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ELIMINATION OF DISTURBING OSCILLATIONS IN HIGH FREQUENCY SYSTEMS

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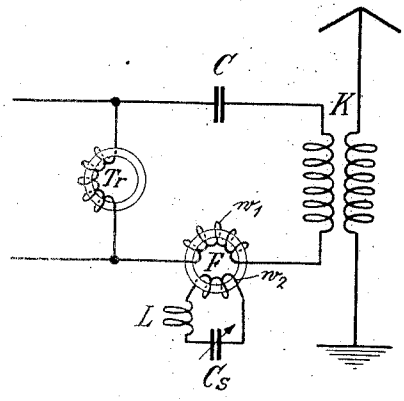


Fig.1

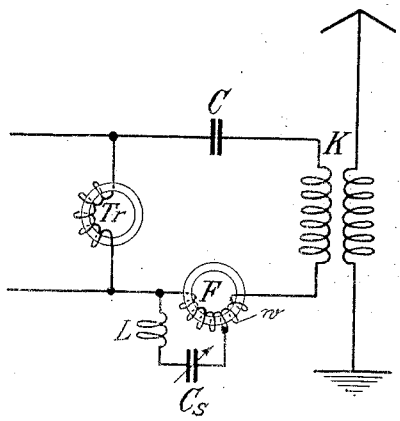


Fig.2

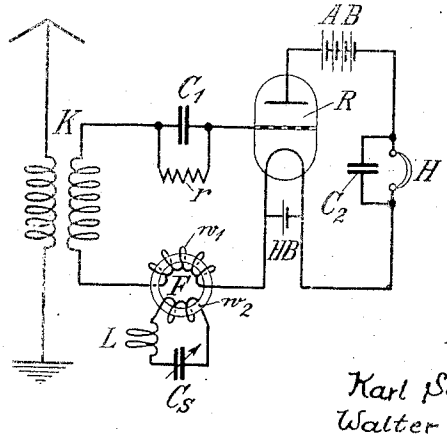


Fig.3

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UNITED STATES PATENT OFFICE

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ELIMINATION OF DISTURBING OSCILLATIONS IN HIGH-FREQUENCY SYSTEMS

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The present invention relates to radio transmission systems, and has for its object the elimination either in the transmitting or receiving circuits of higher harmonics, side frequencies or other disturbing waves.

According to this invention the objectionable frequencies are eliminated by the insertion, in any circuit in which such frequencies appear in conjunction with the operative frequency, of an iron core choke coil (which may be called a filter transformer) with a secondary coil short circuited by a combination of inductance and capacity in series. This capacity and inductance circuit is tuned to the operating frequency and acts as an acceptor circuit with the result that the choke coil operates in the manner of a short circuited transformer at the operative frequency, that is, it has very small magnetic field and therefore the losses almost disappear, while at all other frequencies, since a large impedance is presented by the primary winding of the transformer, a magnetic field would be present and the consequent losses will act to choke off the undesired frequency. In this way the impedance of the combination at the operating frequency is negligibly small, but retains its full value at the undesired frequency.

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 which illustrates diagrammatically three applications of the invention.

Figure 1 is a circuit diagram of a preferred embodiment of our invention.

Figure 2 is a modification of Figure 1 in which an auto-transformer replaces the transformer of Figure 1 and

Figure 3 is a circuit diagram by way of example, of an application of the invention to a receiver circuit.

Figure 1 shows a transmission circuit employing a static frequency transformer Tr in which higher harmonics and side frequencies are highly undesirable.

According to this invention there is connected in series with a tuning capacity C and a coupling device K for transmitting the oscillations to the aerial a filter transformer F constituted by an iron core provided with two windings w^1 and w^2. A variable capacity Cs, which represents a secondary tuning member in series with a self-inductance L is connected in circuit with the winding w^2 and is intended to tune the circuit of this winding to resonance with the operative waves. In the circuit Tr, C, w^1, in addition to the desired operative waves, there is a series of higher harmonics and side frequencies; these meet, in the primary winding w^1 of the filter transformer, with such a high resistance loss that they become uniformly extinguished, whilst, for the operative wave, the primary winding acts as a low resistance path, since, owing to the high resonance current produced in the secondary circuit w^2, L, Cs, the field of the operative waves in the iron core of the filter transformer F is annulled and in that way the self induction, and therefore the iron losses, are practically cancelled, being reduced to that due to leakage. This can in turn be reduced or minimized by using a transformer as far as possible without leakage, for instance, as shown in the drawing, one with an annular iron core. By making the self-inductance L large with respect to capacity Cs the damping of the secondary circuit may be held at a low value, so that very close side frequencies will be suppressed and the filtering action of the transformer improved.

Figure 2 shows the same arrangement, but an auto-transformer is employed as will mostly be the case in practice on account of the freedom from leakage of such an arrangement.

Figure 3 shows by way of example the application of the invention to a receiving circuit, the secondary circuit of the transformer F being tuned to the wave to be received, which is thus solely operative in affecting the grid circuit of the valve, whilst disturbing waves are suppressed. Alternatively, an auto-transformer could be used or the transformer could be inserted in the aerial circuit instead of in the secondary circuit.

It is a well-known thing in the art of electrical engineering that a short circuited transformer presents a very low impedance in the circuit and therefore will pass a considerable

current without any rise of voltage at the terminals. This is especially true with iron core transformers arranged in a ring shape, where the stray fields and the consequent leakage inductance are negligible. As the impedance of the secondary circuit is increased the impedance of the primary circuit varies correspondingly until at open circuit the primary impedance is a maximum corresponding to the magnetizing current of the transformer, and taking practically the full available voltage.

In this invention this well-known function of a transformer is taken advantage of for the purpose of permitting the desired frequency to pass through and for blocking off all of the undersired frequencies. The secondary winding instead of being short circuited is connected to an inductance and a condenser which are tuned to the desired frequency. As a result the secondary circuit presents an extremely low impedance at the desired frequency, corresponding to an impedance of such a series connection at the instant when the reactance of the inductance is equal to the reactance of the condenser.

On the other hand, at all other or undesired frequencies the reactance of the condenser does not cancel the reactance of the inductance and therefore there is an appreciable impedance in the secondary winding of the transformer. As a result the primary of the transformer also presents in the circuit a considerable impedance and a certain amount of voltage will accumulate at the terminals of the primary winding. The presence of voltage of the terminals of a winding is of course accompanied by a corresponding magnetic flux through the iron core of the transformer and such a magnetic flux will produce considerable losses. Thus, in addition to the blocking effect of the choke coil there is also an absorbing effect, due to the losses of the iron core.

Again referring to the mode of operation with the desired or with the operative frequency; on account of the very low secondary impedance, the primary impedance is also negligible, no voltage is found at the terminals, and therefore there is no necessity for a magnetic flux, hence the losses at the operative frequency are non-existent, or very small.

Further insight into the operation of the device can be obtained by considering what would happen if the secondary of a transformer were connected to the terminals of a condenser. Obviously, if the condenser were exceedingly small a very minute amount of current passing through the secondary would be sufficient to charge the condenser to full A. C. potential and the effect on the primary would be approximately the same as if the secondary were on open circuit. If the secondary were connected to the terminals of a condenser of extremely large size, a large amount of current could surge through the secondary, and the effect on the primary would be the same as if the secondary were short circuited. That is, with a small condenser all frequencies would meet with great impedance in the primary of the transformer, with a large condenser all frequencies would meet with very slight impedance in the primary. In other words, the placing of a condenser alone in the secondary would not permit sharp tuning to a given desired frequency unless the transformer had large inherent leakage inductance. Hence the inclusion of an inductance along with the condenser in the secondary circuit as described and illustrated.

What we claim is:

1. An apparatus for the elimination of higher harmonics, side frequencies or other disturbing waves in a radio transmission circuit comprising the primary of an iron cored transformer inserted in the circuit in which such waves exist in conjunction with the operative series of oscillation and electrical means associated with the secondary coil of said transformer whereby the circuit of said secondary coil may be tuned to react on the primary to render its impedance a minimum with respect to the operating frequency.

2. An apparatus for the elimination of higher harmonics, side frequencies or other disturbing waves in radio transmission systems, comprising a primary coil of a transformer inserted in a circuit in which such waves exist in conjunction with the operative series of oscillations, an iron core for said coil, a secondary coil for said transformer and shunted by a variable capacity in series with an in inductance-coil the thus formed secondary circuit being tuned to react on said primary to make its impedance a minimum in respect to the operative oscillations.

3. An apparatus for the elimination of higher harmonics, side frequencies, or other disturbing waves in radio transmission systems, comprising a coil wound on a closed iron core inserted in the circuit in which such waves exist in conjunction with the operative series of oscillations and comprising a capacity in series with an inductance coil connected in parallel with a portion of said coil, the thus formed shunt circuit being tuned to react on said coil to make its impedance a minimum in respect to the operative oscillations.

4. An apparatus for eliminating objectionable frequencies from a radio circuit comprising a transformer, a primary for said transformer forming part of said radio circuit, an iron core inductively related to the primary, a secondary for the transformer inductively related to the iron core and a tuned circuit in the secondary tuned to a predetermined frequency whereby the magnetic field produced in said iron core by the predetermined

frequency is destroyed and consequent losses and impedance at all other frequencies are produced.

5. An apparatus for eliminating side frequencies from a radio circuit comprising a choke coil in the circuit, an iron core in the choke coil, a second coil having inductive relationship to the choke coil through the iron core and a capacity in series with an inductance in circuit with said second coil to permit oscillations of operating frequency to pass through said choke coil without impedance voltage drop or loss of energy in said choke coil.

6. An apparatus for reduction of undesirable frequencies comprising a closely coupled transformer, a primary of said transformer forming part of a radio frequency circuit, and a tuned combination of capacity and inductance in series in the secondary circuit of said transformer to produce an equivalent low impedance of the transformer primary at the operating frequency and a relatively high impedance at all other frequencies.

7. An apparatus for the elimination of objectionable frequencies in a radio circuit, comprising an iron core inductance coil inserted in said circuit and means including a tuned circuit in inductive relation with said inductance coil for bypassing the operating frequency and preventing it from producing an appreciable voltage drop through said inductance coil.

8. An apparatus for the elimination of objectionable frequencies in a radio circuit, comprising an iron core inductance coil inserted in said circuit, a secondary winding of said core, and a resonant circuit containing a capacity and an inductance coil in series connected to said secondary for tuning said secondary so as to produce a minimum impedance at said coil in respect to the operating frequency.

In testimony whereof we have affixed our signatures.

KARL SCHMIDT.
WALTER HAHNEMANN.