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L. L. DE KRAMOLIN

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TUNING MECHANISM

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Fig. 1.

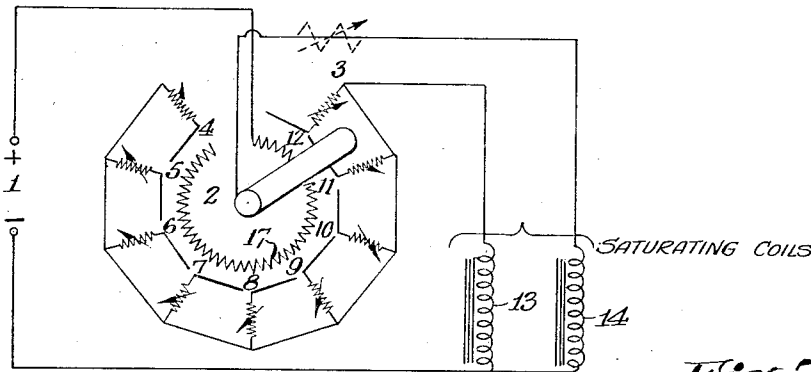


Fig. 3.

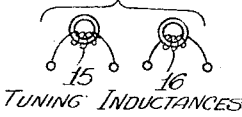


Fig. 2.

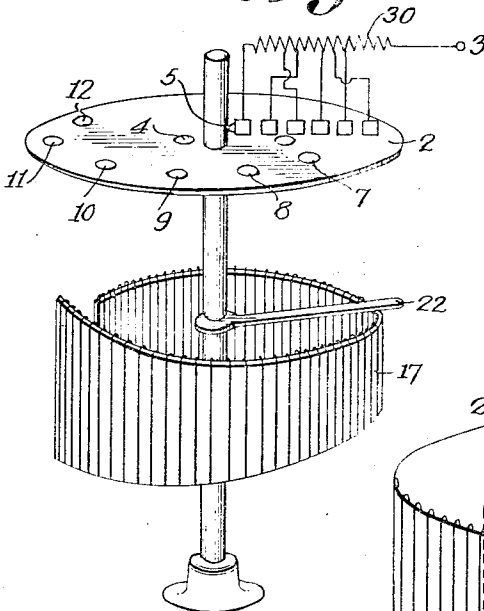
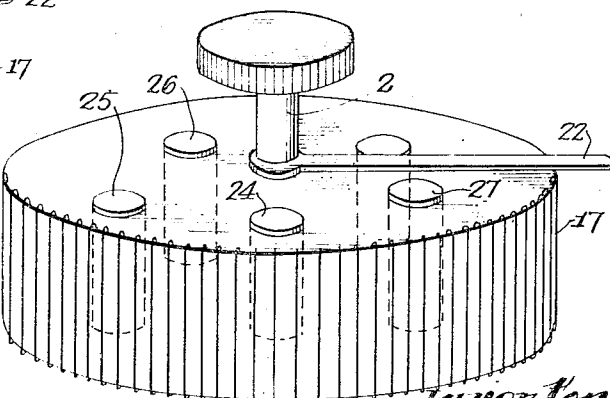


Fig. 4.



Inventor:
LEON LADISLAUS DE KRAMOLIN.
By: *Ferd. M. Munch*
ATTORNEY

UNITED STATES PATENT OFFICE

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TUNING MECHANISM

Leon Ladislaus de Kramolin, Gross-Glienicke,
Berlin-Kladow, Germany

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8 Claims. (Cl. 250—40)

In the United States patent application, Serial No. 749,088, of October 19, 1934, Methods for tuning, especially remote control tuning, of oscillatory circuits are described, and therein either the self-induction of an oscillatory circuit is varied, for example by the saturation of ferromagnetic cores or the resultant capacity of condensers dependent upon biasing potential is regulated by varying an initial potential. In this connection it is necessary to regard as condensers dependent upon potential all those apparatuses which by changing of any initial potential or of a resistance or loading resistance or the like inserted in one of the circuits allow a variation of the effective capacity in this circuit or in another circuit. Such apparatus, that is, for example, remote tuning arrangements, remote coupling variometers and the like, are often required to vary several circuits either in the same sense in the tuning, coupling and the like, as, for example, in the case of tuned multi-stage high frequency amplifiers, band filters and the like, or to vary two or more circuits at the same time according to a predetermined characteristic for each circuit, which two characteristics do not correspond, as, for example, in the case of single knob control of superheterodyne receivers, in which at least one tuning circuit for the picked up signals and a local oscillatory circuit must be varied at the same time in such a manner that for all adjustments a constant frequency difference is maintained between the two circuits. The method hereinafter described may also be employed for separately balancing individual circuits to a predetermined characteristic. In the case of a larger number of circuits corresponding changes occur so that the means necessary for balancing one circuit to another or to a predetermined characteristic are increased by the number of added circuits. If several circuits exist, which have only to be mutually balanced, it is evident that one circuit does not necessarily require a balancing device as it can serve as standard circuit for the balancing of the others. In the case of a number of circuits to be mutually balanced the balancing means illustrated by way of example in the following embodiment of the invention are required $n-1$ times.

In the accompanying drawing—

Fig. 1 shows a diagrammatic representation of a two-circuit tuning apparatus.

Fig. 2 shows a perspective view of an alternative construction of tuning regulator.

Fig. 3 shows a perspective view of an auxiliary correcting resistance.

Fig. 4 shows a constructional form of the tuning regulator shown diagrammatically in Fig. 1.

The character of the tuning mechanism illustrated diagrammatically in Fig. 1 consists in that either a common main resistance 17 or two as far as possible similar rheostats mounted on an axle are provided for each circuit which is to be regulated, in the present instance for the two saturating magnets 13, 14 which influence the high-frequency self-inductances 15, 16. It is immaterial whether the two magnets 13, 14 are connected to a single individual rheostat 17 or whether two rheostats controlled by a common axle are provided, one for each of the magnets 13, 14, provided no other considerations make one of the arrangements preferable to the other, since it is impossible to obtain an absolute uniformity of the self-induction values of 15, 16 over the entire range of adjustment owing to the irregularities mostly unavoidable in the windings 13, 14, in the material of the iron cores of the windings 13, 14 and consequently in the self induction values of 15, 16.

For compensating these irregularities, irrespective of whether a common main rheostat 17 or two rheostats provided with a common axle are employed, a series of contacts (4 to 12 in the example illustrated) are provided according to the invention, each of which contacts is connected with the point 3 over a small rheostat. The regulating lever, which turns about the axle 2, then contacts simultaneously with the rheostat 17 (or the main resistances, when a separate rheostat is used for each circuit), and with one of the contacts 4 to 12. A rheostat, illustrated in dotted lines in Fig. 1, may be provided in the wire connecting 2 and 14 for an initial balancing of this branch of the circuit. The balancing of the two inductances 15, 16 is effected by placing the regulating lever first on contact 12 and varying the resistance shown in dotted lines and the resistance situated between 12 and the point 3, until 15 and 16 in this initial position have the same value. If the regulating lever is moved on, the number of windings of the main resistance in the circuit and therefore the saturating current in the coils 13 and 14 will be varied. Although in the initial position the two self inductances 15, 16 were accurately balanced, the balancing, owing to the above-mentioned differences, would not be maintained over the entire range of the main resistance 17, but the balancing would be more and more lost during the gradual switching in of a larger part of 17, so that for example after a turning through an

angle of 180 or 200° there is already a difference in the value of the two self inductances 15, 16 which would often have a disturbing effect. However, after turning through an angle of 20 to 30° no appreciable difference between the inductances of coils 15, 16 can yet be ascertained. If, however, the angle of 20 or 30° is exceeded, the regulating lever leaves the contact 12 and contacts with the contact 11 to which again a small rheostat is coordinated which can then be balanced so that, even when the lever connects the main resistance 17 with the contact 11, the two self inductances 15, 16 are balanced. As the contact 11 is also only brushed by the lever during a short angle of rotation, a conformity which is practically sufficient can then be obtained between the self-inductances 15, 16. That which has been shown concerning the contacts 12 and 11 repeats itself during the continued turning of the lever on the contacts 10, 9, 8 and so forth.

After the balancing has taken place, an apparatus is obtained in which the two inductances 15, 16 to be balanced have variation characteristics over the entire range of adjustment which are sufficiently similar for all requirements occurring in practice. The number of contacts 4 to 12 is chosen according to the desired degree of uniformity. Therefore, if a very high degree of accuracy is desired, a large number of contacts must be provided, whereas for the construction of the commonly used receiver experience has shown that three or four contacts will suffice.

Under certain circumstances it may be undesirable to have a momentary connection of the two contacts when passing from one contact to the other, as this may result in mutual detuning of the inductances 15, 16 during this momentary connection during the turning of the lever. This can be avoided either by making the lever and contacts of such width that a short cannot occur between two neighbouring contacts.

It is evident that the above example for wire resistances also applies for all carbon compression resistances, liquid resistances and the like.

Where the not absolutely continuous variation by a wire resistance shown by way of example is disturbing, a continually variable resistance can be connected in series or in parallel with the same for the purpose of fine adjustment.

The individual small auxiliary regulators on the contacts 4 to 12 and also the auxiliary regulator shown in dotted lines may be of very simple shape in the practical form of construction. Thus, they may be for example small rods or plates of porcelain, kalit, that is a ceramic insulating material with very low high-frequency losses, or other refractory insulating material, on which the few windings of bare resistance wire are wound at short distances apart. For maintaining the spacing it is advisable to flute the insulating materials. If, for example, bare nickeline wire of about 0.5 millimetre in diameter is used as resistance wire and the flutes in the insulating body produce a space of 0.2 mm. from winding to winding, the single adjustment of these small balancing resistances can be carried out in a very simple manner by shorting more or less windings by passing a hot tinned soldering iron over the windings. If during the balancing too many windings have been accidentally shorted, the windings can be easily re-separated by a wire brush, so that the balancing of such a resistance element can be carried out extremely quickly and easily. As the deviations, which have to be corrected, are small, the individual re-

sistance elements also can be made extremely small. For example a resistance element can be accommodated on a cylinder of insulating material about 8 mms. in diameter and 15 mms. in length. These small cylinders may be connected with metal caps, to which the ends of the windings are actually connected, and these metal caps may be used at the same time as contact studs.

Figs. 3 and 4 show by way of example a form of construction incorporating this idea. Fig. 3 shows a small cylinder which is provided with a wire winding 18 connected to the two metal caps 19 and 20, whereas some of the windings are bridged by a bead of tin 21 for the purpose of balancing.

Fig. 4 shows a resistance regulator of normal construction with main winding 17, axle 2, contact lever 22 rotatable about this axle and in the main resistance 17 a number of bores in which the individual resistance elements 24, 25, 26, 27 are arranged like cartridges in a revolver barrel, so that knobs provided with metal caps project from the bores and contact with the lever 22 sliding thereover. The opposite ends of the small resistance elements only shown in dotted lines in the drawing may contact with a common metal plate, which corresponds with the point 3 of Fig. 1.

Another form of construction is illustrated by way of example in Fig. 2. In this figure the main resistance 17 is so shaped that the adjustment of the self induction takes place somewhat more uniformly than in a resistance strip of uniform width. If the resistance strip is made uniformly wide, then at the smallest resistance value, i. e., at the maximum pre-magnetizing current value or low induction values a more rapid change of induction takes place than at high induction values and consequently an extraordinarily irregular spacing of the picked up stations results in different sections during rotation of the tuning knob, which may be undesirable. As, moreover, the variation curve, when the current intensity of the magnetic polarizing current is plotted on one coordinate of a curve and the corresponding self induction values on the other coordinate, does not extend in a straight line, a compensation and consequently a rectilinear self-induction variation can also be attained hereby shaping the resistance strip 17 to a predetermined form. In this manner, by corresponding shaping of the resistance strip or by equivalent means in other constructions of rheostats, similar effects can be attained in inductances as in circular plate condensers, for example logarithmic or frequency proportional condensers.

It is again pointed out, that all that which has been said in connection with the above forms of construction for self-induction regulation by magnetic polarization variation also applies for the capacity regulation by such constructional elements which change a resultant capacity by changing an initial potential or by variation of a loading resistance, as is the case for example in mechanical arrangements similar to an electrostatic loudspeaker or in piezoelectric arrangements, in which the capacity of a condenser changes with a dielectric of a crystal composition under the influence of an initial potential or, as is furthermore the case, during the changing of the effective valve capacity under the influence of variations in potential or variations in loading resistance. Consequently all that which has been said in this application, for example as regards the one mode of employment, can be transferred

to another mode of employment, and all modifications and examples of construction herein mentioned can be combined the one with the other and with the subject matter of the above-mentioned patent application.

A further modification of the invention is shown in Fig. 2 which compared with the diagrammatic arrangement of Fig. 1 contrasts also in so far as there are no separate resistances connected to the different contacts 4 to 12, but during the turning of the lever 22 the protrusions 4 to 12 arranged in a spiral line on the metal disc 23 are brought into contact with the stationary contacts arranged in a row which are connected to the resistance 30. As again it is possible to regulate the resistance inserted between the lever 22 and point 3 at a predetermined angle of rotation by shifting the point of connection on the resistance 30, the same object as in Fig. 1 is attained with this form of construction. The invention therefore consists in introducing in such a regulator, besides the main rheostat strip and the like, auxiliary resistances which are arranged in such a manner that different separately and independently adjustable auxiliary regulator values are switched in for different adjustments of the main regulator.

As set forth above, it is possible in the manners described, to obtain not only a perfect synchronism of the jointly regulated self-inductions or capacities, but also to effect the adjustment according to a frequency-proportional curve or the like so that, when applying the principle described to wireless receiving or transmitting apparatus, uniform frequency ranges extend over similar scale angles, and therefore such a regulator can be calibrated.

I claim:

1. In combination a plurality of tuned circuits each comprising a reactance having a control element responsive to variation of a control current, a single current control network for said control elements, preadjustable elements in said network for controlling the relative distribution of current to said control elements, and a single continuously variable element in said network for simultaneously varying currents through said control elements to tune said circuits through a predetermined frequency range.

2. A structure as defined in claim 1, wherein said network comprises a variable resistor in series with one of said control elements, another of said elements having a plurality of connections to spaced points along said resistor, and

individually adjustable resistors in each of said connections.

3. In combination a tuned circuit comprising an impedance having a control element responsive to variation of electric control energy, a resistance, a variable control means coacting with said resistance for varying the energy supplied to said control element, a plurality of auxiliary resistance elements, and means responsive to variation of said control means for sequentially connecting said auxiliary resistance elements in the control circuit as the variable control means is varied.

4. In combination a plurality of tuned circuits each comprising an impedance having a control element responsive to variation of electric control energy, a single energy control network for said control elements, preadjustable elements in said network for controlling the relative distribution of energy to said control elements, and a single continuously variable element in said network for simultaneously varying the energy supplied to said control elements to tune said circuits simultaneously to maintain the same frequency relation between them.

5. In combination a plurality of tuned oscillatory circuits each comprising an impedance the value of which depends upon the value of an applied voltage, a source of electric potential, a network comprising a main regulating resistance having control means for regulating the voltage applied to said impedances, a plurality of auxiliary resistance elements, and means for successively connecting said auxiliary resistance elements in at least one of the branches of said network as the control means for the main regulating resistance is operated simultaneously to tune the said oscillatory circuits in accordance with a predetermined characteristic for each circuit.

6. Apparatus as defined in claim 3, wherein the auxiliary resistance elements are individually adjustable.

7. Apparatus as defined in claim 3, wherein a conducting member carried by the operating spindle of the control means contacts with the auxiliary resistance elements in turn as the operating spindle is rotated.

8. Apparatus comprising an insulating body, a resistance carried by said body, a rotatable contact arm engaging with said resistance, and a plurality of auxiliary resistance elements arranged in apertures in said body and contacted sequentially by said contact arm as the contact arm is rotated.

LEON LADISLAUS DE KRAMOLIN.