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BAND-PASS SELECTOR

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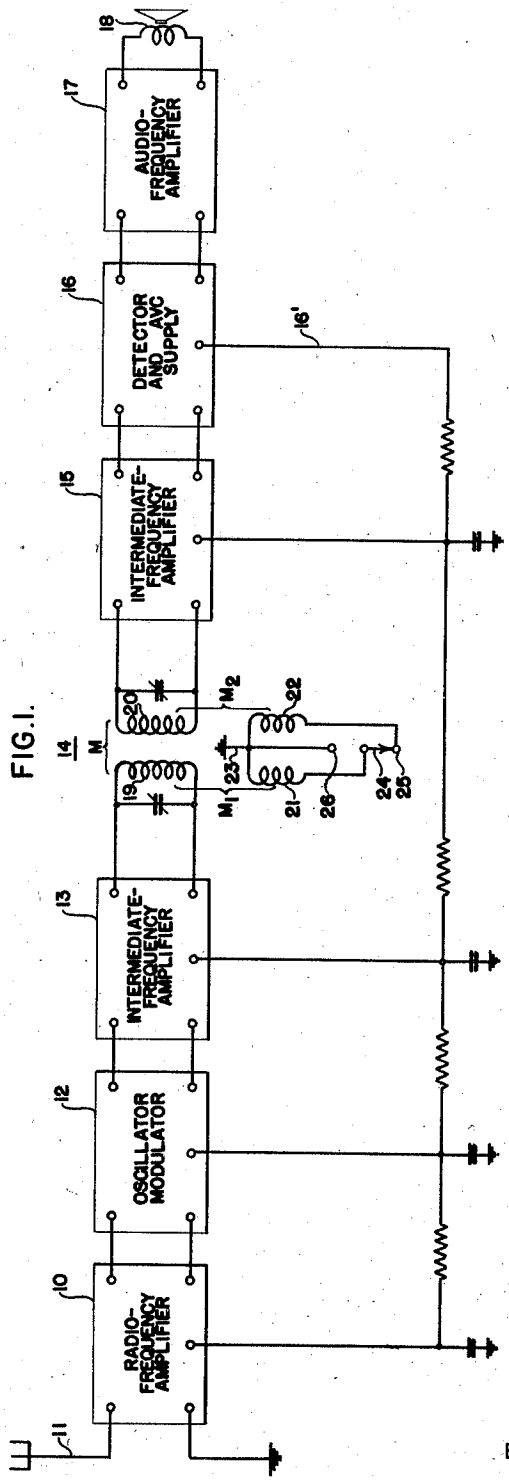


FIG. 1.

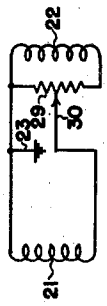


FIG. 3.

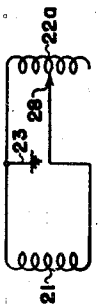


FIG. 2.

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BAND-PASS SELECTOR

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This invention relates to band-pass selectors of simplified form and, more particularly, to band-pass selectors having band-pass characteristics adjustable about a fixed mean frequency. While the invention is of general application, it is particularly suitable for use in the intermediate-frequency channel of a superheterodyne radio receiver.

It is frequently desired to tune a modulated-carrier signal receiver to one of two stations on adjacent channels having a signal strength of the same order as, or less than, that of the adjacent undesired signal. In such a case, it is essential that the receiver have selector circuits which are sufficiently selective to transmit the desired signal without undue interference from the adjacent undesired signal. In general, however, if highly selective circuits are used, the side-band frequencies remote from the mean frequency of the signal channel are necessarily attenuated, resulting in a reduction in the quality or fidelity of signal reproduction. Such highly selective circuits are not needed where the desired signal has an amplitude substantially greater than that of the signal on an adjacent channel. Under such circumstances, it is desirable that the selector circuits of the receiver have a flat-topped band-pass characteristic which is at least as broad as the total modulation-frequency band of the received signal, so that all signal components are transmitted uniformly.

It is present practice, therefore, to provide the receiver with one or more selector circuits which are adustable to meet the two conditions of receiver operation described above. Such selector circuits are generally relatively complicated in that they employ either complicated mechanical arrangements to vary the coupling between two or more tuned circuits, or relatively complicated electrical arrangements for varying the coupling therebetween. It has been proposed normally to couple the circuits of the selector by means of two coupling paths having opposite coupling effects, one of which is greater than the other, thus providing maximum selectivity, and to vary or remove one of the coupling paths to provide a net coupling greater than the critical value and thereby widen the band of frequencies passed. Circuits of this type previously proposed, however, have been such as to detune the selector circuits in the same direction when the coupling between the circuits is varied, thus tending to shift the mean frequency of the band of frequencies passed by the selector.

It is, therefore, an object of the invention to provide a simplified circuit arrangement for varying the coupling between the tuned circuits of a band-pass selector and for simultaneously detuning the tuned circuits symmetrically with respect to the mean frequency of the band.

In accordance with an embodiment of the invention, a band-pass selector circuit comprises fixed-tuned terminal circuits having a nondirective coupling means for coupling the terminal circuits. There is also included in the selector circuit auxiliary coupling means coupling the terminal circuits and means for adjusting the width of the pass band of the selector circuit comprising means for adjusting the coupling effect of the auxiliary coupling means and for simultaneously effectively introducing reactive components of opposite sense in the terminal circuits.

In accordance with a specific form of the invention, in a band-pass selector circuit of the type described the auxiliary coupling means has a coupling effect opposite to that of the first-named coupling means, the coupling effect between the terminal circuits being less than the critical value of coupling therebetween, and the means for adjusting the width of the pass band of the selector circuit comprises means for decreasing the coupling effect of the auxiliary coupling means and for simultaneously detuning the terminal circuits in opposite senses, the reactive constants of the coupling circuits being such that the effective gain of the selector circuit remains substantially constant.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawing, in which Fig. 1 is a circuit diagram, partly schematic, of a radio broadcast receiver of the superheterodyne type embodying a band-pass selector constructed in accordance with the invention, while Figs. 2 and 3 represent different embodiments of the band-pass selector of Fig. 1, per se.

Referring now more particularly to Fig. 1 of the drawing, there is illustrated one form of the improved band-pass selector system embodied in a radio broadcast receiver of the superheterodyne type, for controlling the selectivity of the intermediate-frequency channel of the receiver. Briefly described, the receiver comprises a radio-

frequency amplifier 10 connected to an antenna-ground circuit 11 and coupled to an oscillator-modulator or frequency changer 12. Connected in cascade with the output circuit of the frequency changer 12 are an intermediate-frequency amplifier 13, a band-pass selector 14, intermediate-frequency amplifier 15, a detector and automatic amplification control or A. V. C. supply 16, an audio-frequency amplifier 17, and a sound reproducer 18. A bias potential derived from the automatic amplification control source 16 may be applied, by way of conductor 16', to one or more of the stages of the radio-frequency amplifier 10, to the oscillator-modulator 12, and to one or more of the stages of each of intermediate-frequency amplifiers 13 and 15.

Considering first the operation of the receiver as a whole, without regard to the details of the band-pass selector 14, per se, the desired received signal wave is selected and amplified in the radio-frequency amplifier 10 and is converted into a modulated intermediate-frequency carrier by the frequency changer 12. The signal as thus converted is further amplified in intermediate-frequency amplifier 13, selected and amplified in selector circuit 14 and intermediate-frequency amplifier 15, and rectified in the detector 16, thereby producing the audio frequencies of modulation, which are, in turn, amplified in the audio-frequency amplifier 17 and reproduced by the sound reproducer 18. The amplification of the received signal is subject to automatic amplification control by the control-bias potential derived from the source 16, according to the manner well understood in the art.

Referring now more particularly to the details of the band-pass selector system, indicated generally at 14, and constructed in accordance with the invention, the system comprises a fixed-tuned input or terminal circuit 19 and a fixed-tuned output or terminal circuit 20, which circuits are coupled to the output circuit of intermediate-frequency amplifier 13 and to the input circuit of intermediate-frequency amplifier 15, respectively. In order to provide a nondirective coupling between the terminal circuits, the inductance elements of the circuits 19 and 20 are inductively coupled, as indicated by the bracket M. For providing a coupling effect between the terminal circuits 19 and 20 opposite to that provided by the coupling M, there is provided an auxiliary coupling means in the form of a link circuit comprising serially-connected inductances 21 and 22 individually coupled to the inductance elements of the circuits 19 and 20, respectively. The mutual inductance between the inductance 21 and the circuit 19 is represented by the bracket M_1, while the corresponding mutual inductance between inductance 22 and circuit 20 is represented by M_2. One side of the link circuit is grounded at 23, while a switch 24, having contacts 25 and 26, is provided in the other side of the link circuit in order to open the series connection of inductances 21 and 22 and short-circuit inductance 21. The circuit constants of the arrangement just described are so adjusted that the coupling effect due to the mutual inductance M is considerably greater than that of the link circuit between the tuned terminal circuits 19 and 20.

In considering the operation of the selector just described, it will be assumed that, with the switch 24 closed at 25 so that the coupling effect of the link circuit opposes that of the mutual inductance M, the circuit constants are such that the resultant coupling between the circuits 19 and 20 is critical or less than critical, so that the selector has relatively great selectivity. When the switch 24 is opened at 25 and closed at 26, the opposing coupling effect of the link circuit between the tuned terminal circuits 19 and 20 is eliminated, while at the same time the effect is to remove inductance 22 from the selector circuit and to short-circuit the inductance 21. Under this condition, the resultant coupling between the circuits 19 and 20 is materially increased and the pass band of the selector correspondingly widened. At the same time, the effective inductance in circuit 19 is materially reduced, because of the fact that the terminals of the low-inductance winding 21 are short-circuited rather than being connected through the impedance of inductance 22, and the inductance 22 is effectually removed from the selector circuit and, therefore, the inductance reflected by it across the circuit 20 is practically eliminated. As a result, circuits 19 and 20 are detuned in opposite directions from the mean resonant frequency of the intermediate-frequency channel of the receiver. This also has the effect of widening the band of frequencies passed by selector 14, without shifting the mean resonant frequency of the band, that is, without causing the band-pass characteristic of the selector to become unsymmetrical about the mean frequency of the band. The switch 24 and its connections with the windings 21 and 22 of the link circuit thus constitute means for adjusting the width of the pass band of the selector circuit, comprising means for adjusting the coupling effect of the auxiliary coupling means and for simultaneously effectively introducing reactive components of opposite sense in the terminal circuits.

In another embodiment of the invention, the link circuit may take the form shown in Fig. 2, wherein parts which are identical with the link circuit of Fig. 1 are given similar reference numerals. In the embodiment shown in Fig. 2, the switch 24 has been omitted and inductance 22*a* comprises an adjustable tap 28 connected in the link circuit, as shown. It will readily be seen that, at one limiting position of the tap 28 of Fig. 2, the inductance 22*a* is entirely included in the link circuit and, at the other limiting position, the inductance 22*a* is effectively removed from the link circuit and the inductance 21 is short-circuited. Thus, the arrangement of Fig. 2 provides, in addition to the advantages of Fig. 1, a further advantage in that the selectivity of the band-pass selector may be gradually varied between the two limiting values.

In a further embodiment of the invention, the link circuit may be as shown in Fig. 3 and comprise a resistor 29 connected across inductance 22 and provided with an adustable tap 30. The operation of the circuit of Fig. 3 is similar to that of Fig. 2 and no further explanation is deemed to be necessary.

It will be understood that, if the circuits 19 and 20 are critically coupled by means of the mutual inductance M and the link circuit comprising inductances 21 and 22, the effect of symmetrically detuning the terminal circuits 19 and 20 by means of the operation of the switch 24 or adjustable contacts 28 or 30 is materially to decrease the gain of the selector. It will further be understood that the selector 14 may be so designed that the coupling effects of the mutual inductance M and the link circuit comprising the inductances 21 and 22 result in a net

coupling which is considerably less than critical. In this case, the effect of operating switch 24 or adjustable contacts 28 or 30 to increase the coupling between terminal circuits 19 and 20 is to increase the gain of the selector system, while the effect of symmetrically detuning the terminal circuits is to decrease the gain across the selector 14. Thus, the system can be so designed that these effects are compensating and a substantially constant gain is obtained in each position of switch 24 or contacts 28 or 30. It will be further understood that in another embodiment of the invention the terminal circuits 19 and 20 may initially be symmetrically detuned when the link circuit is completed between circuits 19 and 20 and that the link circuit may be adjusted effectively to reflect reactance components into the terminal circuits to tune them to the same frequency and at the same time decrease the total coupling between the terminal circuits.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling means therebetween, auxiliary coupling means for coupling said terminal circuits, and means for adjusting the width of the pass band of said selector circuit comprising means for adjusting the coupling effect of said auxiliary coupling means and for simultaneously effectively introducing reactive components of opposite sense in said terminal circuits.

2. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween greater than the critical value, auxiliary means for coupling said terminal circuits having a coupling effect opposite to that of said first-named coupling, and means for adjusting the width of the pass band of said selector circuit comprising means for decreasing the coupling effect of said auxiliary coupling means and for simultaneously effectively introducing reactive components of opposite sense in said terminal circuits.

3. A band-pass selector circuit comprising fixed tuned terminal circuits normally resonant at the same frequency and having a nondirective coupling means therebetween, auxiliary coupling means for coupling said terminal circuits, and means for adjusting the width of the pass band of said selector circuit comprising means for adjusting the coupling effect of said auxiliary coupling means and for simultaneously introducing reactive components of opposite sense in said terminal circuits.

4. A band-pass selector circuit comprising fixed tuned terminal circuits normally resonant at the same frequency and having a nondirective coupling therebetween, auxiliary coupling means for coupling said terminal circuits having a coupling effect opposite to that of said first-named coupling, and means for adjusting the width of the pass band of said selector circuit comprising means for decreasing the coupling effect of said auxiliary coupling means and for simultaneously effectively detuning said terminal circuits in opposite senses.

5. A band-pass selector circuit comprising fixed tuned terminal circuits normally resonant at different frequencies and having a nondirective coupling therebetween, auxiliary means for coupling said terminal circuits having a coupling effect of the same sense of that of said first-named coupling, and means for adjusting the width of the pass band of said selector comprising means for decreasing the coupling effect of said auxiliary means and for simultaneously effectively tuning said terminal circuits toward the mean resonant frequency of the band of frequencies passed by said selector circuit.

6. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween, auxiliary coupling means for coupling said terminal circuits having a coupling effect opposite to that of said first-named coupling means, the coupling effect between said terminal circuits being less than the critical value of coupling therebetween, and means for adjusting the width of the pass band of said selector circuit comprising means for decreasing the coupling effect of said auxiliary coupling means and for simultaneously detuning said terminal circuits in opposite senses, the reactive constants of said coupling circuits being such that the effective gain of said selector remains substantially constant.

7. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween, auxiliary means comprising an aperiodic link circuit for coupling said terminal circuits, and means for adjusting the width of the pass band of said selector circuit comprising means for adjusting the coupling effect of said link circuit and for simultaneously effectively introducing reactive components of opposite sense in said terminal circuits.

8. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween, a link circuit comprising two inductances individually inductively coupled to said terminal circuits, said link circuit having a coupling effect in opposite sense to that of said first-named coupling, and means for adjusting the width of the pass band of said selector circuit comprising means for decreasing the coupling effect of said link circuit and for simultaneously and oppositely adjusting the reactive effects which said inductances reflect into their respective coupled circuits.

9. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween, a link circuit coupling said terminal circuits comprising two inductances individually inductively coupled to said terminal circuits, the coupling effect of said link circuit being less than and opposite to that of said first-named coupling, and means for adjusting the width of the pass band of said selector circuit comprising means for gradually adjusting the coupling effect of said link circuit and for simultaneously gradually adjusting oppositely the reactive effects of said inductances upon their respective coupled circuits.

10. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween, a link circuit comprising two inductances individually inductively coupled to said terminal circuits, the coupling effect of said link circuit being opposite to and less than that of said first-named coupling, and

means for adjusting the width of the pass band of said selector circuit comprising means to adjust one of said inductances to vary the coupling effect of said link circuit and simultaneously oppositely to vary the reactive effects of said inductances upon their respective coupled circuits.

11. A band-pass selector circuit comprising fixed tuned terminal circuits having a nondirective coupling therebetween, a link circuit coupling said terminal circuits comprising two inductances individually inductively coupled to said terminal circuits, the coupling effect of said link circuit being opposite to and less than that of said first-named coupling, and means for adjusting the width of the pass band of said selector circuit comprising a resistor coupled across one of said inductances and having an adjustable portion connected across said link circuit for adjusting the coupling effect of said link circuit and for simultaneously oppositely varying the reactive effects of said inductances upon their respective coupled circuits.

12. A band-pass selector circuit comprising, fixed-tuned resonant terminal circuits having a nondirective coupling therebetween, a link circuit comprising two reactances individually coupled to said terminal circuits, said link circuit also providing a coupling effect between said terminal circuits, and means for adjusting the width of the pass band of said selector circuit comprising means for changing the coupling effect of said link circuit and for simultaneously and oppositely adjusting the reactive effects which said reactances insert in their respective coupled circuits.

13. A band-pass selector circuit comprising, fixed-tuned resonant terminal circuits having a nondirective coupling therebetween, a link circuit comprising two reactances individually coupled to said terminal circuits, said link circuit also having a coupling effect between said terminal circuits, and means for adjusting the width of the pass band of said selector circuit comprising means for opening said link circuit and for simultaneously shorting one of said reactances, whereby the reactive effects which said reactances insert into their respective coupled circuits are changed equally and oppositely.

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