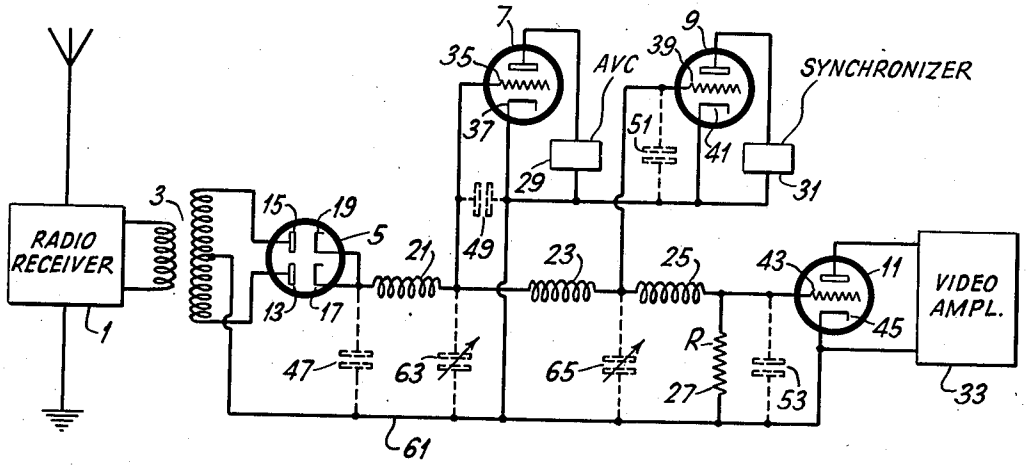
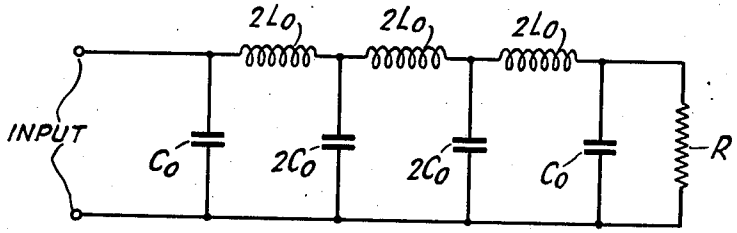


Fig. 2



INVENTOR.
STUART W. SEELEY

BY H. S. Grover

ATTORNEY.

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ELECTRICAL CIRCUITS

Stuart W. Seeley, Bayside, Long Island, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

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7 Claims. (Cl. 250—27)

This invention relates to electrical circuits and more particularly, to detection circuits, such as are used with radio frequency currents, with particular emphasis on an improved method and means for detecting video signal modulation, which signals have interspersed with them synchronizing and background control signals.

In television signalling systems, it is necessary in order to provide high definition, to cover a relatively wide band of signalling frequencies, and in modern television systems, this frequency band is of the order of 3–4 megacycles.

These frequencies, it will be readily recognized, are on the same order as the radio frequencies used in short wave communications and require for their effective transmission, the use of a carrier in the ultra-short wave regions. It is well known that in the region of a megacycle, and beyond that, thermionic amplifying tubes begin to experience a falling-off in efficiency, due to the fact that the inter-electrode capacity between the control electrode and cathode of such tubes, is of sufficient magnitude to provide a relatively low impedance, whereas in the audio range, where the frequencies seldom, except for special purposes, exceed 10,000 cycles, the impedance provided by the inter-electrode capacity is of the order of a megohm, and at such values of input impedances, the tubes function very efficiently. It will be recognized that where the input impedance comprising the inter-electrode capacity between the control electrode and the cathode, together with its associated wiring, is of the order of 25 microfarads, the impedance at 3 megacycles is only of the order of 2,000 ohms or so. Since the plate impedance of the tubes is generally considerably higher than this, there is considerable loss, due to mismatching of the output plate impedance of a tube working into such a value of load resistance. Accordingly, an amplifier of the conventional sort would experience considerable frequency distortion. That is to say, the amplitude or amplification of the tube would fall off as the frequency is increased.

The same remarks apply in general to detectors which are to demodulate the video modulated carrier. It is, accordingly one of the main objects of the invention to provide an improved detector circuit, in which frequency distortion is to a large extent eliminated or minimized.

A further object of the invention is to provide a detecting circuit in which it is possible to filter the carrier out more efficiently from combined video synchronizing and background control signals, and at the same time, to guard against any frequency distortion.

A further object of the invention is to provide a simplified filter circuit with the improved characteristics of avoiding frequency distortion and capable of working with a plurality of connected loads.

In accordance with the invention, a multi-section low-pass filter structure is provided of the constant K type, in which, however, the inter-electrode capacities between the control electrodes and cathodes of the thermionic amplifying tubes, together with their associated wiring, constitute the shunt condensers of the low pass filter, and in which, where the shunt inter-electrode capacity is too small, a small auxiliary variable condenser is connected in parallel with the control electrode and cathode, so that the sum of the capacities is equal to the appropriate value as indicated by the formulas for the design of such low pass filters.

Further in accordance with the invention, only one thermionic tube is connected at the junction point of each section, and it will be readily appreciated, therefore, that there will be a minimum of capacity provided. As is well known and understood in the art, the smaller the value of the shunt capacitors, the higher the impedance of the filter for a given cutoff frequency, and since the structure has minimum values of capacity, there will, accordingly, be provided a filter structure having a maximum characteristic input and output impedance, and hence, the detector working into the filter and the connected thermionic amplifier tubes connected at the junction points of the plurality of sections, will have maximum impedance resulting in a general overall gain in efficiency of demodulation and amplification.

The beneficial results accruing from such a structure will be perceived with even greater clarity upon consideration of the detailed description to follow, together with an examination of the drawing, in which

Fig. 1 shows schematically the circuit connections in accordance with applicant's invention, in which a detector feeds the filter structure and a plurality of load circuits, comprising vacuum tubes, are tapped off at various junction points of the multi-section filter, while

Fig. 2 shows schematically a multi-section low-pass filter for purposes of explaining the invention.

Referring now to Fig. 2, it has represented a multi-section low pass filter, and as is well known

(see, for example, "Transmission Networks and Wave Filters," by T. E. Shea, D. Van Nostrand & Co., New York, 1929, at page 291), the characteristic impedance of such a filter structure is given by

$$R=\sqrt{\frac{LO}{CO}}$$

and consequently, if a number of half-sections are connected serially, the structure shown in Fig. 2 results, and when terminated in a value of resistance R, has an input impedance equal to R. It will be noted that in the structure shown, the inner condensers, i. e., those intermediate the junction points of two sections, have twice the value of the input condenser and the terminating condenser adjacent to the resistance R. Under such conditions, it will be appreciated that by dispensing with actual condensers and utilizing the inter-electrode capacity of the control electrode and cathode of thermionic tubes and their associated wiring, to provide the capacity for the filters, a minimum amount of capacity is necessary, and accordingly, from the above quoted formula, the impedance will be at a maximum.

In practice, the input capacity of the amplifier tubes comprising the inter-electrode capacities and their wiring to the grid and cathode, vary from approximately 20 to 40 micromicrofarads and to provide the necessary balance structure. It may, therefore, be necessary, where the input capacity is of the order of minimum value to supply some auxiliary capacity by connecting a small variable condenser of the "trimming" type connected across the control electrode and capacity.

Generally, it is desirable to dispense with such auxiliary tuning capacitors where possible, and this may be suitably done by connecting the thermionic tube having minimum value of capacity across the terminating section of the filter, since the terminating capacity must be one half of the capacities at the junction points of the sections to provide a uniform transmission response curve for the filter.

Turning now to Fig. 1, which shows schematically detailed connections, there is shown the transformer 3, whose primary is fed with the amplified radio frequency signals from the radio receiver 1. The secondary of the transformer feeds to a thermionic diode detector 5, having two anodes 13 and 15, and cathodes 17 and 19. The cathodes are connected together and a center tap is taken from the secondary of the transformer 3 so as to provide full wave rectification. The condenser 47 shown dotted, represents the capacity between the cathode and the windings and wiring. Connected from the cathode in series are the inductances 21, 23 and 25, corresponding to the inductances 2LO in Fig. 2. Connected at the junction point of the inductance 21 and 23 is the control electrode 35 of a thermionic amplifier tube 7, while the cathode 37 of this tube is connected to the common bush-line 61. The capacitor 49 shown in dotted form, is indicative of the inter-electrode capacity between the control electrode 35 and the cathode 37 and the associated wiring. The output of the tube 7 may feed appropriately to the automatic volume control 29 shown in block diagram form, while across the junction point of the inductances 23 and 25, the tube 9 has its control electrode 39 connected and has an input capacity represented by 51. The tube 9 feeds the synchronizing generator 31, for example. The filter is terminated by the resistor 27, which has a value R corresponding to the surge impedance or characteristic impedance of the filter

$$\sqrt{\frac{LO}{CO}}$$

and the tube 11 has its control electrode connected to the inductance 25 and the bush-line 61 at the cathode, so that its input capacity 53 is likewise connected across the resistor 27. The tube 11 may thereafter appropriately feed a video amplifier 33.

In Fig. 1 it is assumed that the capacities 49 and 51 both have values equal to twice the capacity of 53. If in reality these capacities are less than twice the value of the capacity 53, then a small trimming condenser shown in dotted form as 63 and 65, may be used to bring the total capacity to the appropriate value of twice the capacity of 53. Under such conditions, uniform transmission characteristics are provided throughout the filter at the same time providing sufficient attenuation between the demodulated signals and the carrier frequency energy, perceiving therewith, the maximum input impedance to the filter, so that the detector 5 is capable of working for maximum efficiency. At the same time, the use of the multi-sections in the filter provides video signals impressed between the control electrode 43 and the cathode 45, which are substantially completely free from any carrier frequency or any synchronizing or background control signals. Likewise, the signals fed to the tube 9 will also be freed from any carrier wave energy, although to a lesser degree than that of the video amplifier. However, it is to be noted that since the synchronizing generators, as is well known in the art, provide further filtering action, it is not so necessary to have the same degree of filtering between the synchronizing signals and the carrier wave energy, as it is to provide for the separation between the video signals and the carrier wave energy. The same is true of the background control circuit, since the purpose of this circuit, as is well known in the prior art, is merely to afford control for relatively slow changes in the background values of illumination. Accordingly, a single section of the filter interposed between the detector and the background control amplifier gives sufficient discrimination between the background control signals and the carrier wave energy.

It will be appreciated, of course, that where the input capacity to the video signal amplifier is greater than the input capacity of the amplifier feeding the synchronized generator, then the two tubes may be interchanged without any substantial loss in discrimination between the carrier wave energy and the demodulated signals, since in this case, there would still be at least two sections intermediate the detector and the amplifier.

It will further be appreciated, of course, that more sections of filters may be used where it is desired, for example, to actuate more amplifiers from the detected output. Thus, by adding additional sections of the filter, amplifiers could be connected across the junction points of the added sections for deriving monitoring signals, for recording average depth of modulation, or for making continuous records of the contrast ratios. Conversely, fewer sections may be used than that shown, where, for example, the re-

ceiver is not adapted to utilize the background control or automatic volume control, in which case, one section of the filter may be dispensed with.

It will thus be seen that the invention provides a new method of feeding a plurality of load circuits from a filter, while at the same time improving the efficiency and simplicity of construction of the structure.

Having described my invention, what I claim is:

1. A detector having an input and output circuit, a multi-section filter connected in the output circuit, a plurality of load circuits and means to supply energy having identical frequency components to the load circuits, said means comprising connections from junction points between sections of the filter to each of the plurality of load circuits.

2. A detector having an input and output circuit, a multi-section filter connected in the output circuit, a plurality of load circuits, and connections from junction points between sections of the filter to each of the plurality of load circuits, a terminating resistance for the filter, and a load circuit connected across the terminating resistance.

3. A detector having an input and output circuit, a multi-section filter connected in the output circuit, a plurality of thermionic amplifiers, each having an input circuit, and means to supply energy having identical frequency components to the thermionic amplifiers, said means comprising connections from junction points between sections of the filter to each of the plurality of input circuits.

4. A detector having an input and output circuit, a multi-section filter connected in the output circuit, a plurality of thermionic amplifiers having input circuits, and connections from junction points between sections of the filter to each of the plurality of input circuits, a terminating resistance for the filter, and a thermionic amplifier connected across the terminating resistance.

5. A detector having an input and output circuit, means to feed modulated carrier wave energy to the input circuit, a plurality of serially connected inductances connected in series with a resistance connected to said output circuit, a plurality of amplifiers having input and output circuits, connections from junction points of the serially connected inductances to the input circuits of the amplifiers, and an input circuit of an amplifier connected across the serially connected resistance.

6. A thermionic diode detector having an input and output circuit, means to feed modulated carrier wave energy to the input circuit, a plurality of serially connected inductances connected in series with a resistance connected to said output circuit, connections from junction points of the serially connected inductances to the input circuits of the thermionic amplifiers, and an input circuit of a thermionic amplifier connected across the serially connected resistance.

7. A detector having an input and output circuit, means to feed modulated carrier wave energy to the input circuit, a plurality of serially connected inductances connected in series with a resistance connected to said output circuit, a plurality of amplifiers having input and output circuits, connections from junction points of the serially connected inductances to the input circuits of the amplifiers, means connected to said junction points for compensating for capacity introduced by the input circuits of the amplifiers, and an input circuit of an amplifier connected across the serially connected resistance.

STUART W. SEELEY.