Nov. 12, 1929. P. W. WILLANS 1,735,150

WIRELESS TELEPHONE RECEIVING SYSTEM

Filed Oct. 14, 1925

*Fig. 1*

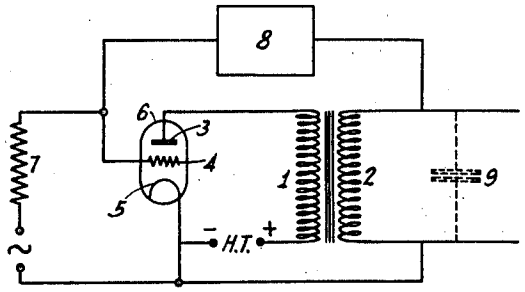



*Fig. 2*

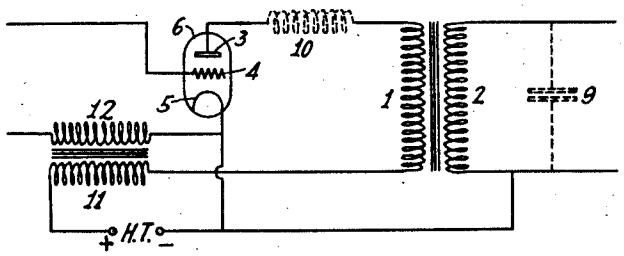
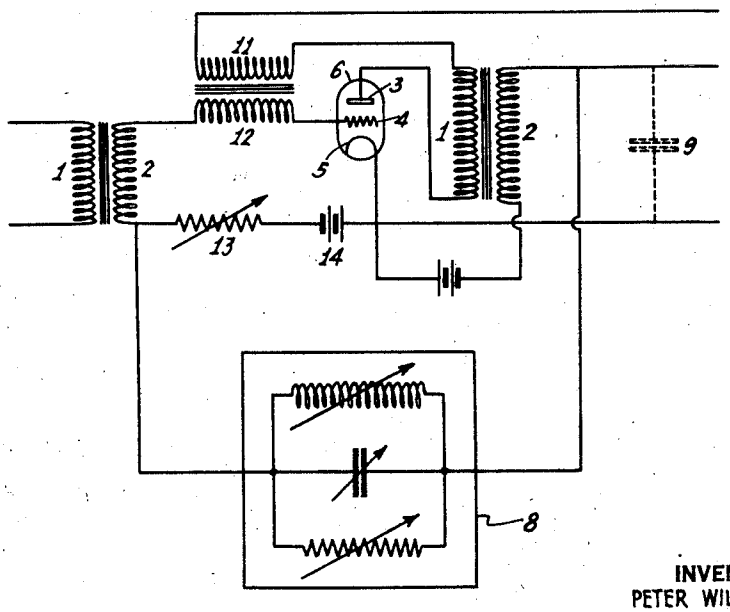



*Fig. 3*




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# UNITED STATES PATENT OFFICE

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## WIRELESS-TELEPHONE RECEIVING SYSTEM

Application filed October 14, 1925, Serial No. 62,471, and in Great Britain October 14, 1924.

This invention relates to receiving systems suitable for use in wireless telephony.

More particularly the invention relates to audio frequency theremionic valve amplifiers for use in such receiving systems.

I have found that the distortion which usually occurs in valve amplifiers is due to three main causes:—(1) The drop in impedance of the intervalve transformer at low frequencies, due to the fact that its inductance is not infinite. (2) The drop in impedance of the transformer at high frequencies, due to the fact that its self capacity is not zero. (3) The magnetic leakage between the primary and secondary windings of the transformer.

According to this invention I annul part or the whole of the distortion by employing reaction between the output and input circuits of an amplifying valve.

With this object the transformer, whose primary is connected in the anode circuit of the valve, has its windings in opposite sense, i. e. at the same instant the polarities of the high potential ends of the windings are in approximate opposition of phase, and an impedance is included in the grid circuit in series with a source of electromotive force. The high potential of this impedance is connected through a second impedance to the high potential of the transformer secondary.

The nature of the impedances depends upon the effect it is desired to produce, but in general the first impedance is preferably a resistance. In this case, if the second impedance be a condenser, the effective self capacity of the transformer will be reduced over a range of frequencies and may even attain a zero or negative value. If an inductance is used, the effective inductance of the transformer will be increased. A combination of the two in parallel produces both effects simultaneously. The impedance should be large in comparison with the resistance at all frequencies concerned.

If the second impedance be itself a resistance, an increase in the in-phase component of amplification is produced.

If a resistance be combined in parallel with an inductance and a capacity, the several effects will be obtained independently of each other.

If an inductance is connected in series with a resistance, the effect of magnetic leakage is counteracted.

The effect of magnetic leakage may also be counteracted by means of a reaction transformer, so arranged as to introduce into the grid circuit a voltage sufficient to compensate for that dropped in the anode circuit, owing to the leakage inductance of the intervalve transformer.

The invention is illustrated in the accompanying drawings.

In these drawings 1 is the primary and 2 the secondary of an intervalve transformer. 3 is the plate, 4 the grid and 5 the filament of an amplifying valve 6. For the sake of clearness, anode, grid and filament batteries have been omitted from most of the drawings, as the application of these batteries is well known.

Referring first to Figure 1, this shows an arrangement in which an impedance 7 is connected in the grid circuit of the valve 6. The primary and secondary of the intervalve transformer are wound in opposite sense, and the high potential of the secondary is connected through an impedance 8 to the grid 4. The impulses to be amplified are represented by an alternating current sign, and the load on the transformer by a capacity 9.

Various results can be obtained according to the nature of this impedance 8. If it be a capacity, the result will be to reduce the effective self capacity of the transformer over a range of frequencies; if it be an inductance, the result will be to increase the effective inductance of the transformer; an impedance comprising an inductance and capacity in parallel gives both results simultaneously; if it be a resistance, the effect is to increase the in-phase component of amplification; a resistance in parallel with an inductance and capacity gives all these results independently of one another; while, a resistance in series with an inductance, compensates for the effect of magnetic leakage. Obviously the exact nature of the impedance 8 will depend upon

the nature of the intervalve transformer, whose distortion is to be compensated for.

Figure 2 shows an arrangement in which the effect of magnetic leakage is compensated for by means of a reaction transformer. The effect of magnetic leakage may be regarded as though it were caused by a separate inductance, shown in the figure as an "imaginary" inductance 10, in series with the primary of the intervalve transformer, the windings thereof being regarded as close-coupled. The effect of the leakage inductance is compensated for by a reaction transformer whose primary 11 is connected in series with the primary of the intervalve transformer, and whose secondary 12 is connected in the grid circuit.

If $m$ is the voltage factor of the valve, then the reaction transformer should be such as to introduce into the grid circuit a voltage equal to $\frac{1}{m}$ times that dropped in the leakage inductance. It will be apparent that the primary 11 has itself to be reckoned as part of the leakage inductance. Assuming a 1 : 1 ratio transformer be used, the inductance of each winding should be made equal to the leakage inductance divided by $m-1$.

This arrangement has the disadvantage that the reaction transformer which is normally small tends to oscillate at its own frequency, and for this reason it is preferable to provide a damping resistance connected across the windings of the said transformer. I have found such a damping resistance to result in practice in a very considerable improvement.

Figure 3 shows an arrangement in which means are provided for compensating for all the forms of distortion likely to be occasioned by an intervalve transformer.

The grid 4 is connected through the secondary 12 of a reaction transformer, the secondary 2 of the intervalve input transformer, a variable high resistance 13 and a battery 14 to the filament 5; the anode circuit contains, in addition to the primary 1 of the output intervalve transformer, the primary 11 of the reaction transformer. The high potential of the secondary 2 of the output intervalve transformer, which secondary is wound in the opposite sense to the primary, is connected to the grid circuit between the input intervalve transformer and the resistance 13 through an impedance 8 comprising a capacity, an inductance and a resistance, all in parallel with one another.

It will be apparent that the electrical constants and characteristics of the input intervalve transformer will have a marked influence upon the necessary values of the various impedances. For this reason, and owing to the complexity of the net-work of which the impedances form part, it is preferable to make the said impedances variable.

It will be apparent to those skilled in the art that many modifications of the arrangements herein described are possible. For example, in a modification of the arrangement shown in Figure 3, the impedance 8 is a substantially pure resistance, and the resistance 13 is replaced by a small inductance and a large capacity in series.

The invention may also be applied to impedance or "choke" coupled valves, for the purpose of compensating for distortion, due to the impedance or choke.

The arrangements as hereinbefore described may also be employed for line telephone systems, for example, in repeater and the like amplifying stations, and for both line and radio telegraph systems.

Having described my invention what I claim is:—

1. In combination a thermionic amplifying valve, an input circuit for said valve, an output from said valve, said output including a transformer, and means comprising a resistance, an inductance and a capacity arranged in parallel connecting said output with said input circuit for compensating for distortion in said transformer.

2. In a valve amplifier, in combination a thermionic valve adapted to operate at audio frequencies, an audio frequency transformer connected with its primary in the plate circuit of said valve, an audio frequency input to said valve, an output from said transformer, and means comprising an inductance and a capacity arranged in parallel connected between said output and said audio frequency input for compensating for distortion in said valve amplifier.

3. An amplifying unit comprising a thermionic valve, a transformer connected in the plate circuit of said valve, a circuit for the input to said valve, a second circuit for the output from said transformer, and an impedance including an inductance connected between said input and output circuits.

4. An amplifying unit comprising a thermionic valve, a transformer connected in the plate circuit of said valve, a circuit for the input to said valve, a second circuit for the output from said transformer, and an impedance comprising a capacity, a resistance and an inductance arranged in parallel connected between said input and output circuit.

5. In a valve amplifier, in combination a thermionic valve, a grid circuit for said valve, a plate circuit for said valve, an output circuit, an intervalve transformer coupling said plate circuit to said output circuit, an impedance connecting said output circuit with said grid circuit and a second transformer coupling said plate circuit with said grid circuit, said impedance connection and said second transformer coupling acting to compensate for distortion in said valve amplifier.

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