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BAND FILTERING DEVICE WITH VARIABLE BAND BREADTH

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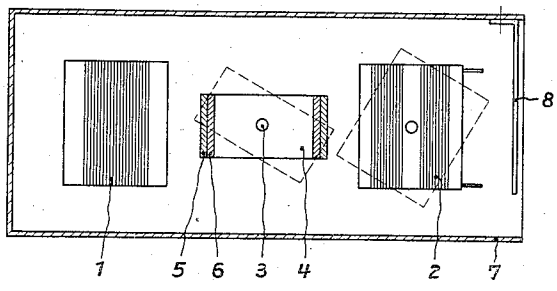

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BAND FILTERING DEVICE WITH VARIABLE BAND BREADTH

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4 Claims. (Cl. 178—44)

My invention relates to band filters for radio or similar apparatus and particularly to means for modifying the characteristic curve of such filters by varying the coupling between circuits of the band filter. The general object of the invention is to provide improved means of the above character.

In order to control the selectivity and fidelity of a radio receiver it is usual practice to vary the characteristic curve of a band filter by varying the coupling of the filter circuits. For this purpose various methods and arrangements have been proposed heretofore. For example it has been proposed to vary the distance between the coils of the coupled circuits, to turn the coils relatively to each other, to vary a capacity which couples the coils, or to provide adjustable magnetic members, for example of powdered iron suitable for high frequency operation, either within or between the filter circuit coils.

All of these methods and arrangements have the disadvantage that when the coil coupling is changed, detuning of the filter circuits occurs which causes a deviation of the resulting band filter frequency, the adjustment of the radio receiver for a given frequency thereby being lost. Moreover, in these arrangements hitherto proposed, the circuit damping or effective circuit resistance of the individual circuits of the band filter was left constant as the coupling was varied as a result of which it was possible to effect only within narrow limits the varying of the width of the characteristic curve of the band filter, as the coupling was changed from its high selectivity value to its high fidelity value and vice versa.

In accordance with my present invention, the foregoing disadvantages are obviated by the provision, in addition to the means for varying the coupling of the band filter circuits, of correction means, positively adjusted simultaneously with the coupling means, both for compensating for the detuning and for changing the circuit damping or effective circuit resistance of the band filter circuits in accordance with the degree of coupling of the circuits. For example, if the coupling device is so operated that the degree of coupling is made closer, the circuit resistance of the band filter circuits is caused simultaneously to increase.

The general solution of the problem may be attained by means of various constructions. In my preferred construction an iron body, variable in its position with respect to the two circuits of the band filter, is mounted between the band filter circuits. By its adjustment the iron body operates to couple the circuits of the band filter more closely or more loosely, in accordance with the position of the iron body with respect to the coils. Simultaneously with the adjustment of the iron body for closer coupling of the circuits, in the course of which adjustment the value of self inductance of the coils increases by reason of the closer approach of the iron to the coils, the position of a member or members whose purpose it is to increase the circuit resistance within close limits is readjusted, or in a modification of my invention, a resistance operatively associated with one of the coupled circuits may be varied. In either case, as the coupling of the circuits is made closer the effective circuit resistance of the band filter circuits is caused simultaneously to increase. Further, as the iron body is adjusted for closer coupling of the circuits, the position of a member the purpose of which is primarily to compensate for the change in tuning caused by the movement of the iron body and which also operates to vary the effective circuit resistance, is also adjusted.

In the preferred embodiment of my invention, the members for compensating for the detuning and for varying the band filter effective resistance are mounted upon and moved by the iron body which constitutes the coupling device. However, as a device for compensating for the detuning and for adapting the circuit resistance of the band filter to the degree of coupling, it is possible when employing coils which are adjustable within a shielding casing to utilize the shielding casing itself. For this purpose the shielding casing may support additional plates or metal members, so arranged that when the coils are adjusted for the purpose of changing the degree of coupling, the strength of the effective field, in which the additional plates or members are located, changes correspondingly. In certain applications of the invention, coils of the band filter may be fixed on a support, and the shielding casing, carrying the additional plates or members, may be made adjustable with respect to the coils.

The novel features which are considered to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation together with further objects and advantages may best be understood by reference to the following description taken in connection with the accompanying drawing the single figure of which is a semi-diagrammatic representation of a band filter, for radio receiving or

like apparatus, in which my invention has been embodied.

In the drawing, the numerals 1 and 2 designate respectively the coils or windings of the two circuits of the band filter. Arranged between the circuits, and rotatably adjustable about an axis 3, is mounted an element 4 formed of magnetic material, for example of powdered iron, for the purpose of varying the degree of coupling between the two circuits. In order, simultaneously with the varying of the coupling, to compensate for detuning and to vary the circuit resistance to the desired degree, pairs of metal members such as plates 5 and 6 are mounted on the opposite ends of the iron member 3. The members 5 and 6 are shown in simple form as flat plates but, in order to obtain a predetermined characteristic, they may be shaped in any desired manner. One of the pairs of plates, for example pair 6, serves particularly for compensating for the detuning but also operates to modify the circuit resistance. It is desirable for most efficient operation that the material of plates 6 be of good conductivity. The other pair of plates 5, serve, in conjunction with the pair 6, to vary within close limits the circuit resistance as the coupling is varied. It is desirable that the material of plates 5 be of high ohmic resistance. In certain instances the compensation for detuning and at the same time the desired varying of circuit resistance, as the coupling is varied, may be accomplished by a single pair of members, mounted similarly to plates 5 or 6, of suitable form and material.

In operation of the band filter device comprising the coils 1 and 2, iron member 4, and pairs of plates 5 and 6, when the iron member 4 is gradually rotated until the foregoing elements are in their positions illustrated in full line, the self-inductance of the coils 1 and 2 correspondingly increases, reaching the maximum value at the illustrated position, since then a maximum of the iron material of member 4 is effective in the fields respectively of coils 1 and 2. When body 4 is thus rotated toward its position of maximum coupling effect, plates 6 are also rotated toward their optimum position in which currents are set up therein producing fields opposing the fields of coils 1 and 2, these opposing fields reaching their maximum when plates 6 approach nearest to the coils. It will be seen that the plates 6 thus tend to cause a decrease of the self-inductance of coils 1 and 2 to compensate for the increase of self-inductance due to iron member 4 when in its position illustrated in full line, for closest coupling, but that the plates 6 have negligible effect on the mutual inductance of the coupled coils 1 and 2 since the fields set up by the opposite members of the pair 6 oppose each other.

Further, when the iron body 4 has been rotated as above described to its position illustrated in full line, then since the coupling between the circuits comprising coils 1 and 2 is the closest of which the device is capable, the characteristic curve of the band filter tends to assume the double humped form. But since the plates 5 and 6 have been rotated to their position most favorable for reflecting resistance to the circuits comprising coils 1 and 2, due to the functioning of the plates as short circuited secondaries for the coils, the effective resistance of these circuits is increased, thereby widening and smoothing out the band filter characteristic curve. The plates 6, being of material of good conductivity, are the more effective in reflecting resistance to the filter circuits, the plates 5, which are of material of high resistance, being provided to adjust to any desired close limit the total reflected resistance.

The iron body 4 and plates 5 and 6, therefore, so operate that when the device is in its illustrated position for closest coupling of the band filter circuits, the selectivity of the radio receiver apparatus is at a minimum and the fidelity correspondingly at a maximum. It is assumed that with the parts 1, 2, 4, 5 and 6 in their positions illustrated in full line, the band filter circuits are tuned, by any preferred means, to a predetermined fixed frequency.

When, now, the iron member 4, supporting the plates 5 and 6, is rotated from its position of closest coupling toward a position perpendicular to the axis of coils 1 and 2, for example to the position of member 4 indicated in dotted line, the coupling of the two circuits is decreased. Further, since less of the magnetic material of member 4 is effective in the fields of the coils, the self-inductance of the coils tends to decrease, thereby tending to cause detuning of the band filter circuits. However, the plates 6 are at the same time moved from their optiumum position for setting up fields opposing the fields of coils 1 and 2, this change in position of the plates tending to cause, in effect, an increase in the self-inductance. The adjustment of plates 6 corresponding to the adjustment of iron member 4 to its position shown in dotted line therefore compensates for the lessened self-inductance of the coils, and thus compensates also for the detuning effect of the change in position of iron member 4. The shift in position of plates 5 and 6 as iron body 4 is rotated to its position illustrated in dotted line further operates to reduce the effect of the plates in reflecting resistance to the band filter circuits.

Therefore the lower degree of coupling due to iron body 4, and the reduction in reflecting resistance, due to the plates 5 and 6, together cause the selectivity of the apparatus to be increased and the fidelity correspondingly reduced, as the body 4 is rotated to its position shown in dotted line without, however, causing detuning of the band filter circuits.

In certain cases it may be sufficient or expedient to vary positively the effective resistance of only one of the band filter circuits. In certain cases also it may be desirable to provide additional or supplemental means for varying the band filter circuit resistance. For the latter purpose a supplemental control plate or member 8 is shown in the drawing, supported on the shielding casing 7, the coil 2 being adjustable with respect to the member 8. In the latter arrangement the degree of coupling of the coils 1 and 2 is additionally varied because of the adjustment of coil 2, which effect may be desirable in certain applications of the invention. If such additional variation of the coupling is, however, not desired, coil 2 may be mounted rigidly, to remain in the position illustrated in full line, and member 8 may be arranged for adjustment with respect to coil 2.

An arrangement along the general lines of the embodiment shown in the drawing but omitting the rotatable control unit, comprising the members indicated by the numerals 3 to 6, may be used if at the same time a supplemental member for modifying the self-inductance is provided. For example, a winding or coil may be provided for this purpose, supported on the member 8 and

extending axially of the shielding casing 7, and of sufficent length to extend within the coil 2, which may be provided with an iron core suitable for high frequency operation.

In the embodiment illustrated in the drawing, members, as 5, adapted especially for changing the circuit resistance, within narrow limits, in accordance with change in the coupling are shown as independent of the means, as 6, designed primarily for compensating for the detuning of the circuits. Circuit resistance control members may, however, be electrically combined with the members adapted for compensating for detuning. Such resistance control members, further, need not be mounted on an adjustable coupling element, as 4, which is provided between the two band filter circuits, nor need they cooperate directly electrically with the coupling member. Members adapted for the band filter circuit resistance control function may in fact be connected to or provided within the band filter circuits and means may be provided whereby these members may be controlled positively in accordance with the adjustment of the means for controlling the coupling of the circuits. From this point of view members adapted for the circuit resistance control may take the form of adjustable ohmic resistances connected electrically in the band filter circuits.

My invention has been described herein in a particular embodiment for purposes of illustration. It is to be understod, however, that the invention is susceptible of various changes and modifications and that by the appended claims I intend to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A band filter system, comprising coupled resonant circuits tuned to a predetermined fixed frequency and each including a coil, means for varying the coupling between said circuits to vary the band width of said filter including a member of magnetic material mounted adjustably with respect to said coils, and means adjustable simultaneously with said first-named means to compensate for detuning of said system caused by said varying of the coupling, said last-named means including a pair of members of conductive material so mounted each with respect to a corresponding one of said coils that as said pair are adjusted said pair have negligible effect on the mutual inductance of said coils but compensate for changes in the self-inductance of said coils.

2. A band filter system comprising coupled resonant circuits tuned to a predetermined fixed frequency and each including a coil, means for varying the coupling between said circuits to vary the band width of said filter including a body of magnetic material mounted adjustably with respect to said coils, means adjustable simultaneously with said first-named means to compensate for detuning caused by said varying of the coupling, said last-named means comprising a pair of members of material of relatively high conductivity so mounted each with respect to a corresponding one of said coils that substantial resistance is reflected to said filter as said coupling is varied, and a pair of members of material of relatively high resistance mounted similarly to said first-named pair for varying the reflected resistance to said filter through close limits.

3. A band filter system comprising coupled resonant circuits tuned to a predetermined fixed frequency and each including a coil, means to vary the coupling between said circuits to vary the band width of said system including a member of magnetic material mounted between said coils adjustably with respect thereto, and means to compensate for detuning of said system caused by adjustment of said magnetic member including members of conductive material operatively associated with said magnetic member and adjustable simultaneously therewith, said conductive members being respectively adapted to be moved each with respect to a different one of said coils as said magnetic member is adjusted.

4. A band filter system comprising at least two coupled resonant circuits tuned to a predetermined fixed frequency, each of said circuits including a coil, means to vary the coupling between said circuits to vary the filter band width including a magnetic member mounted between said coils adjustably with respect thereto, means to compensate for detuning of said system tending to occur as said member is adjusted and to vary the effective resistance of said circuits as said coupling is varied, said second-named means including a pair of members of material of relatively high conductivity mounted respectively at opposite ends of said magnetic member and adapted respectively to be moved thereby each with respect to a different one of said coils, and additional means to vary said circuit resistance as said coupling is varied including a pair of members of material of relatively high resistance mounted on said magnetic member adjacent to said first-named pair of members.

HANS WECHSUNG.