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THERMIONIC VALVE AMPLIFYING CIRCUITS

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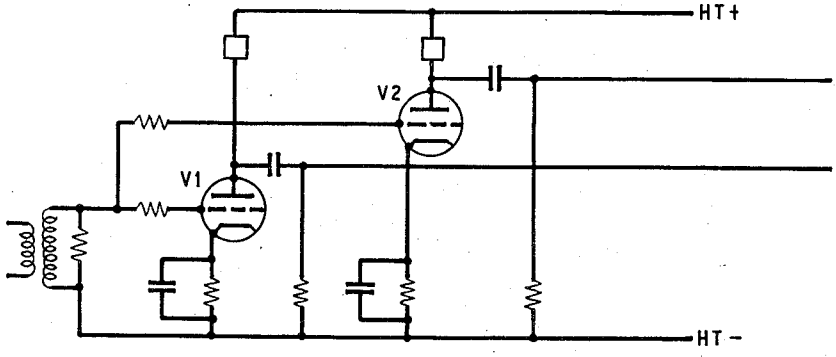

Fig. 1

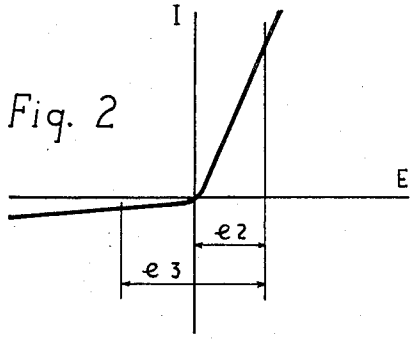

Fig. 2

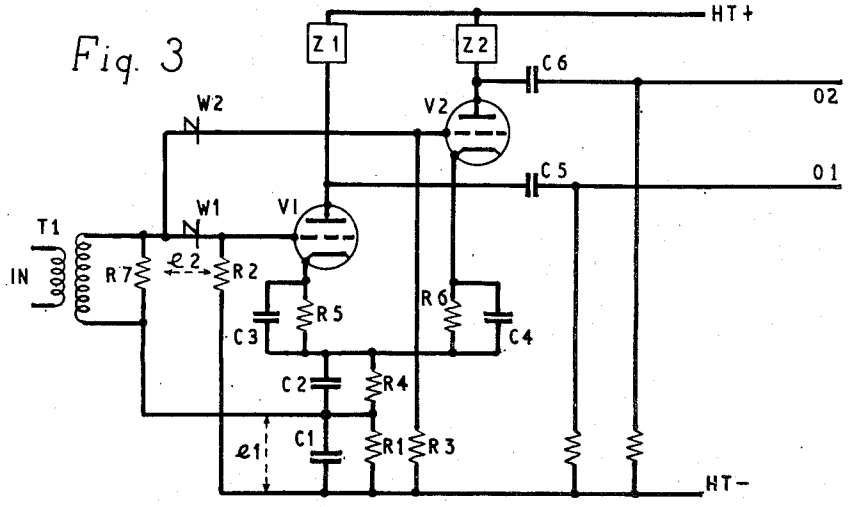

Fig. 3

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THERMIONIC VALVE AMPLIFYING CIRCUITS

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6 Claims. (Cl. 179—171)

The present invention relates to thermionic valve amplifying circuits and is particularly concerned with amplifiers of the dual path type designed to minimise the effect of a valve failure. The invention has special application to amplifiers for carrier current supply as used in multi-channel carrier current telephone systems.

Where such systems include a considerable number of channels, particularly systems involving group and super-group modulation, the carrier current sources may serve a large number of channels for instance as many as 60. It is therefore imperative that the utmost reliability shall be obtainable from the carrier current supplies since a failure of these supplies would put a considerable number of channels out of action. The carrier supply amplifiers are therefore usually arranged to have two amplifying valves opertaing in parallel with common input and output points and a suitable negative feedback path. If this is properly adjusted, the failure of emission of any one valve will reduce the overall gain by only a small amount. If however the grids of the paralleled valves are connected together, as is usually the case with an arrangement of this type, a short-circuit between the grid and cathode of either valve would have the effect of putting the other valve out of action entirely since its input would be short-circuited. Consequently such arrangements as have been outlined above offer no insurance against a valve failure of this type which is not so rare that the chance of its occurrence can be considered negligible.

The chief object of the invention is to provide a circuit arrangement of the type mentioned in which two amplifying valves though effectively operating in parallel are so connected that the failure of one will not reduce the output to zero and particularly that they are sufficiently independent that the short-circuiting of the grid of one valve to its associated cathode will not disable the other valve.

According to the invention in a dual path amplifier employing two thermionic valves the inputs and outputs of which are effectively connected in parallel the feed to the grid of each valve includes a non-linear element and biassing arrangements are provided such that in the event of a short-circuit between the grid and cathode of one valve the non-linear element associated with that valve will become of high impedance so that the input to the other valve will still be effective. In effect it may be said that the non-linear elements constitute automatic switches serving to separate one valve from the other on the occurrence of fault conditions.

The invention will be better understood from the following description of one method of carrying it into effect which should be taken in conjunction with the accompanying drawings comprising Figs. 1 to 3. Fig. 1 represents the essential features of the circuit ordinarily used in which the common feed extends to the two separate grids over comparatively low fixed resistors which would not suffice to enable one valve to perform its

proper functions if the other were subjected to a grid cathode short-circuit. Fig. 2 is a diagram of a rectifier characteristic and serves to illustrate the effect of a change in the biasing voltage which is brought about under fault conditions with the arrangement according to the invention. Fig. 3 represents a preferred circuit acording to the invention.

Referring now to Fig. 3, the input IN is applied to the primary of a transformer T1, the secondary of which is shunted by resistor R7. The feeds to the grids of the amplifying valves V1 and V2 are led respectively by way of rectifiers W1 and W2 and arrangements are provided for suitably biasing these rectifiers by connections extending from HT– over resistors R2 and R3 respectively. The cathode circuits of the two valves include individual resistors R5 and R6 and also common resistors R1 and R4 each of these resistors being shunted by a suitable capacitor C1, C2, C3, C4 respectively. The values of R2, R3 and R7 are so chosen that their combined value gives the correct impedance looking into the input of T1. Resistors R1 and R4–R6 enable the valves V1 and V2 to be negatively biased and provide a potential below that of the grids for the correct biasing of the rectifiers W1, W2. The voltage developed across R4 is provided as a separate bias to both valves to prevent either valve acting as a diode shunt should its anode become open-circuited, in which case anode current would cease to flow. The valves V1 and V2 are provided with anode load impedances Z1 and Z2 and the output is supplied from the anodes over leads O1 and O2 by way of capacitors C5 and C6. These leads may be kept separate initially for convenience of maintenance but are connected together to the equipment at the next stage.

It may be assumed that under normal working conditions when valves V1 and V2 are both emitting, a voltage $e1$ will be developed across R1 and a portion $e2$ of this voltage is applied across W1 which is in series with R2, R2 being very large compared with R7. $e2$ is then of sufficient magnitude to maintain W1 in its low resistance or conducting state as indicated in Fig. 2. Similar conditions apply as regards W2 and R3.

If now the grid of V1 should come into contact with its cathode, the potential of the grid will rise to that of the cathode and the magnitude of the cathode potential $e3$ will now be such that W1 will be biased to its high resistance or non-conducting state. In these circumstances the resistance of the rectifier W1 will be very much greater than R7 and consequently the failure of V1 will have comparatively little effect upon V2. Similarly the presence of W2 ensures that a grid-to-cathode short circuit in V2 would have comparatively little effect upon V1.

It may be pointed out that if the rectifiers are given sufficient forward bias and are within the overall feedback loop of the amplifier no appreciable increase of harmonic distortion will result. It should also be mentioned that for broad band amplification the rectifiers must be of low capacity type.

It will be appreciated that the fundamental need is to provide between the common input circuit and each of the two input stages a network which will isolate a faulty valve from the remainder of the circuit. Since at high frequencies the input capacitance of a valve cannot be neglected, the inclusion of a dissipative network necessarily involves loss and a non-dissipative reactive network incurs phase shift which requires complex equalisation if feedback is to be applied. By the use of non-linear elements the present invention avoids these drawbacks and forms a simple means for increasing the reliability of wide-band amplifiers such as are incorporated in carrier current generators and virtually eliminates

the possibility of serious dislocation of the system in the event of any form of valve failure.

We claim:

1. A thermionic valve amplifier comprising two thermionic valves each having an anode, a cathode and a control electrode, an input circuit, a first asymmetrically-conducting element connected in the low resistance direction between said input circuit and the control electrode of one of said valves, a second asymmetrically-conducting element connected in the low resistance direction between said input circuit and the control electrode of the other of said valves, biasing means for both said elements, a connection between said input circuit and the cathodes of said valves, a first load impedance in the anode circuit of said first valve, a second load impedance in the anode circuit of said second valve and connections from the anodes of said valves to a common output circuit.

2. A thermionic valve amplifier as claimed in claim 1 in which the input circuit includes a transformer which is shunted by a resistor of such value as to give the correct terminating impedance.

3. A thermionic valve amplifier comprising two thermionic valves each having an anode, a cathode and a control electrode, a source of anode current, an input transformer, a first asymmetrically, conducting element connected in the low resistance direction between one terminal of the secondary of said transformer and the control electrode of one of said valves, a second asymmetrically-conducting element connected in the low resistance direction between said one terminal of the secondary of said transformer and the control electrode of the other of said valves, a first resistor connected between the control electrode of said first valve and the negative pole of said source, a second resistor connected between the control electrode of said second valve and the negative pole of said source, a connection from the other terminal of the secondary of said output transformer to the cathodes of said valves, a first load impedance connected between the anode of said first valve and the positive pole of said source, a second load impedance connected between the anode of said second valve and the positive pole of said source, and connections from the anodes of said valves to a common output circuit.

4. A thermionic valve amplifier comprising two thermionic valves each having an anode, a cathode and a control electrode, a source of anode current, an input transformer, a first rectifier connected in the low resistance direction between one terminal of the secondary of said transformer and the control electrode of one of said valves, a second rectifier connected in the low resistance direction between said one terminal of the secondary of said transformer and the control electrode of the other of said valves, a first resistor connected between the control electrode of said first valve and the negative pole of said source, a second resistor connected between the control electrode of said second valve and the negative pole of said source, a pair of resistors connected in series between the negative pole of said source and the cathodes of said valves, a connection from the other termnial of the secondary of said output transformer to the junction of said pair of resistors, a first load impedance connected between the anode of said first valve and the positive pole of said source, a second load impedance connected between the anode of said second valve and the positive pole of said source and connections from the anodes of said valves to a common output circuit.

5. A thermionic valve amplifier as claimed in claim 4 in which the value of the one of said pair of resistors on the cathode side of said junction point is so chosen as to prevent either of said valves acting as a diode shunt if its anode should become open-circuited.

6. A thermionic valve amplifier as claimed in claim 5 in which two further resistors are connected individually in the respective cathode circuits of said valves in series with said pair of resistors.

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