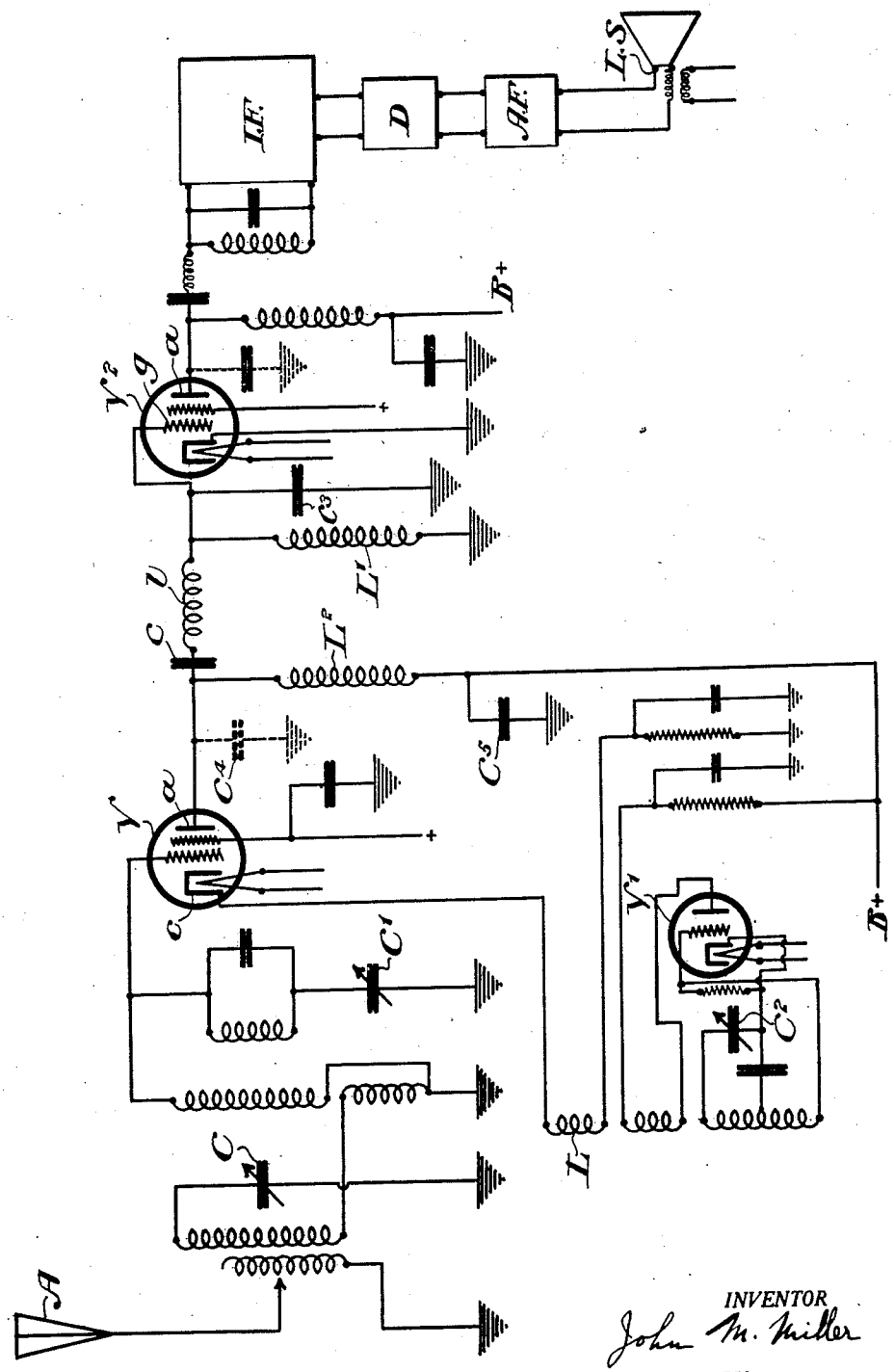
Nov. 22, 1932. J. M. MILLER 1,888,430

RADIO RECEIVING SYSTEM

Filed Sept. 27, 1930



INVENTOR
John M. Miller
BY
Cornelius D. Ehret
ATTORNEY

Patented Nov. 22, 1932 1,888,430

UNITED STATES PATENT OFFICE

JOHN M. MILLER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO ATWATER KENT MANUFACTURING COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

RADIO RECEIVING SYSTEM

Application filed September 27, 1930. Serial No. 484,815.

My invention relates to radio receiving systems and particularly those in which signal oscillations and locally produced oscillations are caused to interact to produce oscillations of beat or intermediate frequency which are amplified and demodulated; and more particularly, my invention relates to superheterodyne sets for reception of speech or music.

In accordance with my invention, tubes of a radio receiver, particularly a superheterodyne, are coupled by a system comprising a low-pass filter, preferably including a series arrangement of inductance and capacity substantially resonant at the desired or intermediate frequency, and which, more particularly, connects the input and output circuits of adjacent tubes.

More particularly, the series combination of inductance and capacity is included in a path above earth or cathode potential, for example, in a connection between the plate of the first detector tube and a coupling inductance, and in addition thereto, there is provided one or more paths to earth or equivalent of low impedance for oscillations of signal or oscillator frequencies, specifically a capacity effectively in shunt to said coupling inductance for tuning to the intermediate frequency offers low impedance to the undesired higher frequency oscillations of the signal and local oscillator.

My invention resides in a system of the character hereinafter described and claimed.

For an understanding of my invention and for an illustration of one of the forms which it may take, reference is to be had to the accompanying drawing in which the figure diagrammatically represents a superheterodyne receiving system.

Between the first detector tube V and the antenna or absorption structure A, there are interposed cascaded circuits tunable by the condensers C and C1 to the desired signal frequency. With the tube V1 are associated suitable circuits for the production of locally generated oscillations whose frequency is determined by the setting or adjustment of the condenser C2, and which are impressed upon the detector V, for example through the coupling inductance L which is included in the input circuit of the detector tube V between the cathode *c* and the lower terminal of the condenser C1. The oscillations of beat frequency resulting from interaction between the oscillator and signal oscillations are amplified and impressed upon the input of the second detector D which usually feeds an audio frequency amplifier in whose output system there is included a reproducing device, for example, a loud speaker LS.

Although receivers of this type may be stable as a whole as well as in their component parts, there is often experienced undesirable noises, as squeals, when the set is tuned through or near the frequency of some transmitting stations, particularly when the station is powerful or disposed near the receiver. This seems to be caused by beats between the fundamental frequency or harmonics of the oscillator or signal and the harmonics of the intermediate frequency in the second detector. The condition cannot be remedied by increasing the selectivity of the circuits between the first detector and the antenna. The undesirable results in reception, particularly the squeals mentioned, are apparently due to the amplification or at least relaying of oscillations of signal or local oscillator frequency by the intermediate frequency amplifier.

The reception is improved and the undesired audio frequency beats in the second detector may be eliminated by highly attenuating oscillations of the oscillator or signal frequencies in the intermediate frequency amplifier, for example by discriminating against oscillations of these frequencies in the coupling system between the first detector tube V and the first tube V2 of the intermediate frequency amplifier.

In the direct coupled system shown, the coupling condenser C which would ordinarily be connected between the plate *a* of the first detector tube V and the grid *g* of the intermediate amplifier tube V2 and would be of low impedance to beat frequency oscillations and of lower impedance for oscillation of signal and/or oscillator frequency is replaced by the condenser *c* and inductance

1 in series forming a network of high impedance to oscillations generated by the local oscillator V1 and also to signal oscillations. More particularly, capacity *c* and inductance 1 in series are substantially resonant at the frequency of beat oscillations to afford, as to them, a path of low impedance.

For the intermediate frequency of 130 kilocycles, the condenser *c* may have a capacity of about 200 micro microfarads and the coil 1 an inductance of about 7.5 millihenries, although it will be understood that these values are for the purpose of illustration and are in no sense limiting. For this same intermediate frequency, the coupling inductance L1 may have a value of about 14 millihenries.

The input system of the tube V2 is preferably tuned to the intermediate frequency by the condenser C3 of about 100 micro microfarads, which offers low reactance for the oscillator and signal frequencies and assists the combination *c*, 1 in attenuating the voltage upon the grid *g* of the tube V2 for oscillations of signal and oscillator frequency. The capacity C4 which may be a physical condenser or the lumped inherent capacity between the plate *a* of the first detector tube V and earth or equivalent, is also of lower reactance for oscillations of signal and oscillator frequency, further serving to exclude them from the input circuit of the intermediate frequency amplifier.

The inductance L2 affords a path for direct current to the anode circuit of the detector tube V and is of proper constants substantially to exclude radio-frequency currents, for example, it may have an inductance of about 200 millihenries. The lower end of L2 for currents of radio-frequency is substantially at cathode or earth potential because of the low impedance offered by the by-pass condenser C5.

The inclusion of these additional elements increases the stability of the receiver, permitting higher amplification if desired without undesired regenerative effects.

For simplicity of explanation, only the tubes and circuits directly involved have been fully shown. It will be understood that the detector, audio frequency amplifier, and the intermediate frequency amplifier beyond the first tube, are or may be of conventional design, with suitable sources of current for supplying the electrode circuits of all the tubes, including those shown. The intermediate frequency amplifier in particular may include one or more tubes suitably coupled by circuits preferably more or less resonant at the intermediate or beat frequency. The coupling systems between the intermediate amplifier tubes and/or between the last tube of the intermediate amplifier may also include a low-pass filter between the anode circuit of one tube, which is preferably of high impedance to the intermediate frequency by virtue of a choke corresponding to L2, and the input circuit of the next tube, preferably also substantially tuned to the intermediate frequency.

What I claim is:

1. A radio receiving system comprising a thermionic tube having an input circuit, a second thermionic tube having an output circuit, one only of said circuits being resonant at a desired radio-frequency, and a series combination of capacity and inductance substantially resonant at said desired radio-frequency directly coupling said circuits and forming therewith a filter having the characteristic of a low-pass filter for frequencies higher than said desired frequency.

2. A radio receiving system comprising a thermionic tube having an input circuit tuned to a desired frequency, a second thermionic tube, a source of anode current, an impedance of substantial magnitude for radio-frequencies in circuit between said source and the anode of said second tube, and a connection from the anode of said second tube to the input circuit of said first tube comprising a combination of inductance and capacity in series of low impedance to said desired frequency and forming with said tuned input circuit a filter having the characteristic of a low-pass filter for frequencies higher than said desired frequency.

3. A heterodyne receiver comprising a first detector, a second detector, an oscillator for generating local oscillations, and an intermediate frequency amplifier utilizing amplifier tubes each having input and output circuits, only one of which is tuned to the intermediate frequency, characterized by the fact that the input circuit of at least one of the amplifier tubes is connected to the anode circuit of the preceding tube by a series combination of inductance and capacity in series resonance at substantially the intermediate frequency and cooperating with the tuned circuit to form a filter having the characteristics of a low-pass filter for frequencies higher than said intermediate frequency.

4. A heterodyne receiver comprising a first detector, a second detector, an oscillator for generating local oscillations, and an intermediate frequency amplifier utilizing a thermionic tube having its input circuit only tuned to the intermediate frequency characterized by the fact that the tuned input circuit is connected to the anode circuit of the preceding tube by a combination of inductance and capacity in series resonance at substantially the intermediate frequency and cooperative with said tuned input circuit to form a filter having the characteristics of a low-pass filter for frequencies higher than the intermediate frequency.

5. A heterodyne receiver comprising a first detector tube, a second detector tube, an oscillator for generating local oscillations, an in-

termediate frequency amplifier, and coupling systems between the first detector tube, the amplifier tubes, and the second detector tube, characterized by the fact that at least one of said coupling systems comprises a circuit in parallel resonance for the intermediate frequency and a series resonant circuit directly connected thereto and forming therewith a filter having the characteristic of a low-pass filter for frequencies higher than the intermediate frequency substantially to prevent transfer to said second detector of oscillations of the signal frequency, or of the local oscillator, or harmonics of the signal oscillations or local oscillations.

JOHN M. MILLER.