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(54) Electrical filter.

(57) A filter comprises at least a pair of resonators (RES1,RES2) having an amplifier (AMP) inductively or capacitively coupled between the pair of resonators so that the power of an input signal input at IN passes through the amplifier and output at OUT to provide filtered and amplified output signal. By integrating an amplifier into the filter, this removes the need for an amplifier usually provided externally to the filter, thus saving space in a product incorporating this filter.This filter could be used as part of a duplex filter of a radio transceiver, where, for example,the amplifier could replace one of the stages of a multistage amplifier in the transmission branch of the radio transceiver.

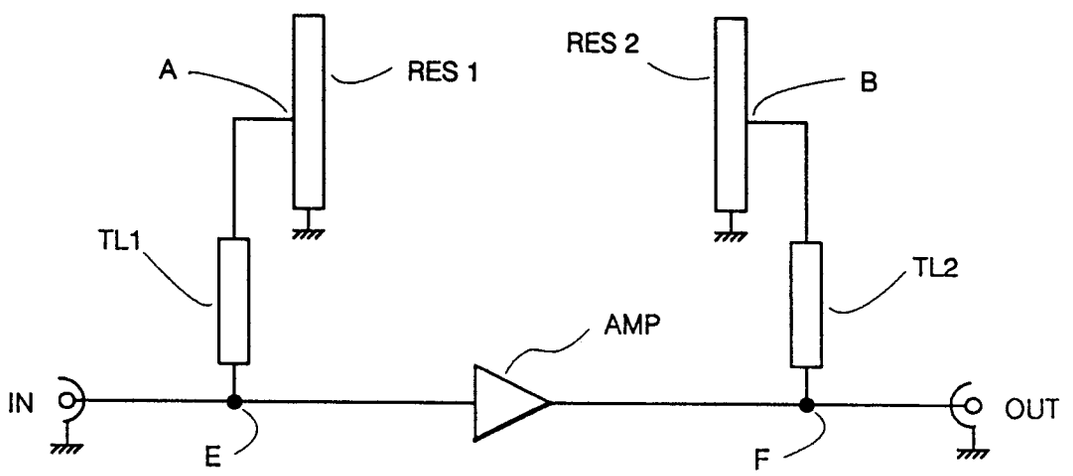


Fig. 3

EP 0 614 243 A1

The present invention relates to a filter for providing an output signal from an input signal input thereto,the output signal having a frequency in a predetermined frequency range, and the filter comprising at least one pair of intercoupled resonators. The invention also relates to a radio transceiver comprising such a filter.

In virtually all communications systems, for example, in radio transmitter - receivers (transceivers),for example in radio telephones, one or more filters are used for the purposes of separating wanted signals e.g information - bearing signals from unwanted signals such as interference, noise and distorting products.

A simplified block diagram of part of a radio telephone is shown in Figure 1 of the accompanying drawings.

As is well known to persons skilled in the art,a radio transceiver,for example, as used in a radio telephone includes a receiver section and a transmitter section for receiving and transmitting radio frequency (RF) communication signals. When transmitting, audio signals are input via a microphone to a modulator where a carrier signal is modulated with the input audio signal. The carrier signal is provided by a synthesizer or, for example,a crystal oscillator,for sufficient frequency stability, and has a frequency of between 6 and 25 MHz. The modulated signal is amplified by a power amplifier 1 and then coupled to a band pass filter 3 and, then to an antenna 4 for onward transmission. The power amplifier 1 of the receiver section of the radio telephone usually comprises several stages.

When receiving,a received signal is detected by the antenna 4 and coupled via the filter 3 to a radio frequency amplifier 2 and then to a mixer where the signal is mixed with a signal from a local oscillator thereby translating the output from the RF amplifier 2 to an intermediate frequency signal which is subsequently further amplified and demodulated. For sufficient selection ability and gain the receivers are usually constructed on the so-called double superhet principle in which the RF signal is translated twice before demodulation. The gain of the RF amplifier 2 is, in general low, and the bandwidth large.

When a single antenna 4 is used for both transmission and reception,a duplex filter 3 is used to prevent the transmission signals from travelling to the receiver section, and the received signals from travelling to the transmitter section. As with all the above, this is well known to persons skilled in the art, as is the construction and operation of duplex filters.

As is well known to persons skilled in the art, filters having the desired properties can be realised by the appropriate interconnection of a number of resonators. The individual resonators are in the form of a transmission line resonator corresponding to a parallel connection of an inductance and a capacitance. It is well known in high frequency technology to employ different types of resonators for different applications depending on the conditions of use and the desired characteristics. Known resonator types include dielectric, helical, strip line (including microstrip) and air isolated rod resonators. These various resonator types each have a relevant range of uses.For example, dielectric resonators,and filters constructed therefrom are commonly used, e.g in radio telephone applications because of their relatively small size and weight, stability and power endurance. For instance, a duplex filter such as the one described above with reference to Figure 1 may be constructed from discrete dielectric blocks, wherein an individual resonator is formed in each block.However, instead of dielectric resonators, other resonator types may be used, for example,helical,strip line or coaxial resonators. All of these filter designs are well known to persons skilled in the art and need not be described in any further detail except in the context of the present invention.

Figure 2 illustrates,schematically, a bandstop filter composed of two resonators RES1,RES2.Coupled galvanically,at an appropriate point A,B,to each resonator RES1,RES2 is a transmission line TL1 and TL2 respectively. By selecting the coupling points A,B appropriately, the impedance level of each resonator RES1,RES2 can be defined and the resonator RES1,RES2 matched to the rest of the circuit. This matching is called tapping and the coupling point A,B the tapping point. This is well known to persons skilled in the art.When using helical resonators they are matched respectively by tapping, whereby, for example, a transmission line is soldered, at a given point, to the helical resonator coil, usually in the first round of the coil. The filter is constructed by inductively or capacitively coupling the resonators RES1, RES2 together depending on what kind of filter is desired. In the example described herein, the bandstop filter is constructed by coupling the two resonators together RES1,RES2 using an inductance L as illustrated in Figure 2. In this example, the filter is a low pass filter. If the two transmission lines TL1,TL2 are replaced by capacitances,then a high pass filter is produced. Alternatively, if the inductance L is replaced by a capacitance, then a band pass filter is obtained. An input IN and an output OUT are provided at the ends of the coupling of the resonators. Filters can also be constructed with more than two resonators.

Usually, amplifiers such as the two amplifiers described above are located before or after a filter, for example,the duplex filter described above. The filters and the amplifiers are separate components and, as such, take up a relatively large amount of space on the printed circuit boards upon which they are placed. This, in turn, puts constraints on the design and manufacture of the circuits and circuit boards and, particularly, limits the amount of space that can be saved, and, consequently, the amount of miniaturization that can be achieved.

According to an aspect of the present invention there is provided an amplifier coupled between the at least one pair of intercoupled resonators such that the input signal is coupled through the amplifier to provide an amplified output signal is amplified. This has the advantage that by incorporating an amplifier in the filter, the amplifier is no longer a separate component which needs to be placed on the circuit board, and, as such, space can be saved.

The filter may comprise three or more resonators and,may, therefore, incorporate more than one amplifier. The filter may be part of a duplex filter of a radio transceiver in which the integrated amplifier or amplifiers may be part of the power amplifier of the receiver section and/or the multistage power amplifier of the transmitter section. This has the advantage of providing for significant space saving and, therefore, reduction in size of, for example,a radio transceiver using such a filter.

The invention will now be described, by way of example only, with reference to the accompanying drawings of which:

Figure 1 is a schematic block diagram of part of a radio telephone;

Figure 2 is a schematic circuit diagram of a stop filter of the prior art;

Figure 3 is a schematic circuit diagram of a filter in accordance with the invention;and

Figure 4 is a schematic circuit diagram of a second embodiment of the invention.

As with the filter of the prior art described with reference to Figure 2,a filter in accordance with the invention - illustrated schematically in Figure 3 - comprises two resonators,also designated by the same references RES1 and RES2 for ease of understanding. Those components which correspond to those in the prior art have been designated with the same references. The filter of Figure 3 is what is known as a notch filter serving as a low pass filter.It is almost identical to the prior art filter of Figure 2,except that the inductance L has been replaced by an amplifier AMP i.e. the amplifier AMP is placed in the coupling path of the filter.The filter operates at the resonance frequency of the resonators RES1, RES2 as a bandstop filter, filtering out higher frequencies from an input signal input at IN. Such a filter could be used for example in the transmitter branch of a duplex filter in a radio telephone where the reception frequency band is above the transmission frequency band. The resonators RES1,RES2 present high impedances at points E and F of Figure 3 to signals at the reception frequencies,while at the transmission frequencies, the signal is input at IN and coupled through the amplifier AMP to the output OUT i.e the RF power passes from the input IN through the amplifier AMP to the output OUT. While the filter also carries out its usual function of filtering out the undesired frequencies,the incorporation of the amplifier AMP in the filter serves to provide a filtered and amplified output signal at the output OUT and, as such, the amplifier AMP can therefore act as one of the stages of a multistage amplifier of the transmission section of the radio telephone,with the other amplifier stages being coupled separately to the input of the amplifier AMP. Because one stage of the amplifier is now integrated in the filter, space can be saved in the rest of the transceiver of the radio telephone e.g on the printed circuit board on to which the components are mounted.

The filter could also be used in the receiver branch of a duplex filter,the integrated amplifier AMP serving as the power amplifier of the receiver branch of a transceiver.

Figure 4 represents schematically, another embodiment of the invention. In this example, a filter comprises three resonators RES1,RES2,RES3, to which respective transmission lines TL1,TL2,TL3 have been galvanically coupled as in the previous example.Coupled between the other ends of transmission lines TL1 and TL2 is a first amplifier AMP1 and between transmission lines TL2 and TL3 a second amplifier AMP2. This filter also functions as a filter and also serves to provide an amplified, filtered output, but in this case two stages of a multistage amplifier can now be integrated into the filter itself.

As will be understood to a person skilled in the art,various modifications are possible within the scope of the present invention. For example,where there are three or more resonators, only one amplifier can be integrated and an inductance (or capacitance) replaces the other of the amplifiers. Similarly, if there are sufficient resonators coupled in the same manner,more stages of a multistage amplifier can be integrated into the filter. Other filter arrangements are possible,with one or more amplifiers being integrated therein. For example, capacitances can be used rather than the transmission lines for coupling the amplifiers to the resonators i.e the amplifiers are capacitively rather than inductively coupled to the resonators.

Claims

1. A filter for providing an output signal from an input signal input thereto,the output signal having a frequency in a predetermined frequency range, and the filter comprising at least one pair of intercoupled resonators (RES1,RES2), characterised in that at least one amplifier (AMP) is coupled between the at least one pair of resonators such that the input signal is coupled through the amplifier to provide an amplified output signal.

2. A filter as claimed in claim 1 comprising three or more resonators,the at least one amplifier being also inductively coupled to a third resonator

(RES3) adjacent the pair of intercoupled resonators.

3. A filter as claimed in claim 1 comprising three or more resonators,the at least one amplifier being also capacitively coupled to a third resonator (RES3) adjacent the pair of intercoupled resonators.

4. A filter according to claim 1 comprising three or more resonators and a plurality of amplifiers (AMP1,AMP2),each of the amplifiers being coupled between a pair of adjacent intercoupled resonators (RES1,RES2;RES2,RES3).

5. A filter according to any preceding claim wherein the at least one amplifier is inductively coupled to the pair of resonators.

6. A filter according to any of claims 1 to 4 wherein the at least one amplifier is capacitively coupled to the pair of resonators.

7. A radio transceiver comprising an antenna (4),a receiver section,a transmitter section and a duplex filter (3) coupled between the antenna and the receiver and transmitter sections, the duplex filter comprising a receiver branch coupled to the receiver section for filtering a received signal coupled from the antenna to the receiver section,and a transmitter branch coupled to the transmitter section for filtering a signal coupled from the transmitter section to the antenna,characterised in that the duplex filter comprises at least one filter as claimed in any preceding claim.

8. A radio transceiver as claimed in claim 7 characterised in that the at least on filter is in the transmitter branch, the at least one amplifier being part of a multistage power amplifier (1) of the transmitter section.

9. A radio transceiver as claimed in claim 7 or claim 8 characterised in that the at least on e filter is in the receiver branch, the at least one amplifier being part of an amplifier (2) of the receiver section.

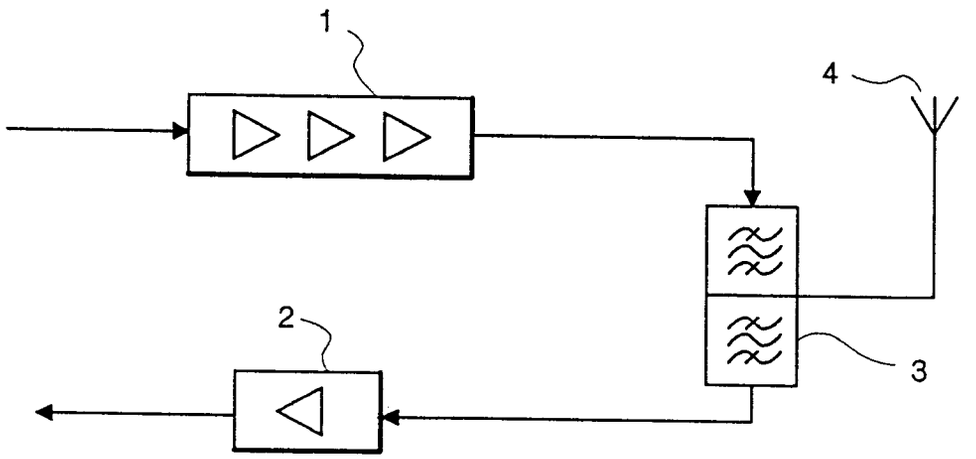


Fig. 1

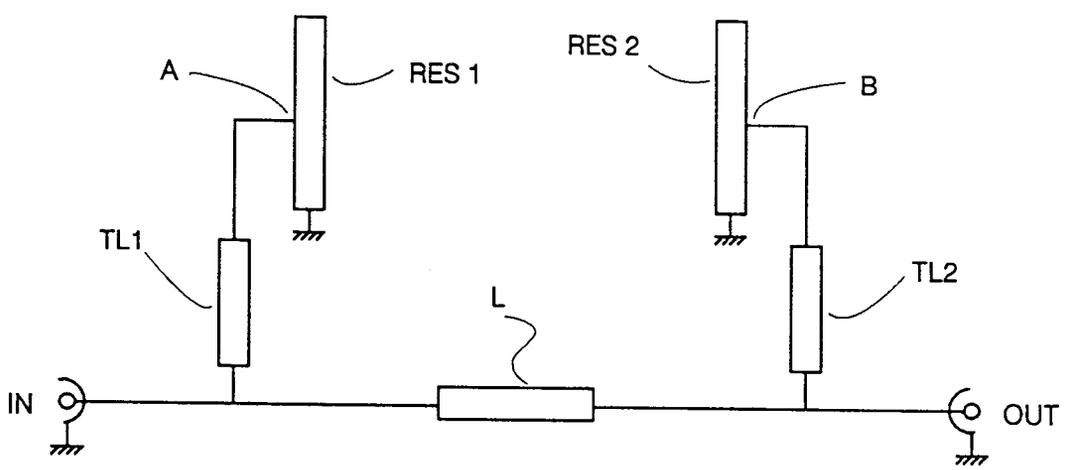


Fig. 2

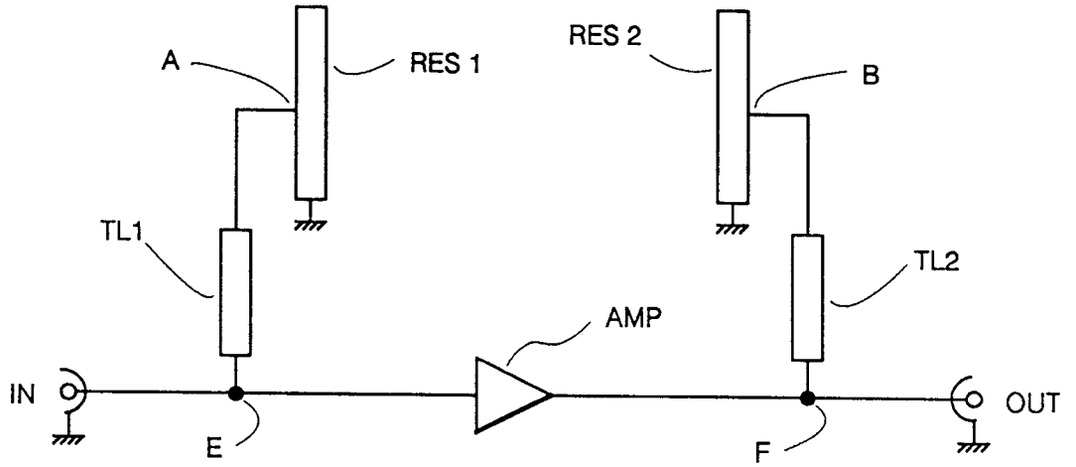

A
RES 1
RES 2
B
TL1
TL2
AMP
IN
E
F
OUT

Fig. 3

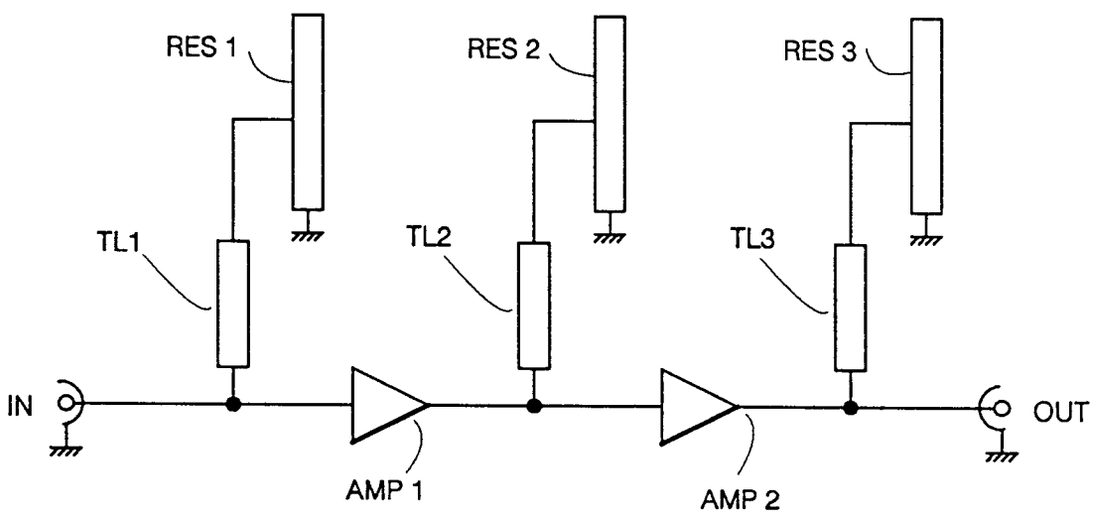

RES 1
RES 2
RES 3
TL1
TL2
TL3
IN
AMP 1
AMP 2
OUT

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 1243

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	IEEE MICROWAVE AND GUIDED WAVE LETTERS, vol.3, no.1, January 1993, NEW YORK US pages 1 - 2 W. SCHWAB ET AL. 'A low-noise active bandpass filter'	1,4	H01P1/203
Y	* page 1, left column, line 1 - page 2, left column, line 6; figure 2 *	2,3,5-7	
Y	PATENT ABSTRACTS OF JAPAN vol. 11, no. 288 (E-542) 17 September 1987 & JP-A-62 086 904 (MURATA MANUFACTURING CO LTD) 21 April 1987 * abstract *	2,5	
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 53 (E-301) (1776) 7 March 1985 & JP-A-59 194 501 (MATSUSHITA DENKI SANGYO K.K.) 5 November 1984 * abstract *	3,6	
Y	US-A-4 168 479 (RUBIN) * column 1, line 20 - line 32 * * column 2, line 12 - line 54; figure 1 *	7	TECHNICAL FIELDS SEARCHED (Int.Cl.5) H01P
X	ANTENNAS AND PROPAGATION SOCIETY SYMPOSIUM June 24-28,1991,Ontario,CA;IEEE,NewYork,US ,1991 Digest,Vol. 1; pages 230-233 M.R. MOAZZAM et al.:"Analysis and design of a novel microwave active filter" *page 230,line 7-page 231,line 26;figure 1,2*	1,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 May 1994	Den Otter, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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