July 22, 1941. W. BUSCHBECK 2,250,090

ARRANGEMENT FOR TUNING HIGH FREQUENCY OSCILLATION CIRCUITS

Filed Oct. 5, 1939 2 Sheets-Sheet 1

Fig. 1

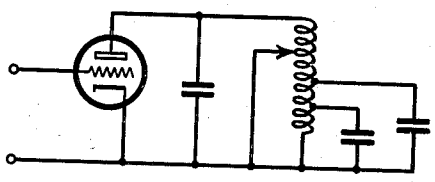


Fig. 2

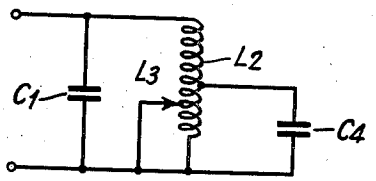
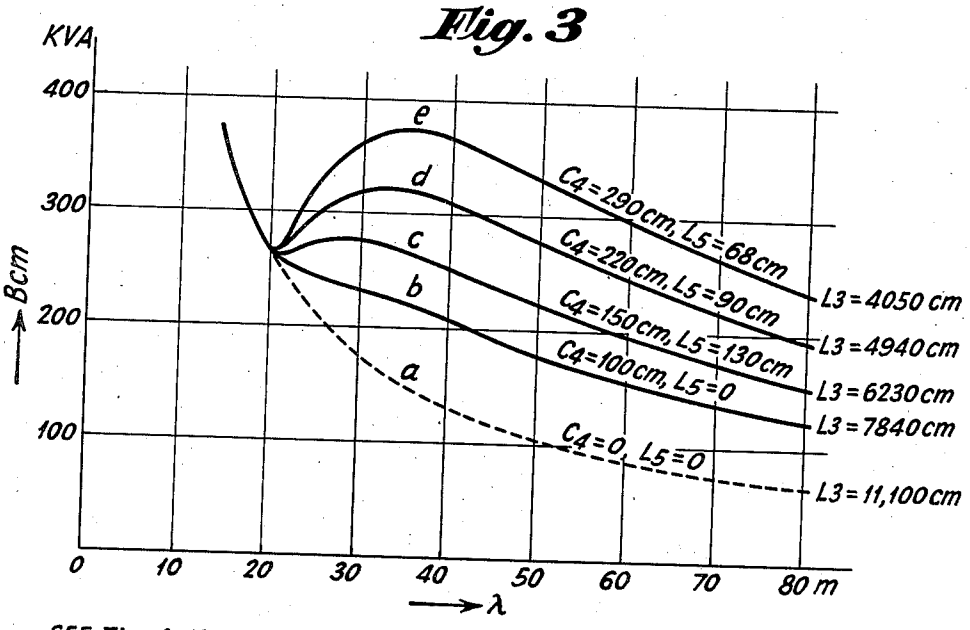


Fig. 3



SEE Fig. 4 FOR EXAMPLE OF CIRCUIT TO WHICH Fig. 3 APPLIES.
APPLIED VOLTS = 5000

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Fig. 4

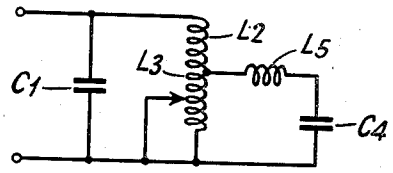


Fig. 5

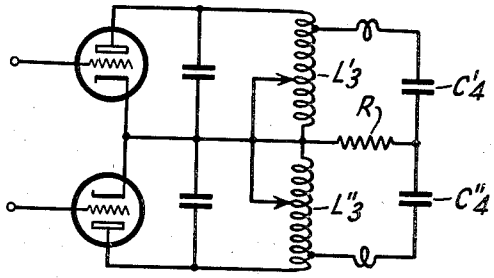
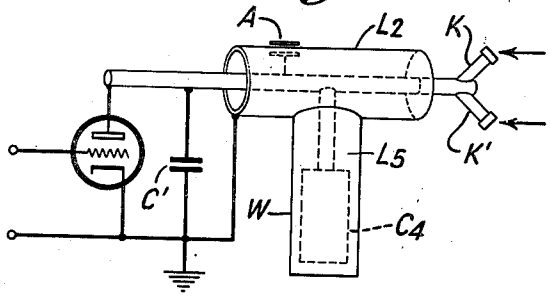


Fig. 6



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Patented July 22, 1941

2,250,090

UNITED STATES PATENT OFFICE

2,250,090

ARRANGEMENT FOR TUNING HIGH FREQUENCY OSCILLATION CIRCUITS

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Application October 5, 1939, Serial No. 297,978
In Germany September 28, 1938

7 Claims. (Cl. 250—40)

For the purpose of governing wider wave ranges without utilizing additionally connectable rough adjustment means, the gliding variometer has found its way more and more into the short wave field. But such structures have the disadvantage that in the case of wider wave ranges it is, for instance, the wattless power of the intermediate circuit which decreases with an increase in the wavelength owing to the pure inductive variation. Moreover, large inductances require larger space and more structural means since the coil of the variometer is in fact to be dimensioned for the maximum current appearing at the shortest wave and for the highest coil potential then prevailing so that the coil will have excessive dimensions as regards the setting of the higher inductance values.

In accordance with the invention, these drawbacks are avoided in that parts of the variometer have one or several capacities connected in parallel thereto (Fig. 1) whereby the said capacities are placed at those variometer turns which at short waves are still short circuited. Therefore, in the case of short waves the parallel capacitances are ineffective. If the inductance is increased by shifting the variometer tapping, the parallel capacities have gradually impressed thereon potentials whose values increase in succession and thus they become ever more effective. The case of a single parallel capacity will next be considered.

If λmn designates a fictitious natural wave calculated from capacities and inductances having the indices m and n, the resonance places of the region according to Fig. 2 follow from the equation:

$$\lambda=\frac{1}{\sqrt{\frac{\lambda 12^2+\lambda 13^2+\lambda 34^2}{2\lambda 12^2\lambda 34^2}\pm\sqrt{\left(\frac{\lambda 12^2+\lambda 13^2+\lambda 34^2}{2\lambda 12^2\lambda 34^2}\right)-\frac{1}{\lambda 12^2\lambda 34^2}}}}$$

The minus sign underneath the square root furnishes the longer coupling wave, i. e., the wave actually corresponding to the tuning. When considering the limit condition, it is seen that the short coupling wave starting at zero approaches the limit value given by the series connection of C_1 and C_4 and L_2.

Fig. 3 shows for a practical example the wattless powers of the intermediate circuit for cases whose additional capacitances differ in value as indicated by the curves *a* and *b*.

The fact that the short coupling wave begins theoretically at zero, is in many cases an undesirable condition. At any short waves lying below the shortest operating wave natural resonances of the grid circuit certainly exist so that at a correspondingly tuned anode circuit feed back effects in accordance with the Huth-Kuehn principle, i. e. disturbance waves, in other words, may be produced owing to the fact that a neutralizing action no longer exists within this wave range. Even though the resonance resistance of the short coupling wave is low against that of the long waves, a quantitative observation shows that in many cases the condition for the feed back will be fulfilled. Hence, it should be aimed at excluding in principle the self excitation at the short coupling wave. This is accomplished according to a further feature of the invention by inserting a further inductance L_5 (Fig. 4) which is placed in series to the parallel condenser C_4. In the case of several parallel capacitances each of them is to be given obviously a respective series inductance. The lower limit value of the short coupling wave now is practically determined by L_5 and C_4 so that the short coupling wave will be moved definitely out of the region of the grid resonance and it may eventually even be brought into the region of the actual operating waves. The curves *c*, *d*, *e* of Fig. 3 show the power curves for such cases in which the short coupling wave is limited to about 9 m. These curves indicate that already at the use of a single additional capacitance the variation of the wattless power of the intermediate circuit can be maintained very small as compared with the case of the simple variometer and that the required maximum inductance can be reduced to a very great extent. It is clear that through the use of a further condenser a renewed raising etc. can be brought about. More especially, it is also possible through a suitable variable dimensioning of the stray capacity between the individual turns of the coils to obtain an extremely flat and stepless pattern of the power curve.

In many cases, for instance, for push-pull stages, symmetrical variometers L_3', L_3'' and corresponding symmetrically connected additional capacities will obviously be employed. As shown in Fig. 5, it will be advisable in this case to compose the parallel capacity of two parts C_4' and C_4'', each of which being symmetrical with respect to ground and whose center is placed across a resistor at ground or at the direct potential. In this way a close coupling can be obtained between the upper and the lower part

of the oscillatory circuit whereby asymmetrical conditions which may eventually be present, for instance, those of the coupling of the load will be compensated for. Furthermore, with this resistor a damping or an eventual tendency to disturbance waves and the avoidance of static charges may be achieved.

It may eventually also be of advantage to represent the inductances and capacitances shown in the circuit diagrams 1 to 5 by open lines and short circuited lines such as shown by way of example in Fig. 6. Such a structure offers an especially convenient possibility of supplying the cooling water at places at which the high frequency is grounded so that additional losses in high frequency due to the cooling water are avoided. Fig. 6 shows the variometer by the coaxial line L_2 having the sliding tapping A. The inductance results from the magnetic field between the inner and outer conductors, and by means of the tapping A this field is confined to the portion of the coaxial line L_2 to the left of the slider, i. e., between the slider and the anode end of the inductance. The line L_2 is tapped at a suitable place by a transversal line W which consists of two different parts L_5 and C_4 having different wave resistances. The part L_5 acts in this case as inductance and C_4 acts as capacity. Such an arrangement has the particular advantage that stray capacities and stray inductances are entirely avoided such as is generally known when using coaxial lines as tuning elements of oscillatory circuits. The cooling water may be supplied at K and passed off at K'.

The invention is not limited to its application for the tuning of short wave transmitters but can be employed whenever at variations of the induction capacitive variations are to be carried out at the same time.

What is claimed is:

1. An amplifier system including a vacuum tube having in its anode circuit inductance and parallel capacity, and a fixed capacity fixedly connected in parallel to a portion only of said inductance, a relatively small inductance placed in series with said last fixed capacity, and tapping means directly connected between the end of said first inductance removed from said anode and an intermediate point on said first inductance for shortening out of said circuit an adjustable portion of said first inductance, said adjustable portion including a part of that portion across which said fixed capacity is fixedly connected.

2. An amplifier system including a vacuum tube having inductance and parallel capacity in its output, and at least one other capacity permanently connected in parallel to a portion only of said inductance, and tapping means on said inductance extending between one end of said inductance and the tapping point thereon for directly short circuiting an adjustable portion of said inductance, said adjustable portion including a part of that portion across which said other capacity is permanently connected.

3. An amplifier system including a vacuum tube having in its anode circuit inductance and parallel capacity and a fixed capacity fixedly connected between the end of said inductance removed from said anode and an intermediate point, and tapping means on said inductance for directly shorting out of said circuit an adjustable portion of said inductance between said end removed from said anode and the tapping point.

4. A transmitter including a vacuum tube having in its anode circuit inductance and parallel capacity, and a plurality of other capacities fixedly connected directly between the end of said inductance removed from said anode and different intermediate points on said inductance, and means for shorting out a portion of said inductance extending from said one end of said inductance to any point on said inductance, whereby as more and more inductance is effectively connected in said circuit more and more capacity in shunt to portions of said inductance is also effectively connected in said circuit.

5. An amplifier system including a vacuum tube having inductance and parallel capacity in its output, and a fixed capacity fixedly connected directly across a portion only of said inductance, and a single control in the form of a short-circuiting member extending between one end of said inductance and an intermediate point thereon for varying simultaneously both the inductance and the effect of said last capacity in parallel to a portion of said inductance.

6. A push-pull amplifier system comprising a pair of electrode structures each including a grid, an anode, and a cathode, an inductance and a parallel capacity connected between the anode and cathode of each of said structures, a capacity individual to each inductance and fixedly connected across a portion of each inductance, and tapping means connected between the cathode terminals of each of said inductances and a point on each of said inductances for directly short circuiting a desired portion of said inductances.

7. An amplifier having an anode and a cathode, an output circuit therefor comprising fixed capacity connected between said anode and said cathode and in parallel relation with said fixed capacity, a path composed of an inductance having one end connected to the anode side of the capacity and an adjustable tap thereon connected to the other side of the capacity, and another path including fixed capacity connected between said cathode and a fixed point on said inductance intermediate the ends thereof.

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