Feb. 28, 1933. K. W. JARVIS 1,899,758

AMPLIFYING SYSTEM

Filed July 17, 1926

Fig. 1.

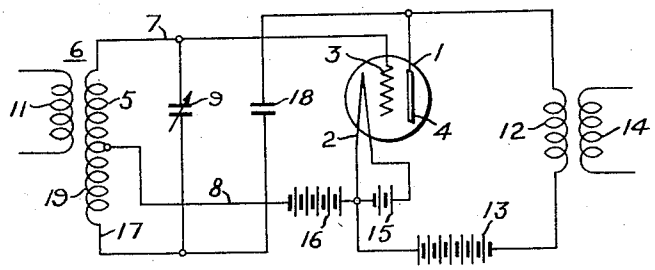


Fig. 2.

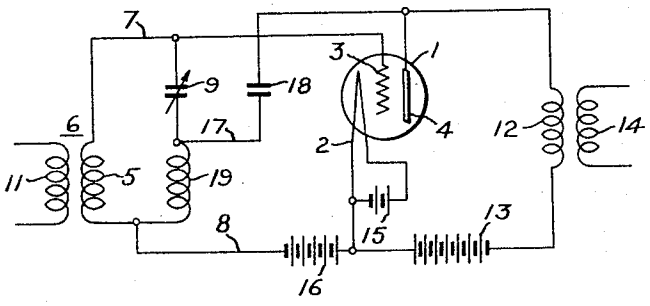


Fig. 3.

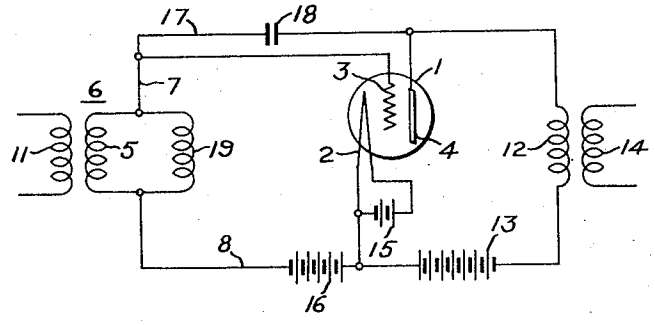
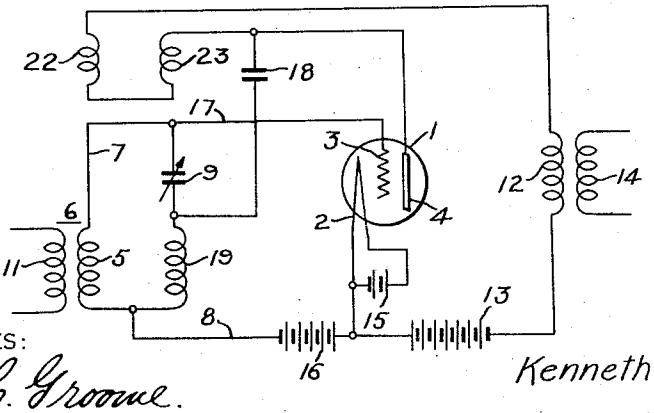


Fig. 4.



WITNESSES:

Anne C. Groome.

J.R. Goldsborough

INVENTOR

Kenneth W. Jarvis.

Wesley G. Carr

ATTORNEY

Patented Feb. 28, 1933

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UNITED STATES PATENT OFFICE

KENNETH W. JARVIS, OF CINCINNATI, OHIO, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

AMPLIFYING SYSTEM

Application filed July 17, 1926. Serial No. 123,211.

My invention relates to amplifying systems, and it has particular reference to systems employing thermionic tubes, either as audio or as radio-frequency amplifiers.

One object of my invention is to provide means for preventing, in thermionic tubes and the circuits associated therewith, the parasitic, ultra-high-frequency oscillations which tend to occur under certain conditions.

Another object of my invention is to provide means for the prevention of parasitic oscillations in amplifier circuits that have already been partially neutralized by known methods.

A still further object of my invention is to provide means for the prevention of parasitic oscillations at frequencies above those to which the circuits associated with an amplifier system are normally tuned.

Numerous attempts have been made to devise circuits which would prevent oscillations from spontaneously starting in circuits associated with thermionic-tube amplifiers, especially when such circuits are being used in the amplification of high-frequency signals.

None of the systems known to the prior art have proved entirely successful, there being always a tendency for the tubes to oscillate at ultra-high, parasitic frequencies, no matter how carefully the circuits have been neutralized against oscillation at the frequencies lying in the normal tuning range thereof.

According to my invention, I provide means, in the nature of reverse-feed-back coils, which are so arranged that all tendency of an amplifier circuit to oscillate at parasitic frequencies is nullified.

In order that a complete understanding of my invention may be had, the following description should be read in connection with the accompanying drawing.

In the drawing, Figure 1 is a diagram of a well-known type of neutralized amplifier circuit,

Fig. 2 is a diagram of the same circuit as that of Fig. 1, in a different form,

Fig. 3 is a diagram of the same circuit, the tuning condenser being omitted,

Fig. 4 is a diagram of the same circuit as that of Figure 2, illustrating the application of a preferred form of my invention thereto.

In all views, like elements are similarly numbered.

Referring specifically to Figure 1, a thermionic tube 1 having a filament 2, a grid 3 and a plate 4, is provided with an input circuit comprising a portion 5 of an inductor 6, located between a connection 7 leading to the grid 3, and a connection 8 leading to the filament 2. The inductor 6 is shunted by a condenser 9 for the purpose of tuning.

Coupled to the input circuit, is an inductor 11, which may be a source of signal frequencies, either radio or audio.

The tube 1 is provided with an output circuit connected between the plate 4 and the filament 2, comprising an inductor 12 and a source of plate potential 13.

An inductor 14 coupled to the output circuit inductor 12, enables variations in the output current to be impressed on the input circuit of a succeeding amplifier stage.

A source of potential 15 for the filament is provided, as is also a potential source 16 for the proper biasing of the grid 3. Connected between the plate 4 and an end 17 of the input inductor 5 remote from the grid connection, is a small condenser 18, which, taken in conjunction with a portion 19 of the inductor lying between the filament connection 7 and the end 17, provides means for neutralizing the tube 1 against oscillating at any frequency determined by the setting of the tuning condenser 9.

The circuit thus far described and illustrated is the now well known "Rice" circuit, shown in the United States patent to Rice, No. 1,334,118, to which reference should be made.

In the patent referred to, a statement is made that, in order to obtain perfect neutralization, it is necessary that unity coupling be had between the two portions of the input inductor.

This statement, according to my experiments, is not necessarily true if the frequencies determined by the setting of the tuning condenser be the only frequencies con-

sidered. For such frequencies, it is not even necessary that the filament connection be made at the exact center of the input inductor, nor is it necessary for the two portions of such inductor to be in inductive relation at all. In fact, the circuit may be arranged as shown in Fig. 2 and still be effectively compensated by the neutralizing condenser, as, in such event, the separate portions of the input inductor are coupled sufficiently through the resonating effect of the tuning condenser.

If the circuit of Fig. 2 is now considered in relation to ultra-high frequencies above those determined by the tuning condenser, it is obvious that the tuning condenser 9 offers substantially zero impedance to these frequencies. Fig. 2 may, accordingly, be redrawn as in Figure 3, with the tuning condenser eliminated, and the two portions of the inductor in parallel with respect to the grid and filament of the tube.

It is obvious that, under certain conditions, the circuit shown in Figure 3 is capable of oscillating at very high frequencies determined by the leakage reactance of the inductors 5 and 19, and the grid-filament capacity of the tube, the necessary feed-back being supplied both by the plate grid capacity inside the tube, and the neutralizing condenser itself.

With unity coupling between the inductors 5 and 19, the inductive reactance of the two would balance, and the effective grid inductance would accordingly be reduced to zero, preventing potential changes on the grid caused by variations in the output current. In practice, however, such unity coupling is substantially impossible of attainment, and the circuit will accordingly oscillate at very high frequencies, as before explained.

In order to prevent parasitic oscillations, I have discovered that it is necessary to compensate the lack of unity coupling in the circuit under consideration by introducing into each portion of the input inductor a flux approximately equal and opposite to that set up by the feed-back coupling at high frequencies.

Referring specifically to Fig. 4, this is a diagrammatic view of a preferred form of my invention as applied to a circuit equivalent to that illustrated in Fig. 2.

Serially included in the plate circuit of the thermionic tube I provide a plurality of reverse-feed-back inductors 22 and 23, the inductor 22 being coupled to the grid-filament portion 5 of the inductor 6, and the other inductor 23 being coupled to the plate-filament portion 19 of inductor 6. The direction of winding of each of these inductors, and the amount of coupling of each inductor to the corresponding portion of the inductor 6 are so chosen that the potentials set up across each portion of the inductor 6 by feed-back at parasitic frequencies are approximately neutralized.

Usually, in practice, the separate inductors 5 and 19 form parts of a single inductor, shown as the inductor 6 in Figure 1. It is accordingly obvious that the total inductive effect of the two reverse-feed-back inductors on the tuned circuit comprising inductor 6 and condenser 9 is substantially zero, and does not decrease the signal intensity.

My invention is capable of use in connection with many differing types of circuit, and is not to be considered restricted to use with the circuit illustrated in Fig. 1.

By my invention, I am enabled to construct an amplifier having either one or a plurality of stages, with complete assurance that none of the stages will oscillate spontaneously at ultra-high parasitic frequencies. My invention is, therefore, of importance in connection with the present trend toward multi-tube tuned radio-frequency amplifiers in which parasitic oscillations practically always tend to be set up.

Although I have illustrated and described but a single specific form of my invention, it will be obvious to those skilled in the art that many modifications thereof are possible. My invention is accordingly not to be limited except insofar as is necessitated by the prior art or by the appended claims.

I claim as my invention:

1. In a thermionic-tube amplifier, means for preventing self-oscillation including a capacity between certain of the elements of said tube, and independent means providing additional coupling between said elements, said coupling being inductive in character, whereby the spontaneous generation of parasitic oscillations at ultra high frequencies is prevented.

2. In a circuit comprising a thermionic tube, means for preventing self-oscillations in said circuit, such means comprising a capacitive coupling between certain of the elements of the said tube, and means, including a plurality of reverse-feed-back inductors, for increasing the range of frequencies over which the circuit is prevented from oscillating.

3. In a circuit comprising a thermionic tube having an input circuit and an output circuit, capacitive coupling means between said circuits for preventing self oscillation, and independent inductive coupling means also between said circuits for the prevention of parasitic oscillation at ultra-high frequencies.

4. In combination, a thermionic tube having a filament a plate and a grid, an input circuit comprising an inductor associated with said grid and filament, means capacitively coupling said plate to said input circuit for the prevention of oscillations over the tuning range, and additional independ-

ent means comprising a plurality of inductors connected to said plate and coupled to said input inductor for the prevention of parasitic oscillations.

5. In combination, a thermionic tube having a filament, a grid and a plate, an input circuit comprising an inductor associated with said tube, means comprising a condenser and a portion of said inductor for neutralizing the effect on said input circuit of variations in potential of said plate, and additional means connected to said plate and inductively coupled to said input circuit, for preventing the tube and associated circuits from oscillating spontaneously at parasitic frequencies.

6. In combination, a thermionic tube having a filament, a grid and a plate, an inductor connected between said grid and filament, a second inductor connected between said plate and filament for the prevention of self-oscillations over a given tuning range, said connection including a condenser, and additional inductors connected to said plate and coupled to said first mentioned inductors for the prevention of parasitic oscillations outside of the tuning range.

7. In combination, a thermionic tube having a plate and a grid, an input circuit for said tube comprising an inductor, one end of said inductor being connected to said grid and the other end of said inductor being connected to said plate through a condenser, means for inductively coupling said plate to said input circuit, said means being so arranged that the total inductive effect on said input circuit is zero at frequencies corresponding to desired signals, but is not zero at frequencies above those of desired signals.

8. In combination, a thermionic tube, having a filament, a grid and a plate, a thermionic tube provided with an input inductor having a plurality of sections which are effectively in parallel at very high frequencies, and means comprising a plurality of inductors connected to said plate and so coupled to said input inductor that parasitic oscillations are prevented from being spontaneously generated.

9. In an inherently oscillatory thermionic-tube amplifier, feed-back means for preventing self oscillation over the range of frequencies for which said amplifier is designed and additional feed-back means for preventing self-oscillation at frequencies above said range, one of said feedback means being capacitive and the other inductive in character.

In testimony whereof, I have hereunto subscribed my name this 28th day of June, 1926.

KENNETH W. JARVIS.