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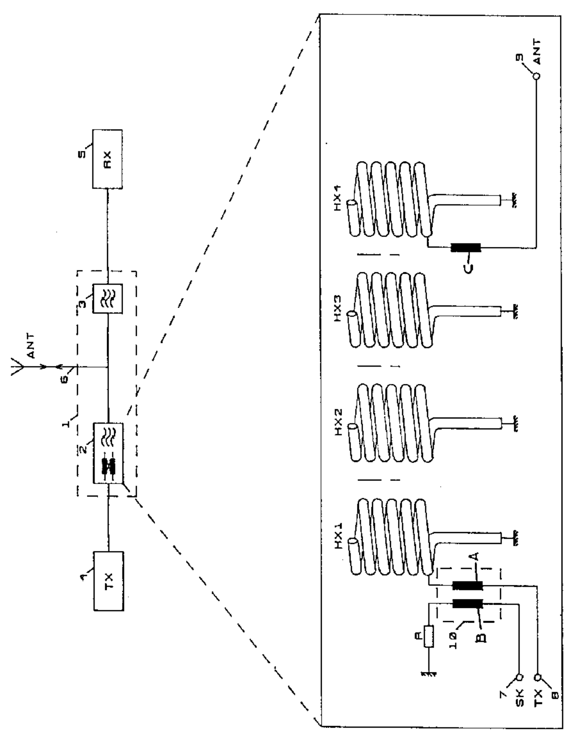
(54) Electrical filter.

(57) A filter (1) for filtering certain frequencies of an electric signal. The filter (1) comprises components (HX1-HX4) for forming the frequency response of the filter, and components (A,C) for accomplishing coupling and impedance matching. The filter is provided with a directional coupler (10) composed of two transmission lines (A,B), one of them being a coupling line (A) or an impedance matching line.



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The present invention relates to a filter.

In the radio telephone industry research and development has for a long time been aimed at the production of smaller, less expensive and more efficient units and components. This direction has lead to efficient exploitation of the available space on circuit board surfaces, to an increase in the degree of component integration, and towards rationalization of functions.

High frequency components of radio telephones constitute an exception to this trend. High frequency components have to date been extremely complex in construction, comprising discrete components and strip constructions.

It is known in the art to employ in the transmitter part of a radio telephone an output control circuit for controlling the output level of the transmission. The operation of the output control circuit is based on indications of the output level of the transmitter and comparison with a reference value. An essential part of the output control circuit is formed by a directional coupler, placed immediately adjacent the separation filter of the reception circuit, with which a voltage comparable with the output of the transmitter is produced. The directional coupler is therefore used for measuring the transmission output power, whereby the output level is controlled with the output control circuit. The directional coupler is usually located after the transmitter or before the antenna.

The directional coupler is conventionally constructed using various coupled transmission line constructions and transformers.

A widely used directional coupler, having low manufacturing costs, can be constructed using microstrips or strip lines mounted directly on a telephone circuit board. Drawbacks of the structure include the relatively large circuit board area required and the high dependence of the operation on the properties of the circuit board substrate material and variations therein. The substrate material affects the dielectric insulation material losses of the microstrip line, these being greatly dependent on the so-called loss tangent of the material, and it affects the line losses, which are affected by the smoothness of the surface of the material.

In order to reduce the costs, an advantageous general purpose material is frequently selected for the substrate material in radio telephones. The use of such a material causes deterioration in the functioning of the directional coupler constructed thereon. The increased material losses of the substrate material and the tolerances of the properties can be directly detected in the insertion attenuation of the directional coupler and in the variation of said properties.

By using a directional coupler design which is based on using separate transmission lines (e.g. coaxial cables), on a transformer, or by constructing the switch on a separate, stable or low loss substrate, these losses can be reduced and the operation stabilized. However, a plate area of at least the same size is needed, and in addition, the use of a separate substrate increases manufacturing costs.

According to the present invention there is provided a filter comprising filter means coupled to impedance matching means and coupling means for coupling the filter to external components, characterized by the filter comprising a directional coupler.

An advantage of the present invention is the avoidance of the above mentioned drawbacks by removing the directional coupler from the substrate of the transmitter as a discrete component or strip structure and by forming the directional coupler as an integral part of the filter.

A filter in accordance with the present invention makes use of transmission lines in the couplings of the filter, such as a receiver (RX) or a transmitter (TX) separation filter, or in the matching circuits for implementing the directional coupler. With the aid of the invention the directional coupler can be transferred from the circuit board substrate, frequently being a high-loss substrate and afflicted by environmental disturbances, into a high frequency filter. The high frequency filter offers an encapsulated environment protected against interference with a low-loss and stable substrate as required by a filter. Furthermore, since the directional coupler in accordance with the invention comprises a transmission line of a filter and a switch transmission line coupled thereto, the only additional losses caused by the coupler are of the magnitude of the output sample sampled by the transmitter system, which is a significant improvement in comparison with the state of the art.

The directional coupler in accordance with the invention is relatively easy to implement by placing the coupler in conjunction with the filter or by making use of the components existing in the filter, such as coupling lines or impedance matching transmission lines. The directional coupler can be produced by adding another microstrip e.g. in parallel with a microstrip. The directional coupler may, in fact, be implemented in a great number of ways using many types of transmission lines, preferably microstrips, or suspended substrate lines. The manner of implementation may vary in accordance with the invention, but the essential feature is that a directional coupler is included in the filter. Preferably, the directional coupler is implemented with the existing filter constructions.

A radio apparatus which is provided with both a transmitter and a receiver and in which the same antenna is used needs a transmission network for directing the signal to be transmitted and signal received appropriately.

The signal from the antenna must be directed to the receiver so that no significant interference is caused by the transmitter. Similarly, a signal from the transmitter must be transmitted to the antenna without causing any interference from the receiver.

As is well known in the art, duplex filters composed of two separation filters and based on resonators are used to separate the signals to be transmitted and received. The duplex filter is therefore usually composed of two separate bandpass filters, one of them being connected to the receiver branch, its mean frequency and bandwidth corresponding to the receiving band, and the other filter being connected to the transmitter branch, its mean frequency and bandwidth corresponding to the transmission band. The other ends of the filters have frequently been connected to a common antenna line via a transmission line matching the impedance. Even though the duplex filter has frequently been accommodated within a single housing provided with terminals for transmitter, receiver and antenna, in practice it is composed of two separate bandpass filters because the isolation between the filters must be made as great as possible so that the electromagnetic leakages therebetween should not impede the functioning of the filter.

The filters constructed using the helix technique are provided with a metal partition between both of the filters, with which the required isolation is efficiently implemented. The couplings in duplex filters to the resonators and the couplings between the resonators have commonly been implemented by means of matching couplings formed by various transmission line constructions and discrete components.

The invention is described below in more detail, by way of example with reference to the accompanying figure, which is a schematic diagram of a filter comprising a filter-directional coupler block in accordance with the invention.

The figure shows schematically the coupling of a duplex filter 1 of a radio telephone to a transmitter block 4 and a receiver block 5. The duplex filter 1 comprises four ports: one port 8 for a transmission signal entering the filter, a port 9 for the antenna, a port (not shown) for the receiver 5, and a directional coupler port 7. A signal from the antenna 6 to be received propagates via the reception filter block 3 of the duplex filter 1 to the receiver 5. Respectively, a signal from the transmitter 4 propagates through the receiver (RX) separation filter block 2 of the duplex filter 1 to antenna 6. From said signal proceeding to the antenna the directional coupler 10 takes a sample of a given level, comparable with the output level of the transmitter, and transmits it to the directional coupler port 7.

The figure illustrates the integration of a directional coupler 10 in the matching circuit at the transmitter end of the RX separation filter 2 of the duplex filter 1. The directional coupler 10 has preferably been implemented on a circuit board using coupled microstrips. One of the strips, strip A, serves as a coupling strip for the filter input to the helix HX1, the other one of the strips, strip B, serves as a coupling strip to the directional coupler port 7. The coupler strip B ends in a resistor R. In the filter of the figure, the directional coupler could be positioned adjacent the antenna port 9, whereby it could be easily implemented by adding another branch next to strip C which carries out the impedance matching. The additional branch would comprise a directional coupler port 7, a coupler transmission line, comparable to line B, and an end resistor R.

The directional coupler 10 is preferably composed of two adjacent microstrips A and B provided with common ground planes. Electromagnetic coupling exists between the strips: a voltage in one strip producing an electric field which induces a voltage also in the other strip. Magnetic coupling is likewise caused by a magnetic field provided by the current propagating in the strip, said field inducing a current also into the other strip. When power is transferred from the transmitter block 4 to port 8, the desired part of the power, which is determined by the coupling, is coupled to the directional coupler port 7, another part thereof passes through the coupler 10 towards a first resonator HX1 of the filter, and a very small leakage part caused by the non-homogeneity and quasi transverse electric and magnetic (TEM) waveform of the switch is short circuited via the end resistor R to the ground. The microstrip coupler 10 described above is bilateral, i.e. any power carried to any port will be coupled in the same way, because of the symmetry.

The proportions of the quasi TEM directional waveform in the coupler is generally used as a quality measure. In other words comparison of the power at directional coupler port 7 and the power at the insulated leakage port leading to ground via resistor R provides a measure of quality.

By using an integrated filter and directional coupler design in accordance with the invention in the duplex filter of a radio telephone, losses caused in the transmitter part of the radio telephone by the directional coupler can be reduced significantly, the operation of the radio telephone stabilized, and the use of the telephone substrate area enhanced.

In view of the foregoing it will be clear to a person skilled in the art that modifications may be incorporated without departing from the scope of the present invention.

Claims

1. A filter comprising filter means coupled to impedance matching means and coupling means for coupling the filter to external components, characterized by the filter comprising a directional coupler.

2. A filter according to claim 1, characterized in that

the directional coupler comprises two transmission lines.

3. A filter according to claim 2, wherein one of the two transmission lines is an impedance matching transmission line.

4. A filter according to claim 2, wherein one of the two transmission lines is a coupling line.

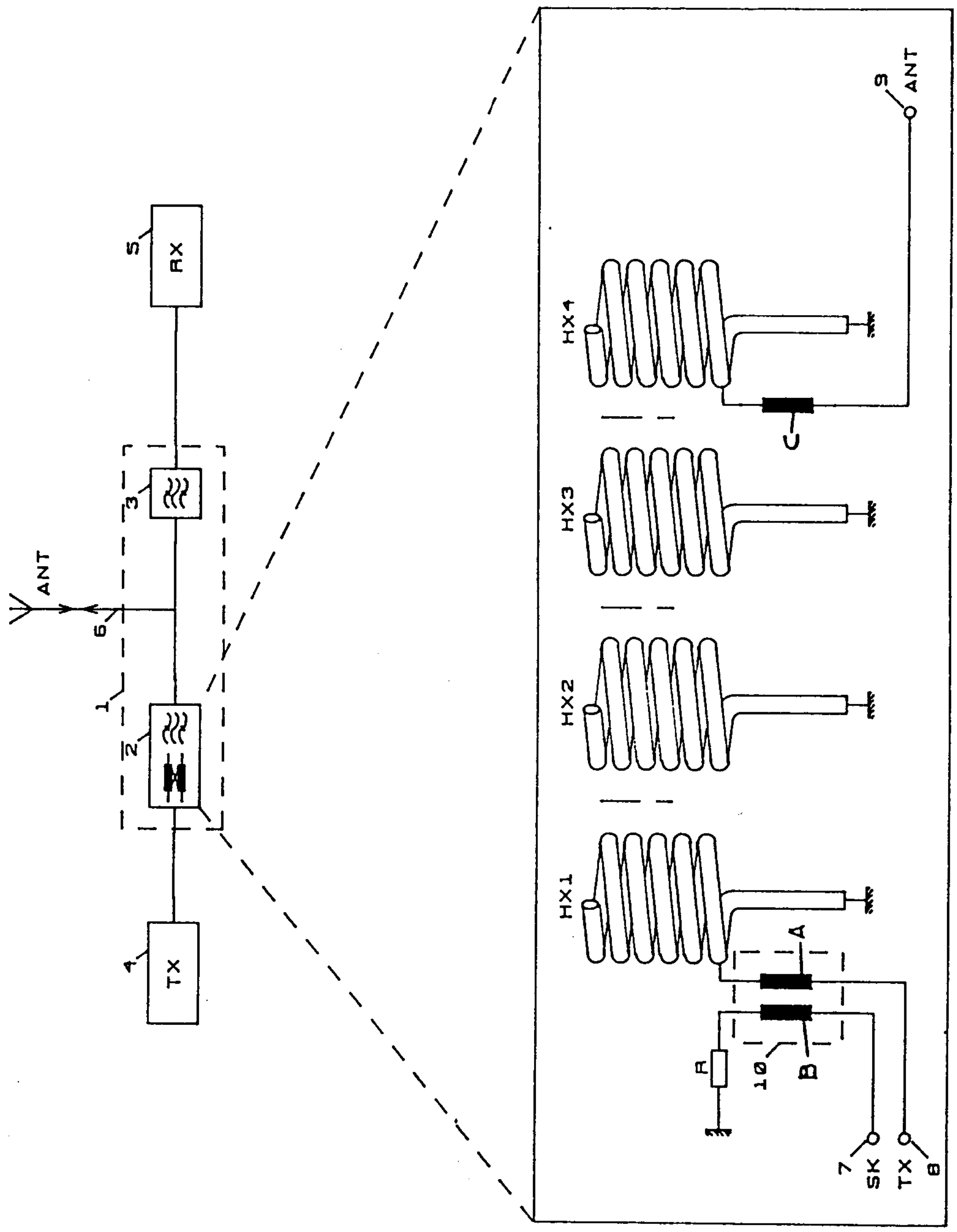
5. A filter according to any one of claims 2 to 4, characterized in that the transmission lines are microstrips.

6. A filter according to any one of claims 2 to 4, characterized in that the transmission lines are suspended substrate lines.

7. A filter according to any one of the previous claims, wherein the filter is a helix filter.

8. A filter according to any one of claims 1 to 6, wherein the filter is a ceramic filter.

9. A filter according to any one of claims 1 to 6, wherein the filter is a filter composed of discrete components.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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	US-A-3 829 770 (STEVENS) * column 3, line 64 - column 5, line 38 * * column 6, line 43 - column 7, line 58; figures 1,6,7 * ---	1-4,9 5-8	H01P1/20 H01P5/18
Y	GB-A-749 337 (STANDARD TELEPHONES AND CABLES LTD) * page 1, line 74 - line 95 * * page 2, line 116 - page 3, line 17; figures 1,7,8 * ---	5	
Y	US-A-4 433 314 (HISLOP ET AL.) * column 2, line 20 - column 3, line 6; figure 1 * ---	6	
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 244 (E-430)(2300) 22 August 1986 & JP-A-61 074 401 (MATSUSHITA ELECTRIC IND. CO. LTD.) 16 April 1986 * abstract * ---	7	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 379 (E-465)(2436) 18 December 1986 & JP-A-61 172 402 (MURATA MANUFACTURING CO LTD) 4 August 1986 * abstract * ---	8	H01P H03H H03G G01R
X	US-A-4 232 401 (CHANG ET AL.) * column 2, line 48 - column 4, line 9; figures 1,3 * ---	1-4	
A	EP-A-0 117 676 (LUCAS INDUSTRIES) * the whole document * ---	1	
A	GB-A-2 156 176 (LITTON SYSTEMS INC.) * page 3, line 53 - line 127; figure 3 * ---	1-5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 MAY 1993	DEN OTTER A.M.

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
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TECHNICAL FIELDS SEARCHED (Int. Cl.5)

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