May 7, 1929. H. J. ROUND 1,711,969

THERMIONIC DEVICE

Filed May 2, 1922

Fig. 1

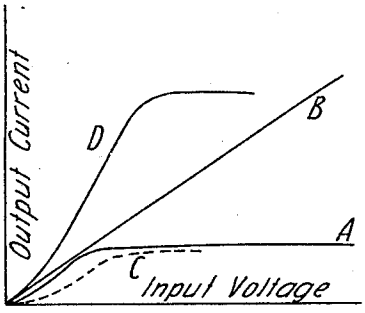


Fig. 2

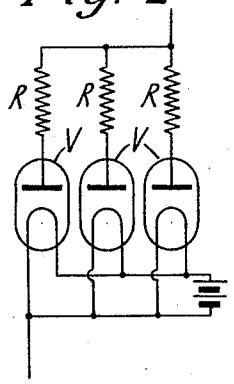


Fig. 3

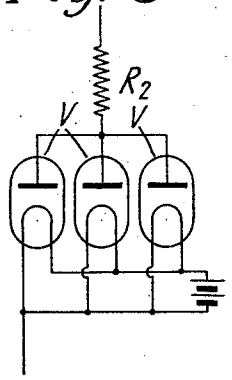


Fig. 4

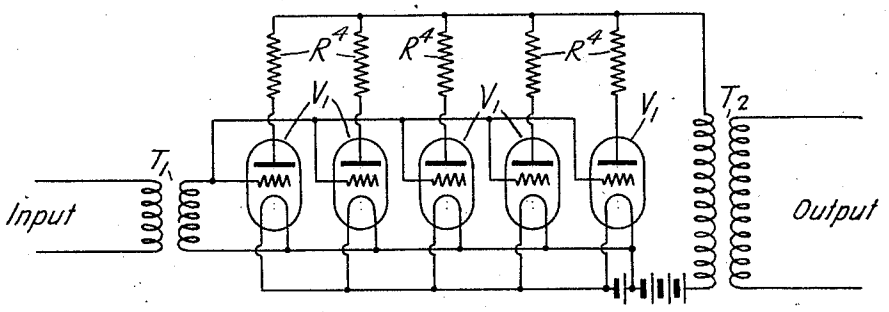
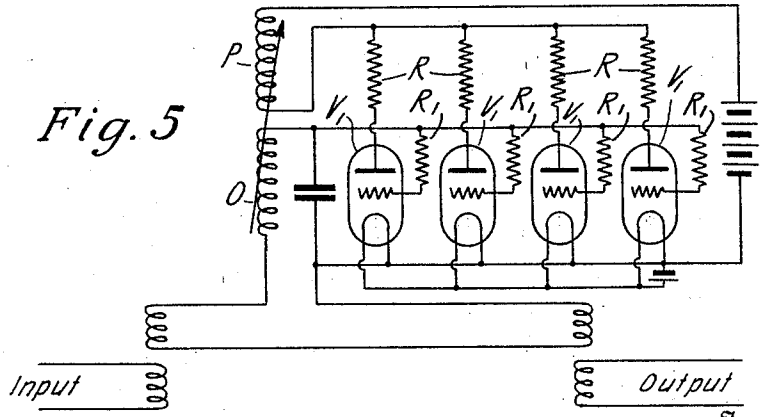


Fig. 5



Inventor

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By his Attorney Lra J Adams

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UNITED STATES PATENT OFFICE.

HENRY JOSEPH ROUND, OF LONDON, ENGLAND, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE.

THERMIONIC DEVICE.

Application filed May 2, 1922, Serial No. 557,918, and in Great Britain May 18, 1921.

It is well known that the relation between the space current and the voltage applied to a thermionic device or vacuum tube is usually not linear and is at the best never linear over more than a very small range.

It has been shown that in a vacuum tube of the heated cathode type, the characteristic is of the exponential type of the form $i=kV^n$, but this has to be qualified by the fact that the voltage drops in the filament and the limitation of the electronic discharge considerably alter the law.

It is frequently desirable for the best working of the apparatus that the characteristic should be of the linear form $i=kV$ over a large range. This is particularly so when a three electrode tube is used for voice magnification. Also when a two or three electrode valve is used in combination with an independent oscillator as in the well known heterodyne method, it is advisable to use a rectifier which has this straight line law so that signals appearing simultaneously do not tend to distort one another, and when a three electrode tube is used for the introduction of negative resistance in the well known way a straight line law is desirable. Also when a valve circuit is arranged to give a certain frequency of oscillations, straight line laws of the characteristic of both anode and grid circuits are desirable.

According to this invention there is introduced into the anode circuit of a tube a resistance which is large compared with the resistance of the tube so that the voltage current relation of this combined system is mainly controlled by the resistance, and then, since the slope of the characteristic is very much less, several of these tube resistance systems are arranged in parallel so that the characteristic of the whole combination is given any required slope.

Both theoretically and experimentally it is found that the result is a characteristic which has its curvature reduced in proportion to the number of tubes used and to the resistance placed in series with each tube, the larger the resistance, and the greater the number of tubes, the straighter the characteristic.

Such a combination can be then used as a unit just as one tube is used.

In some cases the anodes of two or more tubes may be connected to a single resistance if the characteristics of such tubes are the same.

In some cases also a resistance of high value may be inserted into the grid circuit of a three electrode tube in addition to the resistance in the anode circuit.

My invention is illustrated by the accompanying drawings, in which:

Fig. 1 is a series of curves showing the relation between input voltage and output current.

Fig. 2 is a diagram of an arrangement in accordance with my invention, and Fig. 3 is a modification.

Figs. 4 and 5 are diagrammatic representations of circuits embodying the invention for certain purposes.

In Figure 1 curve A represents the characteristic of a two electrode valve, and curve B represents the characteristic of a resistance. By merely adding the voltages at equal currents we get the characteristic C of the series combination of the valve and resistance which is of less slope than either curve A or curve B, and by multiplying all ordinates by three we get the characteristic of three of these combinations in parallel, noticeably a longer and straighter curve than the original single valve arrangement.

The arrangement is shown in Figure 2 where V, V, are three diodes or two electrode devices arranged in parallel with a resistance R in series with the anode of each.

It is obvious that if all the three valves are exactly similar in characteristics the result is equally well obtained by the arrangement shown in Figure 3 where the one resistance R^2 is equal to one-third of any of the resistances R in Figure 2.

A much longer and straighter characteristic still can be obtained by using more valves in parallel with high resistances in series with each.

No modification of this arrangement need be made if the diodes be replaced by triodes or three electrode valves.

Thus twelve valves each with a characteristic similar to that of a French standard receiving valve and with 150,000 ohms in series with it may be arranged in parallel. The result is a characteristic which has about the same slope as the one valve at its best but this slope is maintained with about one twelfth the curvature for twelve times the length.

Such an arrangement may be employed for the magnification of voice currents as shown

in Figure 4, in which the input telephone is coupled through transformer T^1 to the parallel connected grids of the five valves V^1. Resistances R^4 are connected in series with each of the anodes of the valves, and an output transformer T^2 is connected to the tubes which are in parallel. As shown in Fig. 5, the arrangement may be used as a constant wave length heterodyne, or as a reaction circuit of low damping acting as a filter between input and output circuits. The arrangement comprises a plurality of three electrode tubes V^1 having resistances R connected as in Fig. 2. The input circuit is coupled to an oscillatory circuit O which is also coupled to the output circuit. The input circuit of the valves is connected across the condenser of the oscillatory circuit and the output circuit of the valves is coupled through coil P to the inductance of the oscillatory circuit forming a regenerative or feed back circuit. This circuit may act as a heterodyne or a reaction circuit depending on the adjustment of the coupling to produce amplification or generation of oscillations. In this case high resistances R^1 are inserted in series with the grids. In paralleling a large number of valves for transmission it is advantageous to introduce these separate resistances and the larger the number of valves, the greater these resistances can be without the overall loss reducing the efficiency seriously, providing the valves are made to stand high voltages.

Having described my invention, what I claim is:

1. Amplifying means for incoming electrical energy, comprising a plurality of three electrode thermionic devices in parallel, each of said devices having input and output sides, individual means in each of said outputs for accentuating the linear characteristics of said devices when used in combination, said means also serving to equalize the operating characteristics of said devices, and means in said output circuit for affecting each of said devices equally in accordance with said incoming energy.

2. Means for controlling the flow of electrical energy in a circuit, comprising a plurality of parallel paths each of which contains an electron discharge device, means for equally varying the conductivity of each of said devices in accordance with said flow, and means in the anode circuit of each of said devices for accentuating and equalizing the linear characteristics of said devices when used in combination.

3. Amplifying means for electrical energy, comprising a plurality of thermionic devices connected in parallel, and individual means in the anode circuit of each of said devices for equalizing the constants of said devices and accentuating the linear characteristics thereof when used in combination.

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