May 13, 1941. A. H. ROCHE 2,241,925

THERMIONIC AMPLIFIER

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Fig. 1.

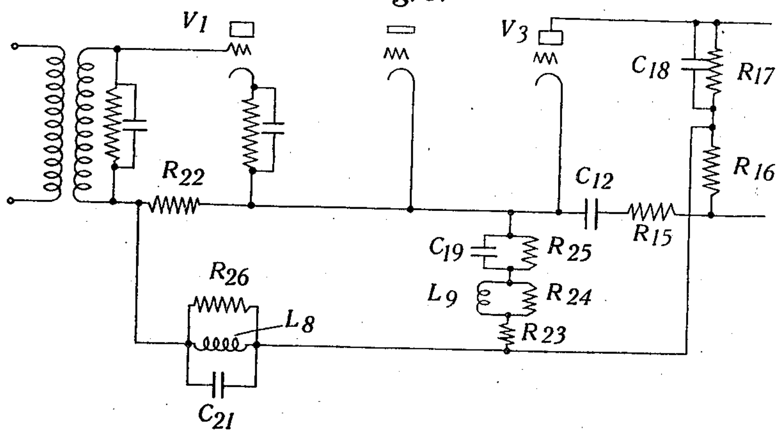

Fig. 2.

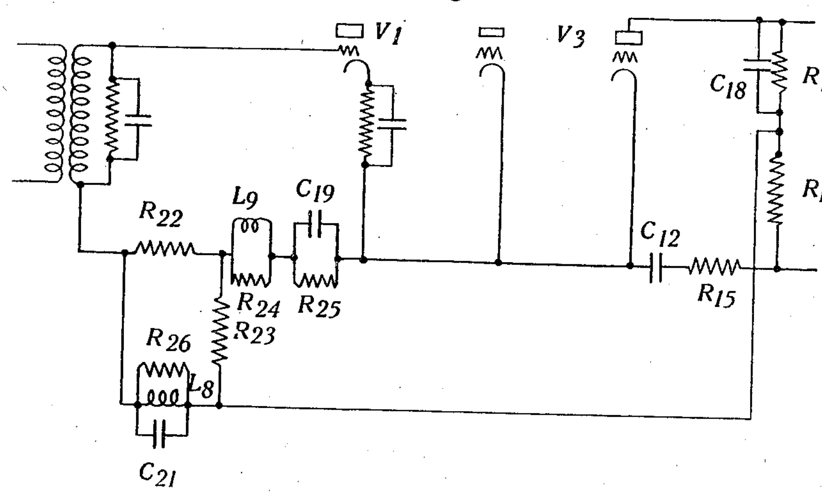

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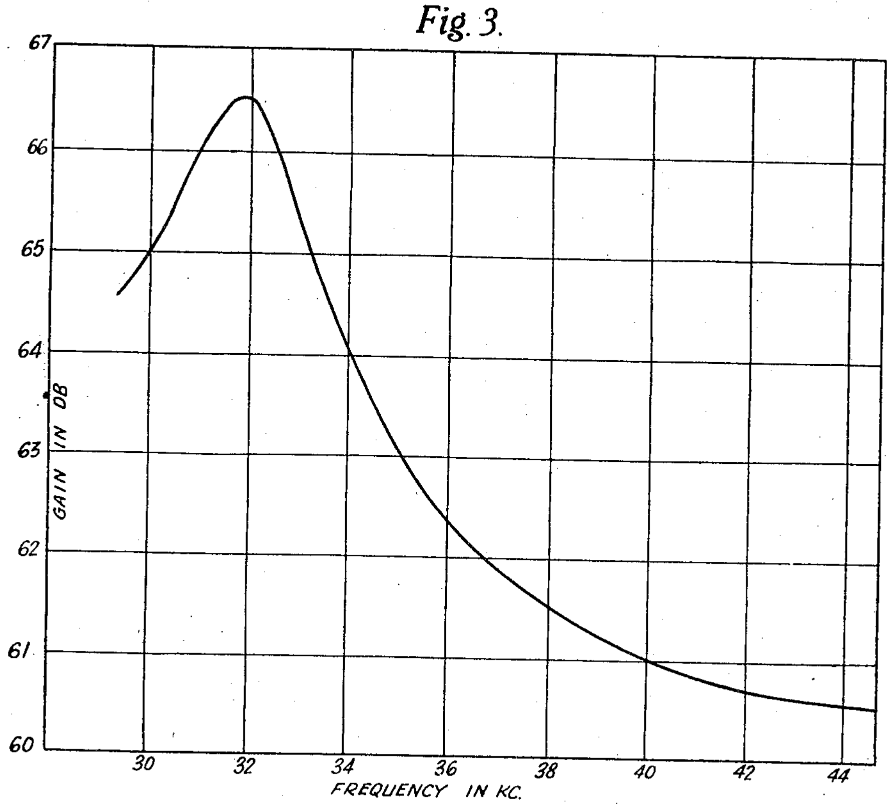
Fig. 3.



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THERMIONIC AMPLIFIER

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Application April 5, 1939, Serial No. 266,129
In Great Britain April 21, 1938

5 Claims. (Cl. 179—171)

This invention relates to thermionic amplifiers and more particularly to such amplifiers in which a feedback circuit is provided for feeding back waves including those of the range of transmitted frequencies from the output to the input of the amplifier to reduce the gain of the amplifier below the value it would have without feedback, in order to reduce unwanted modulation and/or non-linear effects and to render the gain stability greater than it would be without feedback.

The invention consists more particularly in improvements in or modifications of feedback amplifiers in which the feedback voltage applied to the input is obtained from a tapping on a reactive potentiometer which is shunted across the feedback path and the impedance of which is large compared with the impedance presented to it by the feedback path. Such an arrangement provides a simple means of adjusting both the gain and equalization of the amplifier.

According to the present invention in an amplifier as described in the preceding paragraph, one or more networks is or are also incorporated in the feedback path, which network or networks is or are so designed that the phase and gain characteristics of the amplifier outside the operating range are modified in such manner that instability is prevented whilst leaving the gain substantially unaffected in the operating range. Preferably the network or networks is or are shunted across the feedback path in series with an impedance which is low compared with the impedance of the reactive potentiometer. In an alternative arrangement in which the potentiometer comprises a reactive portion and a resistive portion the latter being included in the grid circuit of a valve of the amplifier and in which a low impedance is shunted across the potentiometer, the network or networks is or are inserted between the junction of the resistive portion and the low impedance and the cathode of the valve.

In the accompanying drawings, Figs. 1 and 2 show two embodiments of the invention and Fig. 3 is a curve used in the explanation of the invention in the following detailed description.

Referring to Fig. 1 this shows an amplifier of the kind described in British Patent No. 472,256 but only sufficient of the circuit is shown for a proper understanding of the present invention.

The output bridge consists of the resistance R17 shunted by condenser C18, the resistance R16, the resistance R15 and condenser C12 in series and the plate cathode impedance of the valve V3. This is a balanced bridge and the condenser C18 is made variable for adjustment of the output impedance at high frequencies and the resistance R15 is also made slightly variable to give a measure of output impedance adjustment over the whole frequency range, as described in the above-mentioned patent.

The feedback voltage is taken across the diagonals of the output bridge in the normal manner. Thus a lead is taken from the junction of R16 and R17 and is connected through the impedance R26, L8 and C21 to the feedback resistance R22. Shunted directly across the output bridge feedback diagonals is the circuit consisting of R23 in series with R24 and L9 in parallel in series with R25 and C19 in parallel. The elements C19 and R25 in parallel are inserted to give enhanced stability at the lower end of the frequency spectrum, as described in British Patent 499,315 complete accepted January 23, 1939, and the elements R24 and L9 in parallel serve to correct the upper end of the frequency spectrum, as described in the same patent. The combination of these two correcting networks forms a simple band elimination filter and enables a considerably greater amount of feedback to be employed without fear of oscillation than would otherwise be possible. The resistance R23 is a low impedance shunt whose value is small compared with the impedance of R22 and the equalising network (consisting of R26, L8 and C21 in parallel) in series.

The frequency range covered by a typical amplifier for use in an open wire carrier broadcast channel is 34—42.5 kilocycles. The stability correcting networks, comprising elements C19, R25, R24 and L9, have no effect on the frequency characteristic in this range. The equalising network, consisting of the elements R26, L8 and C21 is inserted in order to correct the gain frequency characteristic of the amplifier for the losses introduced by the line separating filters which are used to separate the 3-channel equipment from the broadcast channel. The type of correction obtained is shown in Fig. 3 in which the gain in db. of the amplifier is plotted against frequency in kc. It will be seen that over the range 34 to 42.5 kc. the variation is approximately 3.3 db. with the highest gain at 34 kc. In order to provide for the manufacturing variations in the line filters, the equaliser has been made variable by providing a small adjustment on the condenser C21.

The feedback voltage is taken from a tapping on a high impedance potentiometer shunted across the feedback path.

The high impedance potentionmeter shunted across the feedback path comprises the feedback resistance R22 in series with the equalising network consisting of R26, L8 and C21 in parallel. R23 is a low impedance shunt across the diagonals of the output bridge.

In order to understand why it is necessary to insert the stability correcting networks in series with the low impedance shunt R23, it is necessary to consider the operation outside the pass range of the amplifier. At the frequencies at which the stability correcting networks take effect, the impedance of the equalising network R26, L8 and C21 in parallel will be negligible, and we may therefore consider R22 as connected directly across the feedback path. It has already been stated that the impedance of R22 is high compared with that of R23, and the effect, therefore, of shunting R22 across R23 will be almost negligible as regards the voltage generated across R23. Any correcting networks inserted in series with R23 will cause a variation in voltage across the resistance R23 at the required frequencies. On the other hand, any networks or impedances inserted in series with R22 will have a negligible effect on the feed back voltage because R22 is already high in impedance compared with R23. This is borne out in practice and no increase in stability is obtained by the insertion of correcting networks in series with R22.

An alternative position for the correcting networks is shown in Fig. 2. In this case, the correcting networks are placed between the junction of R22 and R23 and the cathode lead as shown. In this case, of course, the feedback voltage is corrected by the insertion of the stabilising networks because these are in series with R23 as well as R22.

The values of the various components comprising the stabilising and equalising networks to give a curve such as that shown in Fig. 3, may be as follows:

R22	ohms	830
R23	do	29
R24	do	1000
R25	do	5000
R26	do	1162
L8	millihenries	.588
L9	microhenries	11
C19	m. f.	2
C21	microfarads	.04318

The design of the amplifier is such that if the equalising element is shorted out, a flat gain over the range 34 to 42.5 kc. of 60 db. is obtained.

What is claimed is:

1. A negative feedback amplifier circuit for amplifying a given range of frequencies, which comprises an amplifier having an input and output channel, a feedback channel energized from said output channel, a reactive potentiometer of substantially higher impedance than said feedback channel bridged across said energized feedback channel so as to draw a current therefrom, a circuit branch of substantially lower impedance than said potentiometer also bridged across said energized feedback channel so as to draw a substantially larger current therefrom, connections from one side of said feedback channel and from an intermediate point of said potentiometer respectively to said input channel, and a network connected to be traversed by said substantially larger current and proportioned to vary the gain of the circuit only outside said given range and in such sense as to increase stability.

2. A negative feedback amplifier circuit according to claim 1, wherein said network is serially connected in said lower impedance circuit branch so as to be traversed solely by said substantially larger current.

3. A negative feedback amplifier as claimed in claim 1, in which said potentiometer comprises a reactive portion and a resistive portion said resistive portion being included in the grid circuit of a valve of the amplifier, and said network being inserted between the junction of said resistive portion and said circuit branch and the cathode of said valve.

4. A negative feedback amplifier as claimed in claim 1, in which impedances are connected with the output of said amplifier to form a bridge circuit and said feedback channel is energized from the diagonals of said bridge.

5. A negative feedback amplifier circuit according to claim 1, wherein said network is serially connected in one side of said feedback channel so as to be traversed both by said substantially larger current and also by said current through said potentiometer.

ALLEMAN HOLLY ROCHE.