BANDPASS FILTER FOR PASSING A WIDE RANGE OF FREQUENCIES AND SUPPRESSING A NARROW RANGE OF FREQUENCIES

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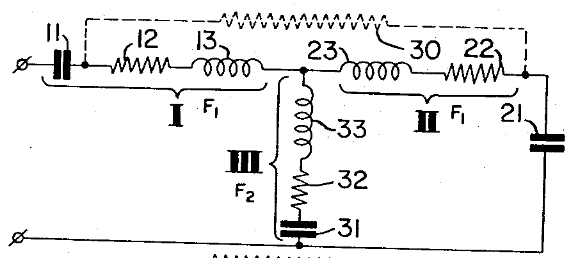

PRIOR ART

FIG.1

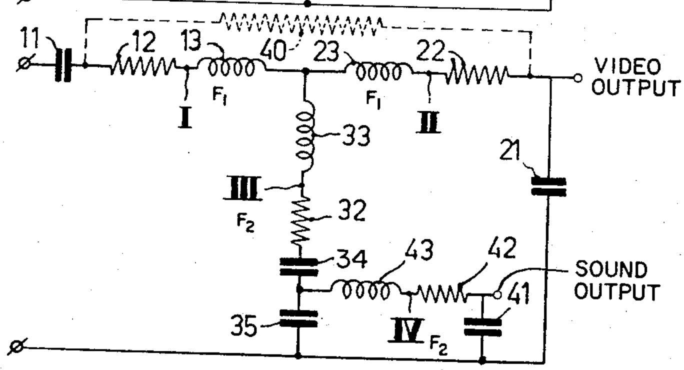

FIG.2

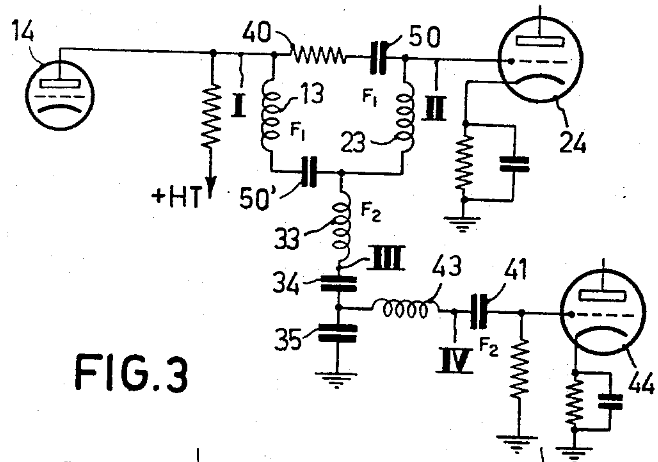

FIG.3

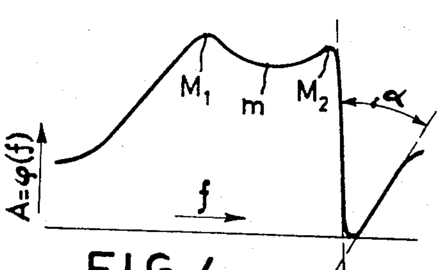

FIG.4

PRIOR ART

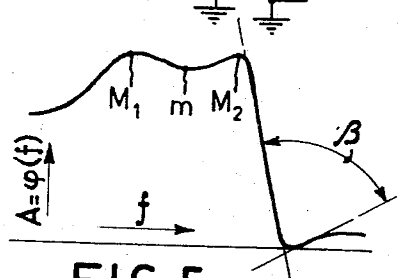

FIG.5

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7 Claims. (Cl. 333—6)

ABSTRACT OF THE DISCLOSURE

A bandpass filter is provided having a pair of series connected tuned longitudinal branches, and a transverse branch connected to the junction of the series branches. The longitudinal branches are tuned to have a low impedance to a wide band of frequencies. The transverse branch is a series resonant circuit tuned to a narrow band in or near the wide band, so the filter rejects the narrow band. A fourth branch comprised of a series resonant circuit tuned to the narrow band is connected in parallel with part of the transverse branch in order to increase the width of the narrow band.

This invention relates to bandpass filters for passing a comparatively wide range of frequencies and also for strongly and selectively suppressing a comparatively nar-rawo range of frequencies located within the said range or in the vicinity thereof, comprising two longitudinal branches connected in series and each comprising a series-resonant circuit and a transverse branch coupled to the common point of the longitudinal branches and comprising a series-resonant circuit which is tuned to a frequency located in the comparatively narrow range of frequencies.

Such filters are used inter alia in television receivers as intermediate-frequency bandpass filters. The comparatively wide range of frequencies comprises the intermediate-frequency video-signal and the comparatively narrow range of frequencies comprises the sound carrier wave. As is well-known, the sound carrier wave must in many cases be considerably suppressed relative to the intermediate-frequency video-signal in the intermediate-frequency portion of the receiver. Also the sound carrier wave is in many cases derived from said intermediate-frequency portion.

The invention has for its object to provide an improvement in such filters. To this end, the band-pass filter according to the invention is characterized in that parallel with a portion of the transverse branch there is connected a further branch which likewise comprises a series-resonant circuit which is tuned to the frequency located in the comparatively narrow range of frequencies.

In order that the invention may be readily carried into effect, it will now be described in detail, by way of example, with reference to the accompanying diagrammatic drawing, in which:

FIGURE 1 shows a bandpass filter of known type;

FIGURE 2 shows a bandpass filter according to the invention;

FIGURE 3 shows a circuit including a bandpass filter according to the invention;

FIGURE 4 shows a response curve of the filter of FIGURE 1, and

FIGURE 5 shows a response curve of a bandpass filter according to the invention.

The known filter shown in FIGURE 1 is built up from:

a primary branch I, comprising the series-combination of a capacitor **11**, a resistor **12** and an inductor **13**;

a second branch II, comprising the series-combination of a capacitor **21**, a resistor **22** and an inductor **23**;

a third branch III, comprising the series combination of a capacitor **31**, a resistor **32** and an inductor **33**.

The branch III is tuned to the frequency to be eliminated whereas the branches I and II behave as a transformer of which I is the primary winding and II is the secondary winding. In practice the two branches I and II are usually tuned to the same frequency, the width of the pass band, as is well-known, being substantially determined by the value of the coupling coefficient. Such a network shows a response curve as illustrated in FIGURE 4, in which the response A is plotted as a function $\varphi(f)$ of the frequency f. The figure shows that said curve has two relative maxima M1 and M2, which are as far remote from each other as possible, and between them a relative minimum m. In practice, it is ensured that the two relative maxima of the function $\varphi(f)$ have the same ordinates and that the relative minimum differs from this function as little as possible.

It is known that with such a filter the response for the tuning frequency f_3 of the branch III may be reduced at will by means of a neutralizing resistor **30**. However, in spite of these advantages, such a filter suffers from a severe drawback: the suppression range of the response curve is comparatively narrow and this fact may hazard the efficaciousness of the suppression, e.g. if frequency drift of the local oscillator occurs. The narrowness of the suppression range can be seen in FIGURE 4 from the fairly acute character of the angle α shown therein.

The aforementioned disadvantage is avoided in the filter according to the invention as shown diagrammatically in FIGURE 2.

This filter includes, relative to the filter shown in FIGURE 1, a fourth branch IV which is tuned to the same frequency f_3 as the branch III of the filter previously described and which is capacitively coupled to the branch III. To this end, the capacitor **31** of the branch III of the filter shown in FIGURE 1 is replaced by two series-capacitors **34** and **35**, whilst the branch IV which comprises the series-circuit of a capacitor **41**, a resistor **42** and an inductor **43**, is connected to the terminals of one of said capacitors, i.e. **35** in the figure. When such a filter is used in a television receiver the voltage derived from the terminals of capacitor **21** is applied to the input of the subsequent stage of the intermediate-frequency amplifier of the video-circuit, whereas the voltage set up at the terminals of capacitor **41** is applied to the input of the first stage of the intermediate-frequency amplifier of the sound-circuit. The amplitude of the signal applied to the last-mentioned amplifier increases as the suppression of the sound carrier wave in the filter increases.

In FIGURE 2 the neutralizing resistor is indicated by **40**. The response curve $A=\varphi(f)$ of the filter of FIGURE 2 is shown in FIGURE 5, from which it can be seen that this curve is in its response range substantially identical with that of FIGURE 4 but exhibits an angle β which is approximately equal to 2.5 times the angle α of the last-mentioned figure. Due to this fact, a fairly satisfactory suppression of signals located in the comparatively narrow range of frequencies is also guaranteed with frequency shifts of the signals relative to the filter curve, provided such shifts are not too great.

FIGURE 3 shows one practical embodiment of a filter as shown in FIGURE 2, which is included between two intermediate-frequency stages of the video-circuit of a television receiver. This filter serves, on one hand, to eliminate the sound carrier wave from the video-circuit and, on the other hand, to apply said sound carrier wave to the sound circuit. The capacity **11** of the branch I is formed by the anode capacity of the tube **14**, which precedes the filter, and the capacity 21 of the branch II is formed by the input capacity of the tube 24 which follows after the filter. The branch IV is coupled to the control grid of tube 44 of the first intermediate-frequency stage of the sound circuit.

Capacitors 50 and 50′ serve as direct-current uncoupling capacitors.

FIGURE 3 shows the tubes 14, 24 and 44 as triodes. It will be evident that these tubes can be pentodes or can even be replaced by transistors.

It is to be noted that in FIGURE 3 the inductors 13 and 23, on the one hand, and 33 and 43, on the other, are not inductively coupled to one another. As a result, the filter can be adjusted very easily.

In the filter shown the various branches are coupled together directly and by capacitive means (III and IV). It will be evident that the branches can alternatively be coupled together by inductive means.

What is claimed is:

1. A bandpass filter for passing a comparatively wide range of frequencies and also for strongly and selectively suppressing a comparatively narrow range of frequencies located within the said wide range or in the vicinity thereof, said filter comprising first and second longitudinal branches connected in series and each comprising a series-resonant circuit tuned to provide a low longitudinal impedance for said filter in said wide range, a transverse branch coupled to the common point of the longitudinal branches and comprising a series-resonant circuit tuned to a frequency located in said comparatively narrow range of frequencies and input and output circuits connected to points on said first and second branches other than said common point; wherein the improvement comprises a fourth branch connected in parallel with only a portion of the transverse branch, said fourth branch comprising a series-resonant circuit tuned to said frequency located in the comparatively narrow range of frequencies whereby the range of suppression of said narrow range is increased.

2. A bandpass filter for passing a wide continuous range of frequencies and selectively suppressing a narrow range of frequencies adjacent said wide range, comprising first and second series connected longitudinal branches and a transverse branch connected to the junction of said first and second branches, an input circuit connected to a point of said first branch other than said junction, an output connected to a point of said second branch other than said junction, each of said first and second branches comprising a series resonant circuit tuned to provide a low longitudinal impedance of said filter in said wide range, said transverse branch comprising a series resonant circuit tuned to a frequency in said narrow range, whereby the impedance of said transverse branch is low at said frequency, and a fourth branch connected in parallel with only a portion of said transverse branch, said fourth branch comprising a series resonant circuit tuned to said frequency, whereby the frequency range of suppression in said narrow range is increased.

3. The bandpass filter of claim 2, comprising a second output connected to said fourth branch for receiving signals in said narrow range.

4. The bandpass filter of claim 2 in which said first and second series branches are tuned to substantially the same frequency.

5. The bandpass filter of claim 2 comprising a neutralizing resistor, and means for connecting said neutralizing resistor between a point on said first series branch and a point on said second series branch.

6. A bandpass filter for passing a comparatively wide range of frequencies and also for strongly and selectively suppressing a comparatively narrow range of frequencies located within the said wide range or in the vicinity thereof, said filter comprising first and second longitudinal branches connected in series and each comprising a series-resonant circuit tuned to provide a low longitudinal impedance for said filter in said wide range, a transverse branch coupled to the common point of the longitudinal branches and comprising a series-resonant circuit tuned to a frequency located in said comparatively narrow range of frequencies, and input and output circuits connected to points on said first and second branches other than said common point, wherein the improvement comprises a fourth branch comprising a series-resonant circuit tuned to said frequency located in the comparatively narrow range of frequencies, the capacitor of the transverse branch being comprised of the series combination of two capacitors, and means connecting said fourth branch in parallel with one of said capacitors.

7. A bandpass filter for passing a wide continuous range of frequencies and selectively suppressing a narrow range of frequencies adjacent said wide range, comprising first and second series connected longitudinal branches and a transverse branch connected to the junction of said first and second branches, an input circuit connected to a point of said first branch other than said junction, an output connected to a point of said second branch other than said junction, each of said first and second branches comprising a series resonant circuit tuned to provide a low longitudinal impedance of said filter in said wide range, said transverse branch comprising a series resonant circuit tuned to a frequency in said narrow range and being comprised of the series circuit of an inductor, and first and second capacitors, connected in that order between said junction and a point of reference potential, whereby the impedance of said transverse branch is low at said frequency, and a fourth branch connected in parallel with said second capacitor, said fourth branch comprising a series resonant circuit tuned to said frequency, whereby the frequency range of suppression in said narrow range is increased.

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