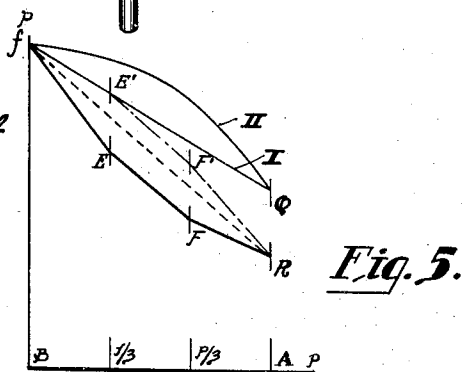
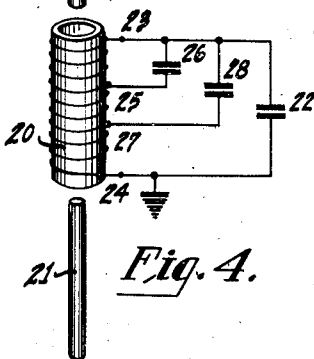
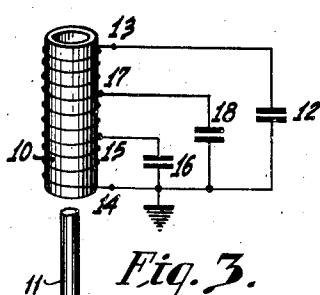
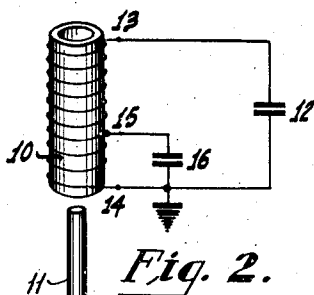
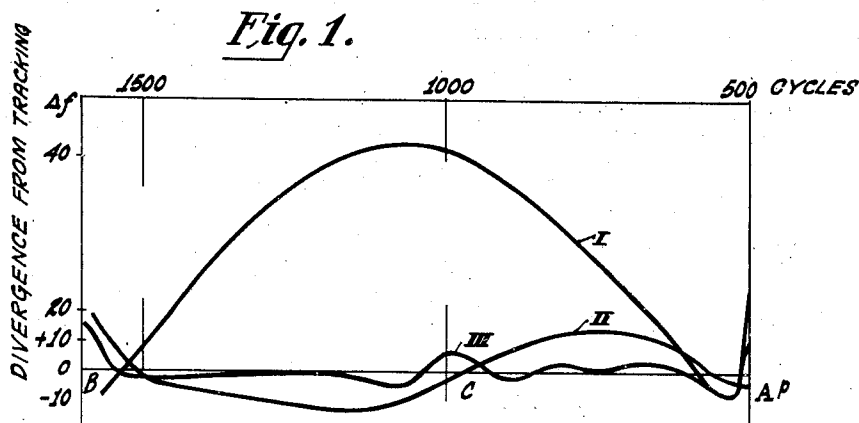


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T. A. SPOOR

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TUNING DEVICE COMPRISING AT LEAST TWO TUNING
CIRCUITS HAVING AN UNEQUAL FREQUENCY RANGE
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2,427,331

TUNING DEVICE COMPRISING AT LEAST TWO TUNING CIRCUITS HAVING AN UNEQUAL FREQUENCY RANGE

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1 Claim. (Cl. 250—40)

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This invention relates to a tuning device, particularly for superheterodyne receivers, comprising at least two tuning circuits which have an unequal frequency range and which are tuned by shifting a core of magnetic material in the field of each of the coils and in the axial direction thereof, the cores being coupled together mechanically and the extreme values of the frequency range of each of the tuning circuits being adjusted at least approximately to the correct values. The coils which are used here and which have a slidable core are briefly referred to hereinafter as sliding-core coils, the expression "frequency range" being understood to mean the ratio of the maximum frequency to the minimum frequency to which the circuit concerned can be tuned.

Tuning devices comprising at least two tuning circuits of different frequency range are used inter alia in superheterodyne receivers, it being as is well-known, necessary for the tuning frequency of the oscillator tank circuit to exhibit a constant difference from the tuning frequency of the pre-selection circuits throughout the frequency range, said difference being equal to the tuning frequency of the I. F. amplifier. As a rule, the local oscillations have a higher frequency than the oscillations received so that the cut-off frequencies of the oscillator tank circuit are on a higher level than those of the pre-selection circuits, the frequency range of the oscillator tank circuit being moreover smaller than that of the pre-selection circuits.

Various methods have been suggested for adjusting the extreme values of the frequency range of the oscillator tank circuit to the correct values for a given frequency range of the pre-selection circuits. If sliding-core coils are used the extreme values of the frequency range may be influenced, for example, by the choice of the number and of the pitch of the turns and of the diameter of the coil, by connecting a fixed inductance of suitable value in series with the variable inductance and also by the choice of the parallel capacity.

Even if the constants of the oscillator tank circuit are correctly adjusted by any of the above-mentioned methods so that the difference between the tuning frequencies of oscillator tank circuit and pre-selection circuits at the highest and the lowest frequency has the desired value, considerable divergence from the desired frequency difference will occur in the intermediate range.

It is an object of the invention to provide means by which the divergence from a desired frequency

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characteristic can be at least substantially compensated throughout the frequency range.

According to the invention, this object is attained by means wherein the inductance of at least one of the tuning circuits is provided with two or more tapings and at least two condensers are connected at different points between two tapings and/or between a tapping and one end of the coil, the capacities of said condensers being so adjusted that divergence from the desired frequency characteristic of the tuning circuit concerned is at least substantially eliminated.

When the invention is applied to a superheterodyne receiver the oscillator coil is preferably provided with two tapings at about $\frac{1}{3}$ and at about $\frac{2}{3}$ of the number of turns and each of these tapings and the end of the coil in which the sliding core enters into the coil have connected between them condensers of such value that the divergences from the desired difference between the tuning frequencies of the oscillator tank circuit and the preselection circuits are compensated at least approximately throughout the frequency range.

It has previously been suggested to reduce the divergence from the desired frequency characteristic with tuning devices of the said kind by providing the sliding-core coil which forms part of the circuit having the smallest frequency range with one tapping and to connect one condenser between this tapping and the end of the coil in which the sliding core enters into the coil.

Although by this method a considerable decrease of the divergence is obtained the divergence remaining is frequently exceedingly large. This method permits of obtaining the desired difference frequency at the beginning and at the end of the frequency range and also in an intermediate position of the core but between the said points considerable divergence will still be present.

According to the invention, the remaining divergence from the desired frequency range is reduced to a very great extent so that in all practical cases it is less than the maximum admissible deviation.

In order that the invention may be clearly understood and readily carried into effect it will now be described more fully with reference to the accompanying drawing, in which

Figs. 1 and 5 are two graphs;

Fig. 2 shows a circuit arrangement of the kind previously suggested and

Figs. 3 and 4 show two embodiments of the invention.

Fig. 1 shows a few curves indicating the rela-

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tion between the divergence Δf from a desired frequency difference and the tuning frequency of the pre-selection circuits of a superheterodyne receiver with sliding-core tuning.

The curve I shows the characteristic of Δf when at the points where the core is positioned completely within and completely outside the coil (corresponding to points A and B), the desired frequency difference occurs ($\Delta f=0$) but when supplementary measures for the reduction of the divergence in the center of the range are not taken. About the center of the range, the frequency of the oscillator tank circuit is obviously about 70 kilocycles/sec. in excess. For practical reasons the positions of the core at which $\Delta f=0$ do not coincide entirely with the positions in which the core is completely within and completely outside the coil; this condition, however, does not affect the principle of the invention.

The curve II shows the characteristic of the divergence Δf as a function of the tuning frequency of the pre-selection circuits when the circuit arrangement shown in Fig. 2 is used. Fig. 2 shows a cylindrical coil 10 into which a core 11 of magnetic material can be slid. The condenser 12 is connected to the ends 13 and 14 of the coil 10 and the condenser 16 is interconnected between the tapping 15 and the end 14 of the coil where the core 11 enters into the coil. The curve II indicates the results obtained if the position of the tapping 15 and the value of the condenser 16 are optimum. It is thus also possible to obtain a zero frequency divergence at a single intermediate position C of the core. On either side of this position, however, considerable divergence remains, which divergence in the optimum case may be as much as 12 kilocycles/sec.

According to the invention, this divergence can be reduced to a very great extent and a characteristic of the divergence Δf as a function of the tuning frequency of the pre-selection circuits as shown by the curve III can be obtained by the use of the circuit arrangement shown in Fig. 3.

Referring to this figure, in addition to the tapping 15 provision is made for a second tapping 17, a condenser 18 being connected between this tapping and the end 14 of the coil. The tapings 15 and 17 are preferably arranged at $\frac{1}{3}$ and at $\frac{2}{3}$ respectively of the number of turns of the coil; a correct choice of the values of the condensers 16 and 18 permits of obtaining a characteristic of Δf as indicated by the curve III of Fig. 1, the values of the condensers 16 and 18 being in this case $33\mu f$ and $10\mu f$ respectively.

If desired, remaining divergences may be reduced further by arranging more than two tapings on the coil and connecting condensers across the coil parts concerned.

A further possibility of compensating the divergence from the desired frequency difference between the oscillator tank circuit and the pre-selection circuits in accordance with the invention is diagrammatically shown in Fig. 4. This figure shows one of the pre-selection-circuit coils 20 whose inductance can be adjusted by means of a sliding core 21 of magnetic material. A fixed condenser 22 is connected between the ends 23 and 24 of the coil 20 and the condensers 26 and 28 are connected respectively between each of the tapings 25 and 27 and the end 23 of the coil which is reached last by the core 21. In this embodiment the frequency characteristic of the pre-selection circuits is corrected instead of that of the oscillator tank circuit.

The invention is based on recognition of the

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fact that the frequency characteristic of a tuning circuit with sliding-core coil as a function of the position of the core can be considerably influenced by connecting a fixed condenser across a part of the coil. This is set out more fully with reference to the graphs of Fig. 5.

The line I of the figure shows the desired characteristic of the tuning of the oscillator tank circuit of a superheterodyne receiver as a function of the position p of the core of magnetic material, this characteristic being assumed to be linear for the sake of simplicity. In fact, however, divergences from this characteristic occur if special measures are not taken, the frequency deviation occurring in fact being exceedingly high in the central region; this is shown by the curve II which corresponds to a sliding-core coil shunted by a condenser, the condenser and the coil being so proportioned that the oscillator tank coil is tuned to the correct frequency when the core is completely within the coil (corresponding to point A) and when the core is completely outside the coil (corresponding to point B).

In the use of the circuit arrangement shown in Fig. 3 in which the condenser 16 is larger than the condenser 18, starting with the core entirely within the coil, and assuming the frequency to follow the ideal curve I if the condensers 16 and 18 were not present, the frequency will fall off considerably more steeply than is indicated by the line I as the core is moved in up to the point E (corresponding to the tapping 15 of Fig. 3) and then, by reason of the lower value of the condenser 18, as the core is moved to point F the frequency will fall off less steeply up to the point F than along the part FE, but more steeply than the curve I. Beyond the point F, the slope of the curve will be approximately equal to that of the curve I. It is to be seen from the figure that the line PEFR has such a form that it permits of the curvature of the line II, which shows the frequency characteristic occurring in fact if the condensers 16 and 18 are not present, being compensated in principle. Of course the modified frequency range should be readjusted to the desired value by one of the methods mentioned above.

In the use of the circuit arrangement shown in Fig. 4 the inductance characteristic will follow the line I up to the point E' then assume a given greater steepness up to the point F' and, if the condenser 26 is larger than the condenser 28, assume even a steeper slope over the part F'R. If the circuit arrangement is used for the coils of the pre-selection circuits, such a characteristic of the inductance may also be used for compensating divergence from the desired frequency range.

What I claim is:

A tuning device, particularly for superheterodyne receivers, comprising at least two tuning circuits which have an unequal frequency range and which are each tuned by shifting a core of magnetic material in the field of each of the coils and in the axial direction thereof, the cores being coupled together mechanically and the extreme values of the frequency range of each of the tuning circuits being adjusted at least approximately to the correct values, wherein in order to effect substantial tracking between said tuning circuits the inductance coil of at least one of the tuning circuits is provided with two coil tapings spaced respectively at about one-third and two-thirds of the number of turns of the coil from one end thereof, and a pair of condensers

each connected respectively between a tapping and said one end of the coil, the capacity of the condenser which is connected across the smaller coil part being more than twice the capacity of the condenser which is connected across the larger coil part.

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