Feb. 8, 1944. L. H. VAN BILLIARD 2,341,345

TUNING SYSTEM

Filed Oct. 26, 1940

Fig. 1.

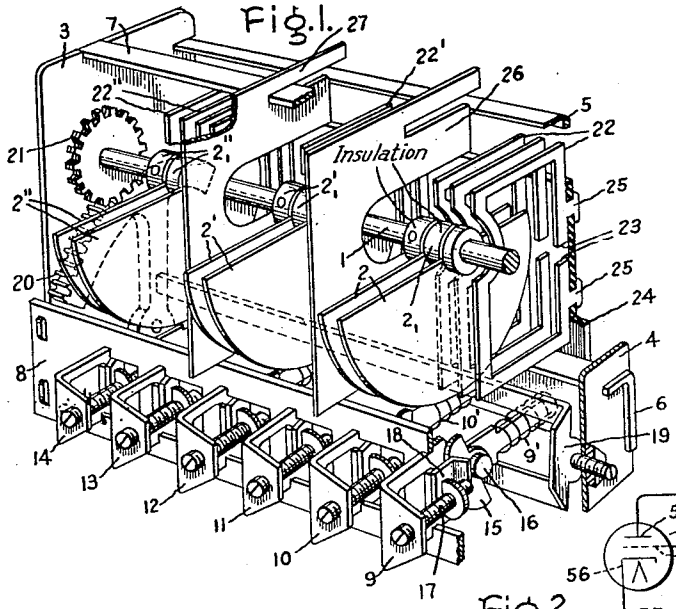


Fig. 4.

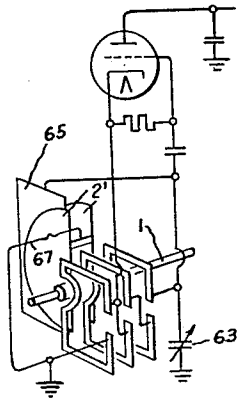


Fig. 2.

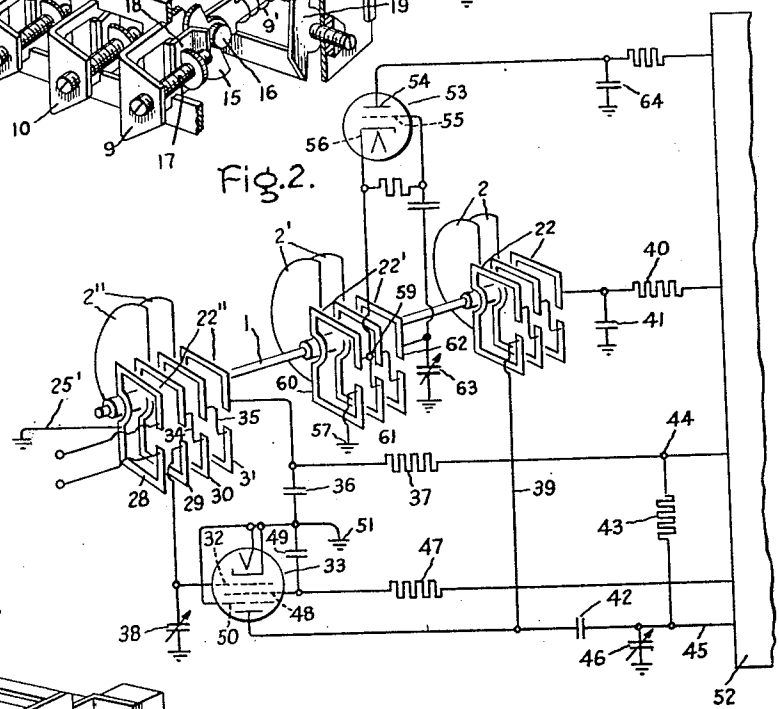
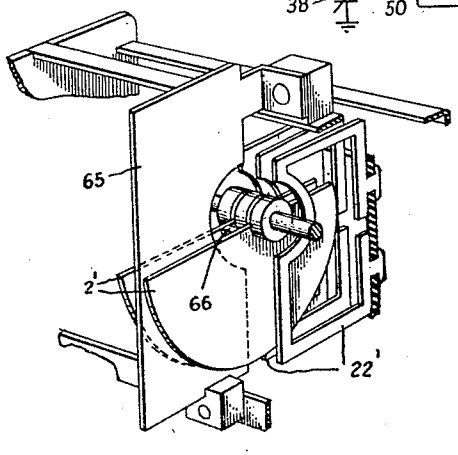


Fig. 3.



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2,341,345

TUNING SYSTEM

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Application October 26, 1940, Serial No. 363,016

14 Claims. (Cl. 250—40)

My invention relates to tuning systems for radio receivers, and more particularly to such systems for use in receivers operating at short wave lengths.

The variation in tuning in radio receivers is commonly effected by variation in capacitance of one or more variable condensers. Commonly, where more than one condenser is varied, the variable elements of the different condensers are arranged for unicontrol, the different condensers being assembled together in a single frame having stator and rotor structures including a shaft common to all of the condensers in the assembly. Such assemblies are commonly known as "gang condensers" and are used universally in household receivers.

In accordance with my present invention the tuning is effected primarily by variation in inductance. Tuning by variation in inductance possesses certain advantages particularly with respect to securing desired impedances in circuits tunable over a range of frequencies, and also in other respects. An object of my invention is to secure these advantages resulting from tuning by variation of industance while at the same time retaining the advantages which are secured by tuning by the gang condenser now commonly employed, such as compactness, facility of operation, and economy of construction, especially on a mass production basis.

Thus, an object of my invention is to provide an inductive tuning assembly which is economical to construct, which is compact, and by which the variation in inductance of a plurality of circuits may be effected by unicontrol means with the same facility as is secured by capacitance tuning with the gang condenser.

The novel features which I believe 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 thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents a structural view of my invention; Fig. 2 represents a circuit comprising the invention and Figs. 3 and 4 represent certain modifications thereof.

Referring to Fig. 1 of the drawing, I have shown therein a shaft 1 upon which is mounted a plurality of groups of vanes 2, 2' and 2'' similar to the rotors of ordinary variable gank condensers. The number of vanes employed in each group may of course be varied from a single vane to a large number of vanes as required. These vanes are mounted on insulating bushings 2, 2', and 2'', on shaft 1 whereby they are insulated from the shaft and from each other. This shaft 1 is mounted in a frame which is shown only fragmentarily in Fig. 1 but which comprises the end plates 3 and 4, only a portion of the latter of which is shown, which are connected together by lateral members 5, 6, 7, 8 and other members, if desired. The shaft 1 is arranged to be rotated by manipulation of a handle, or knob, or, if desired, it may be arranged to be rotated to any one of a number of predetermined positions by means of the push button assembly such as that shown in the lower portion of the figure and which are now common in radio receivers. The receiver may be tuned to any one of a number of desired stations to be received by operation of the push buttons of the assembly.

These push buttons include members 9, 10, 11, 12, 13, and 14 mounted in the plate 8 for movement therethrough, each of them being provided with a spring 9', 10', etc., biasing it to the position shown in the drawing. Each of these members is provided with a cam, only one of which is shown and which is designated by the reference numeral 15. These cams may be adjusted about pivot 16 to a radial position in accordance with the station to be selected by the respective push button. It may be retained in that position by means of the clamping mechanism comprising the screw 17 which is arranged to cooperate with the clamp 18 to press against the cam 15 to retain it in position. This cam upon inward movement of the push button, engages a rotor member 19 rotating it to the position determined by the radial position of cam 15. This rotor member is attached to an arcuate gear 20 which meshes with a gear 21 mounted upon the shaft 1. In this way the shaft may be positioned in accordance with the various stations to be selected by operation of any one of the push buttons 9, 10, 11, etc.

As thus far described, it will be seen that the structure is practically identical with structures commonly employed in variable gang condensers. The various groups of vanes 2 are arranged by their rotation to be variably positioned with respect to additional stationary vanes arranged in corresponding groups 22, 22' and 22''. These stationary vanes may be arranged and mounted very similarly to the stator members of a variable condenser but in my inductive tuning device they are shaped and connected to form inductances. It will be seen that the various vanes of

the group 22 are each substantially rectangular in shape, the rectangle being broken at the point 23 and the portions of the rectangle adjacent this point being mounted in a non-conducting terminal board 24 and having terminals 25, projecting therethrough to permit circuit connections to be made to the respective vane. Each of the other vanes of the various groups are similarly mounted, the terminal board being either individual to a respective group or being sufficiently long to extend throughout the assembly and to have the various groups of vanes mounted therein. By means of connections made to the terminals 25, each vane may be connected into a circuit to act as a turn of an inductance coil arranged to have its inductance varied in accordance with the position of an associated rotor vane 2. Thus one of these vanes may have a condenser connected across it to form a tuned circuit, the frequency to which the circuit is tuned being variable in accordance with the position of the rotor vane. If desired, the different vanes in any group may all be connected in series to produce a larger inductance, or in parallel to produce a smaller inductance and of course if desired, all the vanes of the assembly may be connected in desired circuit relation, either series, parallel, or series parallel, in accordance with the values of inductance to be produced and the variations to be effected therein.

While I have mentioned that the stator vanes are rectangular in shape it will be understood that they may be any desired circuitous form to provide required inductance variable by one of the rotor vanes.

If the stator vanes of the different groups be connected in different circuits it may be desired to shield the inductance comprised by one group from the inductance comprised by another group. This may be effected by means of shield plates 26 and 27 mounted in the assembly between the different groups which are to be shielded from each other. On the other hand it may be desirable to have a certain amount of coupling between the circuits comprising the inductance formed by different groups of stator vanes. This may be provided by shaping the plates 26 or 27, as the case may be, to a shape or size to permit the required amount of coupling between the two inductances or, if desired, such plate may be omitted altogether.

It will be observed that the assembly as thus illustrated and described is equally as compact as is the ordinary variable condenser tuning assembly. In addition, it will be seen that it may be manufactured practically as economically as the ordinary gang condenser since the stator vanes 22 may be produced by ordinary punch press operations whereby they are stamped from sheet metal to the required shape and size. Similarly all of the other members may be formed by such punch press operations. The assembly may be mounted in a radio receiver and requires no greater space and presents no difficulties greater than those of the ordinary gang tuning condenser.

In Fig. 2 I have shown a circuit of a superheterodyne radio receiver employing my invention. The gang tuning assembly is represented therein by the reference numerals 2, 2', 2'', 22, 22', 22''.

The left hand stator vane 28 of the group 22'' has its ends connected to a transmission line extending to a di-pole antenna and the midpoint thereof is grounded as indicated at 25'. If desired, either one of these terminals may be connected to an antenna and another point on the vane 28 grounded, the ground being positioned to include so much or all of the inductance of the vane in the antenna circuit as is desired. This member 28 may then comprise the primary of a transformer, the secondary of which comprises the other stator members 29, 30, 31 of the group 22''. These stator members 29, 30, 31 are shown connected in series between the control electrode 32 of an electron discharge amplifier 33 and ground through a circuit comprising stator member 29, connection 34, member 30, connection 35, member 31, and by-pass condenser 36 to ground. The upper terminal of this condenser 36 is connected through a resistance 37 to a suitable source of bias potential which is included in that portion of the receiver not shown in detail in the diagram, but which is represented by the rectangle 52. This source may comprise the source used for automatic volume control purposes, the uni-directional potential thereof being supplied through resistance 37 and then through the inductance members 31, 30, 29 to the control electrode 32 of amplifier 33 to control the amplification thereof. The inductance of the members 29, 30, 31 connected in series is tuned by means of a capacitance 38, which may include an ordinary trimmer condenser for purposes of initial adjustment, the frequency to which this circuit is tuned being variable upon rotation of the shaft 1 carrying the vanes 2''.

The anode circuit of the amplifier 33 is tuned by means of the inductance of the stator group 22 the elements of which are connected in series as described in connection with group 22''. The circuit of the anode of the discharge device 33 extends through conductor 39, the different stator elements of the group 22 in series, and thence through resistance 40 to a source of anode operating potential for the discharge device 33, which is included in the receiver.

The low potential terminal of the inductance made up by the elements of group 22 is connected for radio frequency currents to ground through condenser 41. The high potential terminal thereof is connected through a coupling condenser 42 to the input electrode of a subsequent discharge device of the receiver 52.

Resistance 43 may comprise an ordinary automatic volume control filter resistance utilized to supply automatic volume control potential from the conductor 44 to the said input electrode connected to conductor 45. Condenser 46 may comprise a filter condenser cooperating with resistance 44 in such an automatic volume control circuit.

Screen grid potential for operation of the discharge device 33 is supplied through resistance 47 to the screen electrode 48 which is connected to the cathode of the discharge device by condenser 49.

The suppressor grid 50 of the discharge device is connected directly to this cathode and to ground as shown at 51.

The local oscillator of the radio receiver is represented in Fig. 2 as comprising the electron discharge device 53 comprising an anode 54, control electrode 55 and a cathode 56. The inductance of the group of stator elements 22' is connected in circuit relation with the discharge device 53 to form an oscillatory circuit, these elements being connected in series between the grid 55 of the discharge device and ground, as indi-

cated at 57. The cathode 56 of the discharge device is connected to a point 59 intermediate the elements 60 and 61 of group 22'. The inductance of the three elements 60, 61 and 62 connected in series is tuned by means of variable condenser 63 connected across the three inductances in series and since the cathode is connected to an intermediate point on this inductance and the anode 54 of the discharge device is connected to ground through condenser 64, it will be seen that the conditions for production of oscillations by the discharge device are established.

Oscillations produced in the circuit 22', 63 and which are of a frequency variable by rotation of the shaft 1 and the vanes 2' may be coupled into the circuits comprising the inductance 22, if desired, or alternatively into the circuit comprising the inductive members 29, 30 and 31. If it be coupled to the inductance comprising the group 22, then of course, the next discharge device, the input of which is connected to conductor 45, would comprise the first detector, or converter, of the receiver converting oscillations received through amplifier 33 to a desired intermediate frequency. In that case it may be desirable to insert a shield between the groups 22' and 22'' in the manner described in connection with the plates 26 and 27 of Fig. 1.

If the oscillations in the circuit 22'—63 be coupled to the input of discharge device 33 they may be combined with the received oscillations to provide a first variable intermediate frequency which appears in the group 22 and which may there be combined again with the local oscillations supplied to group 22 from discharge device 53 through discharge device 33 to produce a second fixed low intermediate frequency at the output of the discharge device the input of which is connected to conductor 45. In this case it may be desirable to insert a shield between the conductors 22 and 22'. This latter type of operation may be particularly desirable especially in frequency modulation receivers operating a short wave length.

It may be desired in certain situations to increase the capacitance of a circuit simultaneously with the increase in inductance therein. This may be arranged as shown in Fig. 3 for example, by mounting an additional condenser plate 65 opposite the inductive stator. That is, as shown in Fig. 3, the stator 22' may comprise the inductive stator represented in Figs. 1 and 2 and the plate 65 a condenser electrode arranged to have capacitance between it and the rotor members 2' of the rotor of the assembly shown in Figs. 1 and 2. In this case the rotor vanes 2' are electrically connected together, as shown at 66, and are connected to one side of the stator inductor. Thus if the rotor members are rotated away from the inductive stator 22' they increase the inductance of the inductive stator and simultaneously increase the capacitance between the rotor member 2' and the electrode 65. This electrode may be connected as shown in Fig. 4 in which the rotor vanes 2' are shown connected together and to ground by conductor 67 whereupon the capacitance between electrode 65 and the plates of the rotor 2' are connected directly in parallel with the condenser 63. If desired, in this case, the vanes 2' may be conductively mounted on shaft 1 and that shaft and the frame of the apparatus grounded.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since many modifications both in the circuit arrangement and in the structures disclosed may be made without departing from the spirit and scope of my invention. I, of course, contemplate by the appended claims 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. The combination, in a radio receiver, of a tuning device comprising a rotating shaft having a plurality of groups of vanes arranged thereon for rotation therewith about said shaft each group comprising one or more vanes, a plurality of rigid, self-supporting, conducting plates positioned between said vanes, each plate being shaped to form a circuitous conducting path having a break therein across which said path has inductance, and each plate being positioned near one of said vanes and shaped with respect thereto to have maximum inductance when said vane is in one position and minimum inductance when said vane is in a different position, the plates associated with each group of vanes being connected together to form a high frequency inductance coil having desired inductance, and the plurality of coils thus formed being connected to tune said receiver to respond to frequencies determined by the inductance thereof.

2. The combination, in a radio frequency tuning device, of a plurality of groups of parallel spaced, self-supporting plates, each of said plates being shaped to form a circuitous conducting path having a break therein across which said path has inductance, and the plates of each group being connected together to form an inductance coil, a rotatable shaft having a plurality of conducting vanes mounted thereon for rotation therewith, each vane being rotatable from a position in proximity to and between the plates of a respective group, to a position removed therefrom, thereby varying the inductance of the coil formed by the respective group from a minimum to a maximum, and a plurality of circuits, each circuit including one of said coils, said circuits being tunable together over a range of frequencies by variation of inductance of said coils produced by rotation of said vanes.

3. The combination, in a radio frequency tuning device, of a plurality of groups of parallel spaced, self-supporting plates, each of said plates being shaped to form a circuitous conducting path having a break therein across which said path has inductance, and the plates of each group being connected together to form an inductance coil, a rotatable shaft having a plurality of conducting vanes mounted thereon for rotation therewith, each vane being rotatable from a position in proximity to and parallel with the plates of a respective group to a position removed therefrom, thereby varying the inductance of the coil formed by the respective group from a minimum to a maximum, and a plurality of radio frequency circuits, each circuit including one of said coils, said circuits being tunable together over a range of radio frequencies by said variation of the inductance of said coils produced by rotation of said vanes, two of said circuits being coupled together at radio frequency by mutual inductance existing between the plates of adjacent groups.

4. The combination, in a radio frequency tuning device, of a plurality of groups of parallel spaced, self-supporting plates, each of said plates being shaped to form a circuitous conduct-

ing path having a break therein across which said path has inductance, and the plates of each group being connected together to form a radio frequency inductance coil, a rotatable shaft having a plurality of conducting vanes mounted thereon for rotation therewith, each vane being rotatable from a position in proximity to the plates of a respective group to a position removed therefrom, thereby varying the inductance of the coil formed by the respective group from a minimum to a maximum, and a plurality of circuits, each circuit including one of said coils, said circuits being tunable together over a range of radio frequencies by said variation in inductance of said coils produced by rotation of said vanes, and a shield between adjacent groups of said plates to prevent radio frequency coupling therebetween.

5. The combination, in a radio frequency tuning device, of a frame supporting a rotatable shaft and a plurality of non-conducting terminal boards spaced along said shaft, a plurality of stationary self-supporting vanes mounted on each of said terminal boards and projecting toward said shaft, additional vanes mounted on said shaft for rotation therewith from a position in proximity to and between said stationary vanes to a position opposite thereto, each of said stationary vanes being shaped to form a conducting path having a break therein across which said path has inductance variable dependently upon the position of an adjacent one of said additional vanes and said conducting path having terminals on said terminal board on which the respective vane is mounted, radio frequency circuits including said conducting paths comprising said stationary vanes, said circuits extending through electrical connections on said terminal boards to said vanes, said circuits being tunable over a range of radio frequencies by variation of said inductance of said vanes produced by movement of said additional vanes with rotation of said shaft.

6. In combination, a terminal board having a plurality of self-supporting vanes mounted thereon in parallel relation, each vane being shaped to form a conducting path about the periphery of an enclosure in the plane of the respective vane and said path having a break at one point of said periphery and having terminals at opposite sides of said break attached to said board, connections between the terminals of different vanes on said board whereby said vanes form an inductance coil of more than one turn, an additional vane rotatable in a plane parallel to the planes of said first vanes about a pivot outside said enclosure thereby to vary the inductance of said inductance coil.

7. The combination, in a short wave inductance tuning device, of a support, a plurality of rigid self-supporting conducting plates mounted side by side on said support each of said plates having an aperture therein, said aperture extending through the periphery of said plates and being of such size that said plates have substantial inductance at short wave lengths across said aperture where said aperture breaks said periphery, each of said plates being constructed and arranged to have the points at opposite sides of said break connected to different respective points of another of said plates at opposite sides of said break whereby each plate acts as a turn of an inductance coil, and a conducting plate mounted for movement in a plane parallel to aid plates from a position substantially closing said aperture and reducing the inductance across said breaks to a position opening said apertures and increasing said inductance.

8. A tuning device having mechanical structure comprising a frame having parallel rigid conducting plates supported thereon, each of said plates having an aperture therein, said aperture extending through the periphery and being of such size that substantial inductance at short wave lengths exists across said aperture where said aperture extends through said periphery, a rotatable shaft supported in said frame carrying a conducting vane projecting between two of said plates to reduce the inductance thereof across the aperture of each plate, said shaft being mounted for rotation to carry said vane away from said plates to increase said inductance across said apertures.

9. In combination, a plurality of plates arranged side by side, each of said plates having an aperture therein extending through and breaking the periphery of the plate, said plates and said apertures being of sufficient size that substantial inductance at short wave lengths exists between points thereof at opposite sides of said break in said periphery, said points in the different plates being connected together in circuit relation to provide two points between which inductance exists of value dependent upon the manner in which said plates are connected together, and an additional plate movable between said first plates variably to close said aperture thereby to vary said value of inductance.

10. The combination, in a short wave tuning device, of a plurality of rigid self-supporting conducting plates mounted side by side in parallel planes, each conducting plate extending about the periphery of an enclosure and having a break therein, said enclosure being sufficiently large that substantial inductance at short wave lengths exists across said break in each plate, and capacitance connected in circuit with all of said inductances to resonate with the resultant inductance thereof, and a further rigid self-supporting conducting plate mounted for rotation about a point outside said enclosures in a plane parallel to said conducting plates from a position substantially closing said enclosures and reducing said inductance to a minimum to a position removed from said enclosures and increasing said inductance thereby varying the frequency of resonance of said capacitance and resultant inductance.

11. The combination, in a short wave tuning device, of a plurality of rigid self-supporting conducting plates mounted side by side in parallel planes, each conducting plate extending about the periphery of an enclosure and having a break therein, said enclosure being sufficiently large that substantial inductance exists across said break in each conducting plate at short wave lengths and capacitance connected in circuit with all of said inductances to resonate with the resultant inductance thereof, and a further rigid self-supporting conducting plate insulated from said first condutcing plates and mounted for rotation about a point outside said enclosures in a plane parallel to said first mentioned conducting plates from a position substantially closing said enclosures and reducing said inductance to a minimum by the inductance effect between said rotatable plate and first mentioned conducting plates to a position removed from said enclosures and increasing said inductance thereby varying

the frequency of resonance of said capacitance and inductance.

12. The combination, in a variable short wave inductance device, of a plurality of stationary rigid self-supporting conducting plates mounted side by side in parallel relation, each plate having an aperture therein extending through and breaking the periphery of said plates at adjacent points, said apertures being of sufficient size that substantial inductance at short wave lengths exists across said breaks, each of said plates being constructed and arranged to have points at opposite sides of the break therein connected to respective points at opposite sides of the break in another plate to connect said plates together in circuit relation, a rotor having a plurality of conducting vanes insulated from each other and from said plates and mounted for movement from a position removed from said apertures to a position closing said apertures to said breaks thereby to vary the inductance across said breaks by variation in the inductive effect between the plates of said rotor and said stationary plates, at least one plate of said rotor moving between two of said stationary plates.

13. The combination, in a short wave inductance tuning device, of a support, a plurality of rigid self-supporting circuitous conducting plates mounted side by side on said support, said conducting plates extending about the periphery of an area enclosed thereby, each of said conducting plates having a break therein at adjacent points, whereby substantial inductance at short wave lengths exists in each conducting plate across said break, a pivot, a rotatable plate having a length and width substantially as great or greater than the corresponding dimensions of said area and mounted for rotation about said pivot adjacent its periphery and near the periphery of said area variably to open and close said area enclosed by said first conducting plate substantially to said breaks thereby to vary the inductance across said breaks from an extremely small value to a higher value, and said conducting plates being constructed and arranged to have points at opposite sides of said break connected to corresponding points of another of said conducting plates to produce a resultant inductance variable from an extremely low value at short wave lengths to a substantially higher value by rotation of said rotatable plate.

14. The combination, in an inductance device, of three or more rigid conducting plates arranged side by side in parallel planes and spaced apart sufficiently to permit relative movement between certain of said plates free from mechanical and electrical contact between the surfaces thereof, at least one of said plates having an aperture therein breaking the periphery thereof, said aperture being of sufficient size that substantial inductance at short wave length exists across said aperture where said aperture breaks said periphery, said inductance being minimum when said relatively movable plates are in interleaved position due to inductive effect between said apertured plate and the other of said plates and said inductance being maximum when said relatively movable plates are operated from said interleaved position, and means to operate said relatively movable plates to and from said interleaved position.

LEWIS H. VAN BILLIARD.

CERTIFICATE OF CORRECTION.

Patent No. 2,341,345. February 8, 1944.

LEWIS H. Van BILLIARD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 3, for "lengths" read --length--; line 25, for "industance" read --inductance--; line 53, for "gank" read --gang--; and second column, line 3, for " 2, 2', and 2" " read --2_1, $2'_1$ and $2''_1$--; page 4, first column, line 75, for "aid" read --said--; and second column, line 67, for "condutcing" read --conducting--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of May, A. D. 1944.

Leslie Frazer

(Seal) Acting Commissioner of Patents.

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(Seal) Acting Commissioner of Patents.