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STABILIZED THERMIONIC AMPLIFIER

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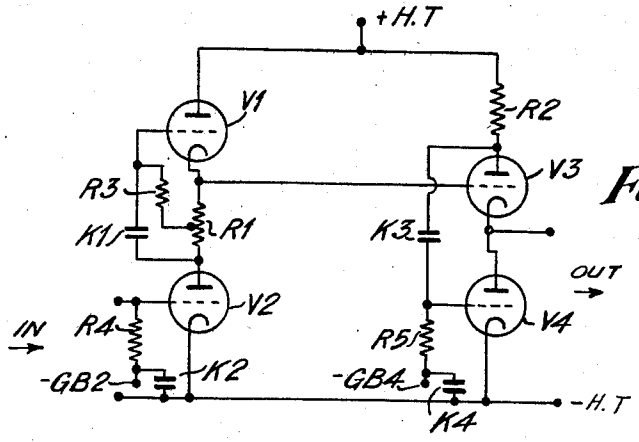

Fig.1.

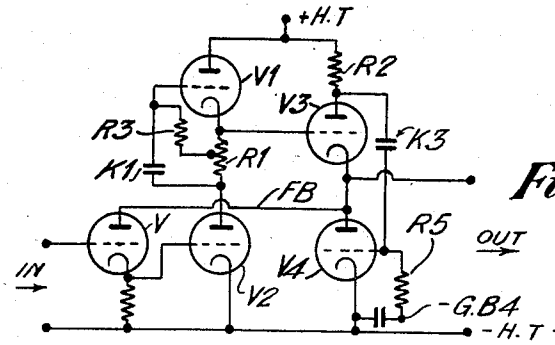

Fig.2.

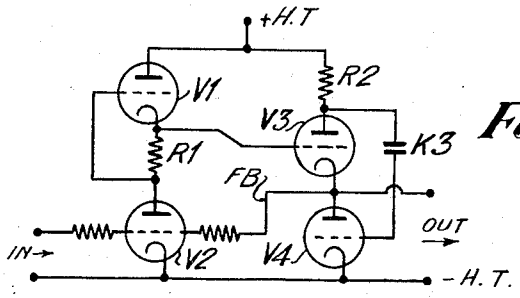

Fig.3.

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STABILIZED THERMIONIC AMPLIFIER

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5 Claims. (Cl. 179—171)

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This invention relates to thermionic valve amplifiers and has for its object to provide improved amplifiers adapted to handle a wide band of signals and give good linearity of response, good gain and a low value of output impedance.

Though not limited to its application thereto the invention has been primarily designed for use in connection with the amplification of television signals for modulated carrier television transmitters of high power.

According to this invention a thermionic valve amplifier comprises two pairs of valves, each pair being in a series circuit across an anode potential source, means for applying signals to be amplified to a control electrode of that valve of the first pair which is further from the positive terminal of the anode potential source, means for coupling a point between the valves of the first pair to the control electrode of that valve of said pair which is nearer said positive terminal, means for coupling a point between the valves of the first pair to a control electrode of that valve of the second pair which is nearer to said positive terminal, means for coupling the output electrode of the last mentioned valve to a control electrode of the remaining valve of said second pair and means for taking amplified output from a point between the valves of the second pair.

In the foregoing statement of invention and elsewhere in this specification single valves are referred to for the sake of brevity in description. It is to be understood, however, that in all cases what is described as a single valve may be replaced by a plurality of valves having like electrodes connected together, and indeed in practice, for reasons of obvious manufacturing convenience, sets of valves thus paralleled will often be employed in place of single valves in one or more parts of a circuit arrangement in accordance with the invention.

Preferably an impedance is included in series between the two valves of the first pair and the point between said pair which is coupled to a control electrode of the more positive valve in the second pair is constituted by the cathode of the more positive valve of the first pair. It is, however, possible, though not usually preferred, to constitute the said point by the anode of the more negative valve of the first pair or by a point on an impedance in series between the valves of said pair.

The invention is illustrated in the accompanying simplified diagrammatic drawings in which Figure 1 is a schematic diagram of a preferred embodiment and Figs. 2 and 3 similarly illustrate

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modifications of Fig. 1 employing negative feed back. Throughout the figures like references indicate like parts.

Referring to Fig. 1 there is a first pair of valves comprising two valves V1, V2 of which the anode of V1 is connected to the positive terminal of an HT source (not shown) and the cathode of V2 is connected to the negative terminal. A resistance R1 connects the cathode of V1 to the anode of V2 and a bias source or network is provided to bias the grid of V1 positive with respect to the anode of V2. This bias may be obtained in any convenient way: as shown a resistance R3 is connected between a tap on R1 and the grid of V1. A coupling condenser K1 is connected between the grid of V1 and the anode of V2. If desired the bias source may be adjustable. Television or other signals to be amplified are applied at "in" between the grid and cathode of V2, the said grid receiving bias from —GB2 through a resistance R4. A condenser K2 connects —GB to HT—. A second pair of valves consisting of the valves V3, V4 is also provided. The valve V3 has its anode connected to HT+ through a resistance R2 and V4 has its anode connected to the cathode of V3 and its cathode connected to HT—. The cathode of V1 is connected to the grid of V3 and the anode of V3 is connected through a blocking condenser K3 to the grid of V4. Valve V4 receives bias through resistance R5 from terminal —GB4 which is connected to HT— through condenser K4. Amplified output is taken at "out" from between the anode of V4 and the cathode thereof.

This arrangement gives improved amplitude linearity, reduced output impedance and has improved reactive and non-linear current handling capabilities as compared to conventional amplifiers. Also it has a better power conversion efficiency as compared to a conventional class A amplifier and is more suitable for the amplification of very wide bands of frequencies such as a television signal band. It may be shown mathematically that the arrangement of the series pair of valves V1 and V2 improves amplitude linearity of response due to non-linearity of the valve characteristics towards current cut-off, the improvement being by an amount equivalent to raising the anode resistance of V2 by the difference between the combined D. C. resistance of V1 and R1 and the A. C. impedance of V1 and $(\mu+1)R$ where μ is the amplification factor of V1. The ratio of A. C. to D. C. load is still further increased by the inclusion of the D. C. bias means between the anode of V2 and the grid of

V1 with the added advantage that V2 operates with an increased equivalent high tension voltage.

Instead of coupling the cathode of V1 to the grid of V3 the anode of V2 or some point between the cathode of V1 and the anode of V2 may be coupled to said grid. This modification results in some increase of overall gain but it is accompanied by an increase of the output impedance of the amplifier pair V1, V2. Accordingly this modification is not usually preferred at any rate for the amplification of wide frequency bands.

The second pair of valves V3, V4 produces an output impedance lower than that attainable with a conventional cathode follower arrangement, the improvement being proportional to the magnitude of R2 and the amplification factor of V4.

The actual valves employed may be any of a variety of suitable types. In Fig. 1 only those electrodes which are necessary to the invention are shown. The valves may, however, be triodes, screen grid valves, pentodes or of any desired suitable types. Further, as already stated, any one of the valves may be replaced by a number in parallel. Thus, to quote a practical case experimentally tested, the valves V1, V2, V3, V4 were constituted by combinations of valves all of the same type having an amplification factor of about 14 and an anode impedance of about 500 ohms. A single such valve was used for each of the valves V1 and V2; the valve V3 was constituted by four valves with like electrodes connected together; and the valve V4 was constituted by three valves with like electrodes connected together. This particular arrangement gave an overall gain of 10 or more with a frequency response extending to over 5 megacycles per second and an output impedance of less than three ohms. The output amplitude level remained constant at about 400 volts R. M. S. when working into a reactive load of 150 ohms. The high tension voltage was 3000 volts and the high tension power input less than 10 kw.

Figs. 2 and 3 show two modifications of Fig. 1 wherein the arrangement is provided with negative feed back. It is thought that these two figures will be largely self-explanatory in view of the description of Fig. 1 already given. In Fig. 2 the input is applied via an additional valve V, a connection FB between the anode of which and the anode of V4 provides the feed back path. In Fig. 3 the negative feed back path is completed through the circuit FB between the anode of V4 and the grid of V2. Both these arrangements are capable of handling wide bands of frequencies.

It is to be understood that the diagrams are highly simplified, necessary D. C. feed connections, which may be of any convenient known nature, being omitted in many cases to avoid complicating the drawing. In particular, in Fig. 3, D. C. bias circuits are omitted altogether.

We claim:

1. A thermionic valve amplifier including two pairs of valves each having at least a cathode, a control electrode and an anode, a common anode potential source for all four valves, means connecting the valves of the first pair in a series circuit across said anode potential source said circuit including a first connection between the cathode of one of the valves of said first pair and the anode of the other of the valves of said first pair including a resistor connected at one end to said last mentioned cathode and at the other end to said last mentioned anode, a tap intermediate the ends of said resistor connected to the control electrode of the first mentioned valve of said first pair of valves, a coupling condenser between the anode of the other valve of said first pair of valves and the control grid of the aforementioned valve of said first pair of valves, means for applying signals to be amplified to a control electrode of said other valve of said first pair, means connecting the valves of the second pair in a second series circuit across said anode potential source, said circuit including a second series connection between the cathode of one of the valves of said second pair and the anode of the other of the valves of said second pair, means for coupling a point on said first connection to a control electrode of said one valve of said second pair, means for coupling the anode of said one valve of said second pair to a control electrode of said other valve of said second pair, and an output circuit connected with said second connection.

2. An amplifier as set forth in claim 1 wherein said tap on said resistor constituting said first connection provides a positive bias for the control grid of said one valve of said first pair of valves and wherein the point on said first connection which is coupled to the control electrode of said one valve of said second pair is the cathode of said one valve of said first pair of valves.

3. An amplifier as set forth in claim 1 wherein said tap on said resistor constituting said first connection imparts a positive bias to the control grid of said one valve of said first pair of valves and wherein the point on said first connection which is coupled to the control electrode of said one valve of said first pair is the anode of said other valve of said first pair of valves.

4. An amplifier as set forth in claim 1 wherein said tap on said resistor constituting said first connection imparts a positive bias to the control grid of said one valve of said first pair of valves and wherein the connection between said tap and the control electrode of said one valve of said first pair includes a series connected impedance.

5. An amplifier as set forth in claim 1 which includes an additional valve having at least a cathode, a control grid and an anode, said additional valve being interposed between the other valve of said first pair of valves and the means for applying signals to be amplified, the cathode of said additional valve being connected with the control grid of said other valve of said first pair of valves and the anode of said additional valve being connected with the anode of the other valve of said second pair of valves for providing negative feed-back in said amplifier.

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