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METHOD AND MEANS FOR PREVENTING AMPLIFIERS FROM OSCILLATING.

APPLICATION FILED FEB. 14, 1918.

1,426,733. Patented Aug. 22, 1922.

Fig. 1.

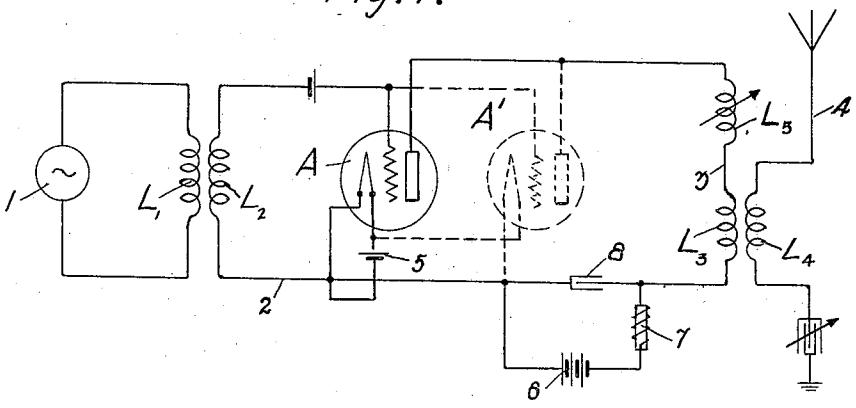


Fig. 2.

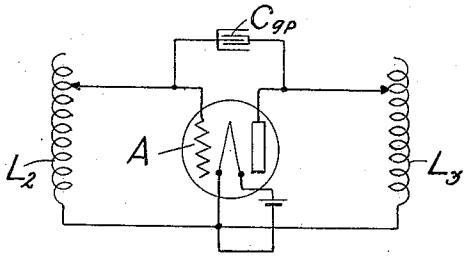
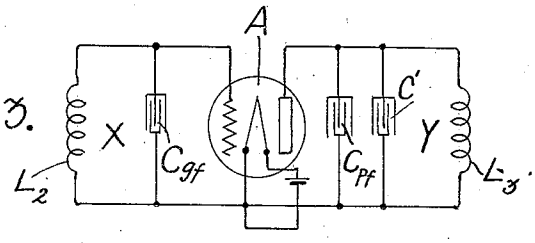


Fig. 3.



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UNITED STATES PATENT OFFICE.

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METHOD AND MEANS FOR PREVENTING AMPLIFIERS FROM OSCILLATING.

1,426,733. Specification of Letters Patent. Patented Aug. 22, 1922.

Application filed February 14, 1918. Serial No. 217,139.

To all whom it may concern:

Be it known that I, RAYMOND A. HEISING, a citizen of the United States, residing at East Orange, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods and Means for Preventing Amplifiers from Oscillating, of which the following is a full, clear, concise, and exact description.

This invention relates to thermionic amplifiers or repeaters, and the object of the invention is to provide simple methods and means whereby a thermionic tube or audion used to amplify alternating current, and particularly high frequency alternating current, can be kept from oscillating with a period or periods of its own, owing to the capacity coupling between the grid and the plate or other elements of the tube. In case a tube so tends to oscillate and its ratio of amplification is sufficiently high, its own oscillations may be magnified to such a high degree as to interfere with the amplifying action of the tube or produce undesired frequencies in the output. In general, then, the object of the invention is to so proportion the parts of an inherently coupled amplifier circuit as to prevent it from oscillating.

When an amplifier tends to set up oscillations due to its inherent coupling, it has been found that this action can ordinarily be prevented by properly proportioning the parts of the circuit. In the case of a tube having an inductive input circuit and an output circuit, oscillations due to grid-plate coupling can be prevented by making the output circuit inductance of sufficiently large value. The value necessary will in general depend upon certain constants of the circuit, for instance, the internal impedance, the capacity between grid and plate, the input and output coil resistances and the effective inductance of the input circuit. The proper value of inductance in the output circuit necessary to accomplish the object stated, may be determined either experimentally or by calculation. If the coil resistances are negligible, the effective output inductance must bear the same or a greater ratio to the effective input inductance as the ratio of amplification in order to prevent oscillation. The grid-filament or plate-filament capacity, or the distributed capacities of the coils, or the combined effects of these several capacities, may also tend to cause oscillations which may be prevented, as, for example, in the manner hereinafter set forth.

In the accompanying drawings, Fig. 1 represents a diagram of an amplifier having means to prevent oscillations due to grid-plate coupling; Fig. 2 illustrates diagrammatically the essentials of the circuit of Fig. 1 when it tends to act as an oscillator due to such coupling; Fig. 3 is a corresponding diagram of a vacuum tube circuit in which the grid-filament and plate-filament capacities are illustrated.

In Fig. 1, a source of alternating current 1 is connected to an amplifying tube A of the audion type. The source 1 may be any suitable means, as, for example, an oscillation generator of the audion type. An inductance L_1 in circuit with source 1 is coupled to an inductance L_2 in the input circuit 2 of tube A, which will have an amplified current variation in its output circuit 3 in which is located coil L_3 coupled to coil L_4 located in an antenna 4 for impressing oscillations upon the antenna to cause the electromagnetic waves to be radiated. In case greater power is desired, one or more additional tubes A′, as shown in dotted lines, may be placed in parallel with tube A, that is, with the grids, filaments and plates respectively, of the tubes connected. The usual heating battery 5 and output battery 6 are provided. Battery 6 may be placed in series with choke coil 7 and be shunted about condenser 8, through which high frequency current will pass.

An inductance L_5 of proper magnitude placed in the output circuit 3 will prevent free oscillations of the tube circuit due to grid-plate coupling. Inductance L_5 should ordinarily not be larger than is necessary to accomplish the desired result. It is unnecessary that the inductance be a separate coil L_5, as the same result may obviously be obtained if the self-inductance of coil L_3 is sufficiently large.

Fig. 2 represents the circuit of Fig. 1 in a simplified form, and shows a tube A with input inductance L_2, output inductance L_3, the grid-plate capacity being diagrammatically shown by a connecting capacity C_{gp}. The frequency of oscillations set up will depend upon capacity C_{gp} and inductances L_2 and L_3. If L_3 is made sufficiently large,

no oscillations result as the energy fed back to the input will be too small to cause enough amplification of any existing oscillations to cause them to continue.

In Fig. 3, the capacity C_{gf} represents the grid-filament capacity, and the distributed capacity of inductance L_2 and C_{pf} represents the plate-filament capacity and the distributed capacity of inductance L_3. Thus two tuned circuits X and Y are formed which, if tuned to the same or approximately the same frequency, will tend to cause the tube A to act as a generator. In order to prevent such generation, the circuits X and Y should be tuned to different frequencies, in which case oscillations will not be generated. This can be readily accomplished by adding a small capacity C′ in parallel with the capacity C_{gf}, or as shown in parallel with C_{pf}. The desired result will be obtained in either case. It should be understood that the arrangements of Figs. 2 and 3 are not alternative or mutually exclusive, but are directed to counteracting different but analogous causes of oscillations, and both may be applied to a single system if both those causes exist. Instead of using capacity or inductance to prevent oscillations, the resistance of the circuit may be increased as shown in Heising Patent 1,199,180, dated September 26, 1916.

The invention is not limited in its application to radio systems but may be generally applied where thermionic audion devices are used as amplifiers and it is desired to prevent free oscillations such as are due to internal capacity coupling of the tube or other tendency of the circuit to oscillate.

What is claimed is:

1. The method of repeating and amplifying substantially without distortion with a thermionic device comprising a vacuum tube having cathode, anode and control electrodes therein which comprises supplying the impulses to be repeated to the control electrode of said device and thereby establishing variations in potential across said cathode and anode, leading off the established variations exclusively to the outgoing circuit except for such variations as are supplied to the control electrode circuit of said device through the coupling between the electrodes internal of said tube, and in compensating for said coupling and thereby preventing free oscillations.

2. A transmission system adapted to amplify waves in substantially the same form as they are received comprising means for preventing free oscillations in a vacuum tube amplifier having negligible external input and output resistance, which means consists of an effective inductance in the output circuit having a ratio to the effective inductance of the input circuit not less than the amplifying ratio of the tube.

3. A transmission system adapted to amplify waves in substantially the same form as they are received comprising means for preventing free oscillations in a thermionic vacuum tube amplifying system which has negligible external input and output resistance, said means consisting of inductance in the output circuit sufficiently large relatively to the effective inductance of the input circuit to accomplish the said preventing.

4. A transmission system adapted to transmit high frequency carrier waves in substantially the same form as they are received comprising a three-element vacuum tube amplifier having an output circuit, said tube also having an inductive input circuit and an internal capacity coupling, and said output circuit including an inductance approximately equal to the effective inductance of said input circuit multiplied by the amplification ratio of said tube, to prevent said tube acting as an independent generator of oscillations, while permitting the transmission through said inductance of said high frequency waves.

5. The method of repeating and amplifying substantially without distortion with a thermionic device comprising a vacuum tube having cathode, anode and control electrodes therein which comprises supplying the impulses to be repeated to the control electrode of said device and thereby establishing variations in potential across said cathode and anode, leading off the established variations exclusively to the outgoing circuit except for such variations as are supplied to the control electrode circuit of said device through the coupling between the electrodes internal of said tube, and in reactively compensating for said coupling and thereby preventing free oscillations.

6. A transmission system comprising an incoming line adapted to supply high frequency weak impulses to be amplified, an outgoing line adapted to transmit said impulses substantially without distortion and of amplified form, and an amplifier between said lines, said amplifier comprising an electron discharge device having a cathode, an anode, a grid, a source of potential in circuit with said grid and cathode, said device having an input and an output circuit coupled substantially wholly through the capacity of said electrodes, and an inductance in said output circuit and cooperating with said capacity to prevent said amplifier from generating free oscillations, while permitting said high frequency impulses to flow through said inductance.

In witness whereof, I hereunto subscribe my name this 5th day of February A. D., 1918.

RAYMOND A. HEISING.