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NEGATIVE FEED-BACK AMPLIFIER

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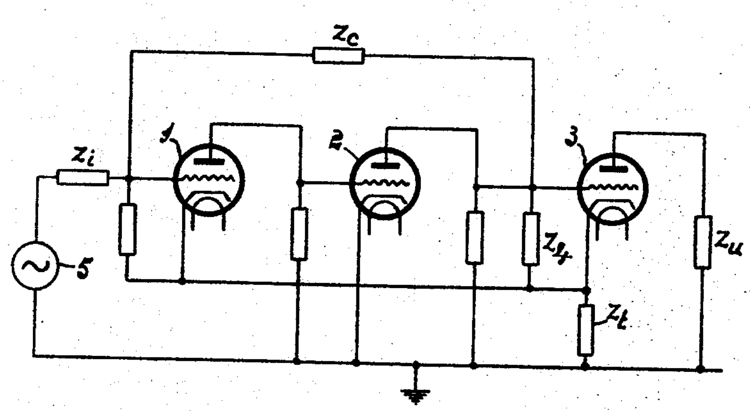

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NEGATIVE FEED-BACK AMPLIFIER

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6 Claims. (Cl. 179—171)

This invention relates to negative feed-back amplifiers comprising an odd number, preferably three, cascade-connected tube stages and a negative feed-back impedance which is common to the cathode circuits of the first and the last tube-stages of the cascade. It has for its purpose to compensate for the undesirable current passing from the anode of the penultimate tube-stage of the cascade via the impedance, comprising the internal grid-cathode capacity between the grid and the cathode of the last tube-stage, through the negative feed-back impedance. As is well known, this current permtis the reduction of distortion of the amplifier to be improved only to a given limit.

In comparison with several prior proposals for attaining this effect, the present invention provides an extremely simple solution. According to the invention, in order to compensate for the part of the anode current of the penultimate tube-stage of the cascade that flows via the grid-cathode impedance of the last tube-stage through the negative feed-back impedance, the grid of said last tube-stage is connected by way of a suitably proportioned compensation-impedance to the grid of the first tube-stage of the cascade. More particularly, the input impedance of the amplifier, said compensation impedance, said grid-cathode impedance and said negative feed-back impedance constitute a capacitatively balanced Wheatstone bridge at least within the frequency pass-band of the amplifier.

In order that the invention may be readily carried into effect, it will now be described in detail wth reference to the accompanying drawing showing one example thereof and in which an amplifier comprises three cascade-connected tubes 1, 2 and 3, that is to say that the output circuit of tube 1 is coupled to the input circuit of tube 2, and the output circuit of tube 2 is coupled to the input circuit of tube 3. The input circuit of the first tube 1 of the cascade comprises a source 5 of oscillations to be amplified, in series with an input impedance Z_i which may entirely or partly consist of the internal resistance of source 5, the output circuit of the last tube 3 of the cascade comprising a load impedance Z_u. The cathode circuits of the tubes 1 and 3 comprise a common negative feed-back impedance Z_t bringing about negative feed-back of the amplifier.

As is known, the fact that the negative feed-back impedance Z_t is not only traversed by the cathode-current of the last tube 3 of the cascade, but also in part by the anode current of the penultimate tube 2 and this via the grid-cathode impedance Z_4 of the last tube 3, which impedance mainly consists of the internal grid-cathode capacity, results in that the reduction of distortion cannot be improved to an unlimited degree by choosing higher values for the negative feed-back impedance Z_t. In order to permit greater reduction of distortion, the last-mentioned current should be compensated for, which, according to the invention, is achieved by means of a properly proportioned compensation impedance Z_c.

To this end, the impedance Z_c together with the input

impedance Z_i, the negative feed-back impedance Z_t and the grid-cathode impedance Z_4 constitute a Wheatstone bridge which is capacitatively in equilibrium with respect to the frequency pass-band of the amplifier, that is to say

$$Z_c=\frac{Z_i}{Z_t}\cdot Z_4$$

as a result of which the voltage between the grid and the cathode of the first tube 1 of the cascade is exactly equal to the difference between the voltage of source 5 and the voltage producing the cathode current of tube 3 via the negative feed-back impedance Z_t.

Since Z_i and Z_t are mostly resistive, whereas Z_4 is substantially of a capacitative character, a capacitor, whose capacitative value is

$$\frac{Z_i}{Z_t}$$

times as low as the capacity between the grid and the cathode of the tube 3, should be chosen for Z_c. In practice, this value is usually lower than $2\mu\mu f$. On the other hand, this capacity causes a low negative capacity parallel to the input circuit 5—Z_i of tube 1. Sometimes, it may therefore be desirable to choose other frequency-dependent impedances for the impedances Z_c and Z_t, particularly if the input impedance Z_i itself is frequency-dependent.

Of course, the circuit-arrangement may alternatively comprise five or, in general, an odd number of cascade-connected tubes in exactly the same manner, but in this case the risk of self-oscillation is much greater than in the case of three tubes. Of course, a tube-stage comprising two push-pull connected tubes may alternatively be substituted for one or each of a plurality of the tubes.

In a practical embodiment comprising three push-pull stages, the impedances had the following values: $Z_i=800$ ohm, $Z_t=20$ ohm, $Z_4=18\mu\mu f$, $Z_c=0.45\mu\mu f$. In this case, the negative input capacity brought about by Z_c was 1.5 to $3\mu\mu f$, in accordance with the mutual conductance (9 to 19 ma./V) of the last push-pull stage of the cascade.

What is claimed is:

1. A negative feed-back amplifier comprising an odd number of cascade-connected stages each having an electron discharge tube provided with a cathode, a grid and an anode and circuits therefor and the last stage having an internal grid-cathode impedance, a negative feed-back impedance connected in common to the cathode circuits of the first and last tube-stages, and a compensation impedance connected between the grid of the first tube-stage and the grid of the last tube-stage and having a value which compensates for the anode current of the penultimate tube-stage which flows through said grid-cathode impedance to said negative feed-back impedance, thereby reducing distortion in said amplifier.

2. An amplifier, as set forth in claim 1, wherein said odd number is equal to three.

3. An amplifier, as set forth in claim 1, further including an input impedance coupled to the first tube-stage and wherein said input impedance, said compensation impedance, said grid-cathode impedance and said negative feedback impedance comprise a capacitatively balanced Wheatstone bridge at least within the frequency pass-band of the amplifier.

4. An amplifier, as set forth in claim 2, wherein said compensation impedance is a capacitor having a value less than two micro-microfarads.

5. A negative feed-back amplifier comprising three electron discharge devices, each having a cathode, an anode and a control grid, a first impedance connected between the control grid and cathode of the first device, a

source of oscillations connected at one end to ground, an input impedance connected between the other end of said source and the control grid of said first device, a second impedance connected to conduct electrical oscillations between the anode of said first device and ground, the anode of said first device being connected electrically to the control grid of the second electron discharge device, the cathode of said second device being connected electrically to ground, a third impedance connected to conduct electrical oscillations between the anode of said second device and ground, said second device anode being connected electrically to the control grid of the third electron discharge device, a grid-cathode impedance in said third device connected between the grid and cathode thereof, the cathode of said third device being connected to the cathode of said first device, a negative feed-back impedance connected between the junction of the first and third device cathodes and ground, a load impedance connected to conduct electrical oscillations between the anode of said third device and ground, and a compensation impedance connected between the grids of said first and third devices and having a value which compensates for the anode current of said second device which flows through said grid-cathode impedance to said feed-back impedance, thereby reducing distortion in said amplifier.

6. An amplifier, as set forth in claim 5, in which the value of said compensation impedance is equal to

$$\frac{Z_1 Z_2}{Z_3}$$

in which Z_1 is the impedance value of said input impedance, Z_2 is the impedance value of said grid-cathode impedance, and Z_3 is the impedance value of said feed-back impedance.

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