

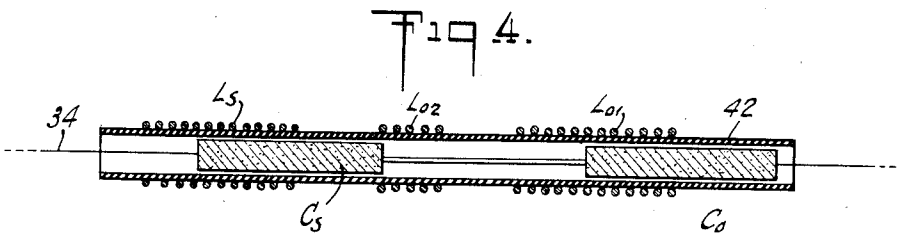
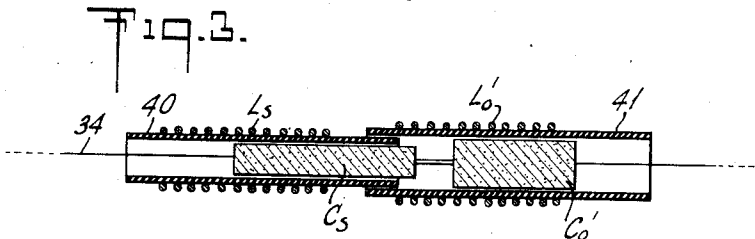
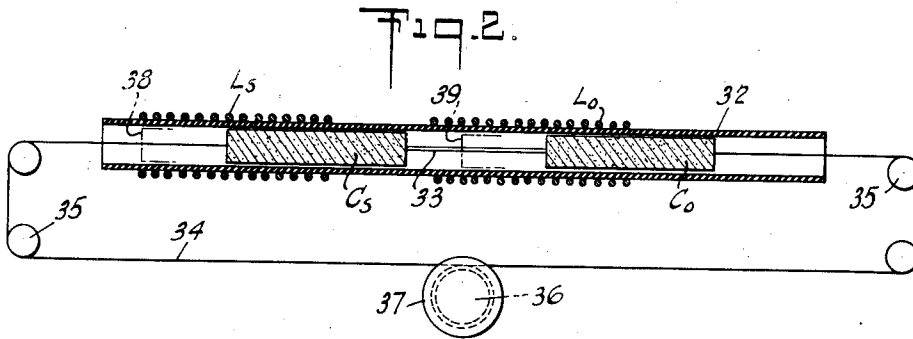
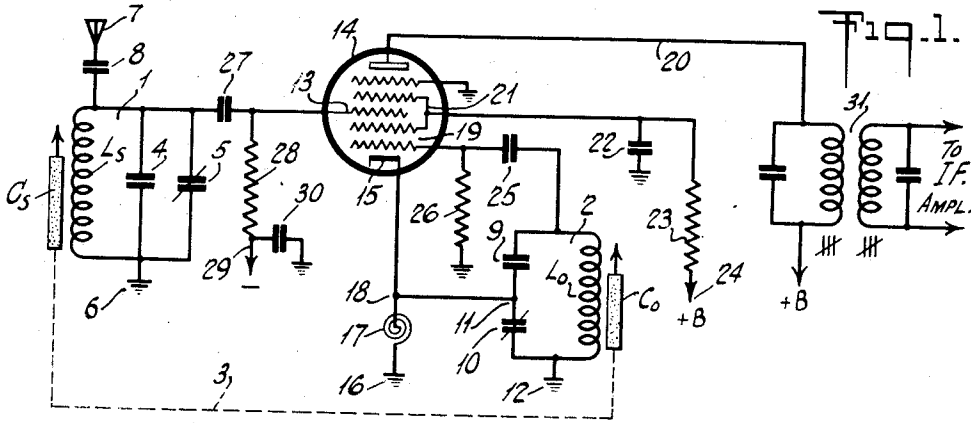
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PERMEABILITY TUNING SYSTEM

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PERMEABILITY TUNING SYSTEM

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8 Claims. (Cl. 250-40)

My present invention relates to a variable permeability tuning system for superheterodyne receivers, and more particularly to the core and coil structure utilized in the signal frequency and oscillator circuits of such receivers for effecting tracking between said circuits.

In receivers of the superheterodyne type it is essential for satisfactory operation that the resonant frequency of the signal circuit differ from that of the oscillator circuit by substantially a constant amount, this difference frequency being commonly known as the intermediate frequency. It is the usual practice to tune the oscillator circuit through a frequency range higher than the range through which the signal circuit is tuned. As a result in order to insure a constant frequency difference the frequency range of the oscillator circuit must be narrower in percentage, and if the variable tuning elements of the two circuits are to be uni-controlled, as is the usual practice, suitable means must be provided whereby the frequency variation of the oscillator circuit must be "slowed up" in order to keep in step with the frequency variation of the signal circuit.

It is therefore one of the objects of my invention to provide, in a superheterodyne radio receiver, an improved variable permeability tuning system for causing the oscillator and signal input circuits to track accurately one with the other throughout a predetermined frequency range.

There are several known methods and means for effecting tracking in the tuning of two or more circuits by variable permeability tuning means, some of which are impracticable because of cost or manufacturing difficulties. One known method of securing tracking in a permeability-tuned superheterodyne receiver for the broadcast band uses a variable-pitch winding on the oscillator coil. Other methods have included shaped cores, tapped-coils, or a two-section coil, so that the core enters one section while it is leaving the other section.

In the system according to the present invention, a single constant-pitch coil is used in the oscillator circuit but it is so dimensioned and positioned that as the oscillator core is withdrawn from its coil (in tuning the receiver to a higher frequency) the core that is withdrawn from the coil included in the radio frequency circuit enters the oscillator coil in order to obtain tracking.

It is a further object of the invention to arrange the oscillator tuning inductance and the tuning inductance of the signal frequency circuit

coaxially and in an axially spaced relation on a common coil form, or on separate coil forms of different diameters, the cores for the respective coils in each case being arranged to move in unison and in a manner such that at the high frequency end of the range as the coil for the signal frequency circuit is withdrawn from its associated coil it enters the oscillator coil winding to obtain thereby a predetermined relation in inductance variation of said coils with the core adjustment.

Still another object is to provide an auxiliary oscillator winding so arranged on the coil form that at the high frequency end of the range it is influenced by the core of the signal frequency circuit in a desired manner to effect tracking between the signal frequency and oscillator frequency circuits.

Still a further object is to provide a simple and inexpensive construction for the variable tuning inductors of two circuits which are to be tuned by the same control and which are to be maintained at a constant frequency difference.

The invention will be further understood however from the following description, when considered in connection with the accompany drawing and its scope is pointed out in the appended claims.

In the drawing,

Fig. 1 illustrates a typical circuit of a tuning system for a superheterodyne receiver which will serve to explain the application of the present invention, and

Figs. 2, 3 and 4 show various core and coil arrangements in accordance with the invention.

Referring first to Fig. 1 which illustrates a typical converter circuit of a superheterodyne receiver, the tunable signal input circuit is shown at 1 and the tunable oscillator circuit at 2. In the signal input circuit, the variable tuning inductance L_s is provided with a movable tuning core indicated at C_s , while in the oscillator or second circuit, the tuning inductance L_o is provided with a movable tuning core C_o connected with the first tuning core, as indicated by the dotted line 3, for unitary tuning control movement.

The circuit 1 includes a shunt tuning capacitor 4 for the inductance L_s and a shunt trimmer capacitor 5, the latter being adjusted to establish the low frequency end of the tuning range when the core C_s is moved fully within the winding L_s .

The circuit 1 is connected to ground as indicated at 6 and is connected at its high potential side to any suitable signal source, such as an

antenna 7, through suitable coupling means, such as a coupling capacitor 8.

The second tuned circuit 2 likewise includes shunt capacity means for the inductance L_o comprising two series connected capacitors 9 and 10, the latter being adjustable in a similar manner to the capacitor 5, for adjusting the tuning at the low frequency end of the tuning range of the circuit 2.

The oscillator circuit 2 in the present example is of the Colpitts type, having a cathode connection 11 between the capacitors 9 and 10, and being grounded as indicated at 12, at the low potential side thereof.

The input circuit 1 is connected at its high potential side to a signal input grid 13 of a combined detector-oscillator tube 14. The cathode 15 is connected to ground 16 through a suitable R. F. choke coil 17, the cathode terminal 18 of which is connected with the cathode tap 11 of the oscillator circuit.

The circuit 2 is connected with a second signal grid 19 in the tube 14 for electronically mixing the signals from the circuit 1 with oscillations to produce a predetermined intermediate frequency in the output anode circuit 20 of the detector-oscillator tube. Feedback for the production of oscillations is provided in connection with the screen grid 21, which functions as an anode coupled to ground through a by-pass capacitor 22 in connection with a filter resistor 23 in the screen grid supply circuit indicated at 24. The oscillator grid is provided with the usual grid coupling capacitor 25 and grid leak 26 to ground.

In connection with the circuit 1 and the signal input grid 13, a coupling capacitor 27 and grid resistor 28 are provided, the latter being connected to a bias supply lead 29, with a suitable by-pass to ground through a by-pass capacitor 30.

Signals are derived from the output circuit 20 of detector-oscillator through a suitably tuned intermediate frequency coupling transformer 31.

Referring now to Fig. 2 along with Fig. 1, the same reference characters are used to designate like parts as in the preceding figure, the signal input circuit inductance being indicated at L_s and the oscillator tuning inductance being indicated at L_o and their respective tuning cores being shown at C_s and C_o . The inductance windings are each of constant or uniform pitch and are coaxially arranged and axially spaced on a common insulating cylindrical coil form 32 within which the cores are adapted to be reciprocated. The inner opposing ends of the cores are connected by means of a rigid member, such as the rod 33, and the extreme outer ends of the cores are connected to suitable flexible means, such as a cable 34, which is entrained about idler pulleys 35 and an operating control shaft 36, the latter being provided with a knob 37 for effecting the simultaneous adjustment of the cores.

The coil and core geometry of L_s and C_s are so chosen that movement of the core from its fully entered position (shown by the dotted line 38) to a position wherein it is substantially withdrawn, the tuning of the signal circuit 1 will be varied through a predetermined frequency range, such as the present broadcast band, from the low end to the high end respectively, of said range. In order that the oscillator circuit may track with the signal circuit at the low end of the range more accurately than can be obtained by adjustment of the trimmer condensers 5 and

10 alone, the core C_o may be adjusted relatively to the core C_s as by varying the length of the connecting rod 33, so that its position corresponding to the fully entered position 38 of the core C_s will be as shown by the dotted line 39. Since the oscillator core L_o is of uniform pitch, adjustment of its core C_o in tuning the oscillator circuit toward the high frequency end of the range will result in a decided departure from the desired tracking frequency. In order to compensate for this departure it is arranged that as the core C_s is withdrawn from its associated coil L_s it enters into the field of the oscillator coil L_o , thereby increasing the inductance of the latter coil and slowing up the frequency variation of the oscillator circuit to a sufficient extent to cause it to track properly with the signal circuit.

In Fig. 3 an alternative arrangement for obtaining proper tracking is shown, separate coil forms for the signal and oscillator coils being used. As illustrated the oscillator coil L'_o is mounted on the larger diameter coil form 41, since the increase in the coil diameter has the effect of slowing up the frequency variation of the oscillator circuit with adjustment of its tuning core C'_o . The use of separate coil forms permits the position of each coil to be adjusted with respect to its core. In other respects this modification is like that shown in Fig. 2 and will operate in substantially the same manner.

In Fig. 4, as in Fig. 2, a common coil form 42 is used, there being provided however an auxiliary oscillator coil winding L_{o2} spaced from and suitably connected, in series or in parallel, to the main oscillator coil L_{o1} . In operation, as the core C_s is moved to tune the signal circuit toward the high end of the frequency range it is gradually withdrawn from the signal coil L_s and permitted to enter the field of the auxiliary oscillator coil L_{o2} , thereby increasing the inductance of the latter and affecting the oscillator circuit in a manner similar to that described in connection with the previous modifications.

In the modifications disclosed in Figs. 2 and 4 the coils L_s and L_o (or L_{o1}) do not necessarily have to be of the same length, diameter or wire size, nor do the length, diameter, or permeability of the cores C_s and C_o have to be the same, although from the standpoint of lower production cost it would be desirable to have coils and cores of similar dimensions. In Fig. 4 the pitch, diameter or wire size of the two sections L_{o1} and L_{o2} of the oscillator winding do not have to be the same. The coils in this case do not have to be near one another. For each application, however, it is necessary to determine, by trial or calculation, the dimensions, permeabilities, etc., of the cores and coils which will come closest to the true desired tracking.

While I have shown and described certain preferred embodiments of my invention, it will be understood that various modifications and changes will occur to those skilled in the art without departing from the spirit and scope of this invention. I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim is:

1. In a permeability tuning system for use in radio apparatus having a pair of circuits to be tuned, each of said circuits comprising a tuning coil and a movable magnetic tuning core, said tuning coils being coaxially arranged and their respective cores so constructed and arranged

with respect to each other and with respect to the coils that as one of the cores is withdrawn from its associated coil it is caused to enter into the other coil to thereby effect a predetermined tracking relation between said pair of circuits.

2. In a permeability tuning system for a super-heterodyne receiver having a signal frequency circuit and an oscillator circuit, said circuits each comprising a tuning coil and a movable magnetic tuning core, said coils each being of uniform pitch and coaxially arranged, and said cores being so constructed and arranged with respect to each other and with respect to the coils that as the signal frequency core is withdrawn from its coil it is caused to enter into the oscillator coil to thereby effect a predetermined tracking relation between said signal frequency and oscillator circuits.

3. In a permeability tuning system for a super-heterodyne receiver having a signal frequency circuit and an oscillator circuit, means for effecting tracking between the signal frequency and oscillator circuits over a predetermined frequency range comprising a tuning coil and a movable tuning core for each of said circuits, means for moving said cores in unison to tune the system through said frequency range, said coils each being of uniform pitch and coaxially arranged, and said cores being so constructed and arranged with respect to each other and with respect to their coils that upon simultaneous adjustment of the signal frequency and oscillator cores the inductance variation of the oscillator coil at one end of the frequency range is brought about by the joint action of both cores upon the oscillator coil.

4. In a permeability tuning system for a super-heterodyne receiver having a signal frequency circuit and an oscillator circuit, means for effecting tracking between the signal frequency and oscillator circuits over a predetermined frequency range comprising a tuning coil and a movable tuning core for each of said circuits, means for moving said cores in unison to tune the system through said frequency range, said coils being coaxially arranged and at least the winding of the oscillator coil being of uniform pitch,

the cores being so constructed and arranged with respect to each other and with respect to their coils that as the signal frequency core is withdrawn from its coil to tune the system to a higher frequency it is caused to enter into the oscillator coil.

5. In a permeability tuning system as defined in claim 4, wherein the coils are mounted on a common insulating tubular form.

6. In a permeability tuning system as defined in claim 4, wherein the coils are mounted on separate insulating tubular forms of different diameters.

7. In a permeability tuning system for a super-heterodyne receiver having a signal frequency circuit and having an oscillator circuit, means for effecting tracking between the signal frequency and oscillator circuits over a predetermined frequency range comprising a tuning coil and a movable tuning core for each of said circuits, means for moving said cores in unison to tune the system through said frequency range, an auxiliary coil associated with the oscillator tuning coil, said coils being coaxially arranged and at least the winding of the main oscillator coil being of uniform pitch, said cores being so constructed and arranged with respect to each other and with respect to their coils that as the signal frequency core is withdrawn from its coil to tune the system to a higher frequency it is caused to enter into the auxiliary oscillator coil.

8. In operating a tuning system which includes two circuits each having a coil and a relatively movable ferro-magnetic core to tune said circuits over upper and lower frequency ranges respectively, the method of regulating the inductance variations produced by the relative movement of said coils and said cores to maintain said circuits at a substantially constant frequency difference, which consists in the step of causing the core associated with the coil of the circuit operating over the lower frequency range to enter into the coil of the circuit operating over the upper frequency range and thereby partly affect the inductance variations of both coils at one end of said frequency ranges.

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