May 2, 1939. H. BENDEL ET AL 2,156,649

AMPLIFYING DETECTOR

Filed Aug. 6, 1937

Fig. 1

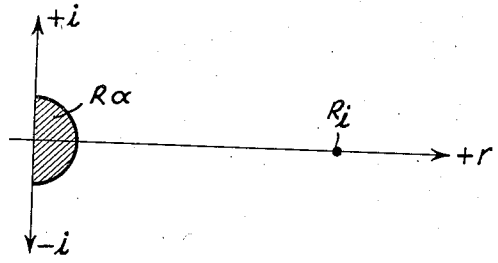


Fig. 2

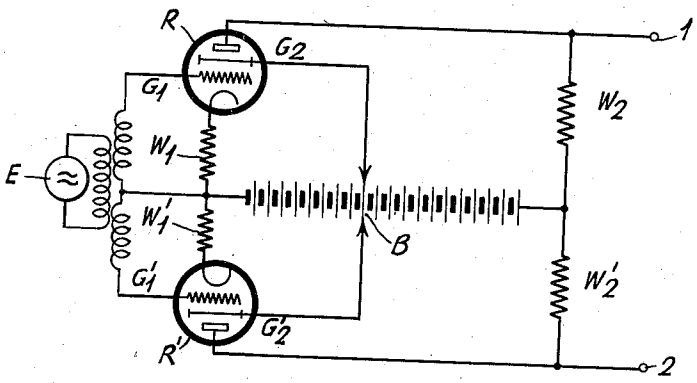
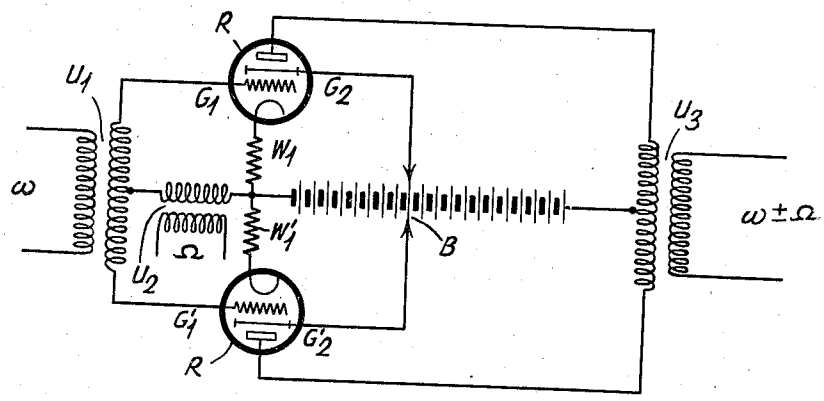


Fig. 3



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2,156,649

AMPLIFYING DETECTOR

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Application August 6, 1937, Serial No. 157,674
In Germany August 7, 1936

2 Claims. (Cl. 250—27)

The invention disclosed in the pending application, Ser. No. 134,227, filed April 1, 1937, of H. Bendel who is a co-inventor of the present invention, concerns an amplifying detector which is linearized by the connection of means insuring a negative feedback between the grid and the plate circuit of the rectifier tube. The exemplified embodiments shown in said above application were concerned with triode tubes. However, the use of tubes of the said short is attendant with certain inconveniences and difficulties as shall hereinafter be explained in more detail.

The linearized plate current of the tube, according to Equation (8) of the above application has been found to be

$$i_a = E_0 \frac{S}{1 + S.R_k}$$

However, as pointed out in the preceding paragraph of the specification it will be strictly exact only when $R_a = O$, or, in other words, when the plate resistance is extremely low in contrast to the inner resistance of the tube, i. e., $R_a << R_i$. In the case of simple tubes, this demand is conducive to difficulties for the reason that the inner resistance is not any too high, and the result is poor efficiency. But when a tube having a high inner resistance is employed, the said condition is readily fulfillable and the requisite gain is obtainable with practically useful values of R_a.

However, in line with what has also been pointed out in the former application, in addition to the said demand this further presupposition must be satisfied that the slope (mutual conductance) must be high and the mutual controllance or transconductance low compared to unity (1). According to the present invention, these demands in their entirety will be fulfilled most satisfactorily by the use of screen-grid tubes (tetrodes).

Now, the idea underlying the invention shall be explained more fully by reference to the accompanying drawing wherein Fig. 1 is an explanatory diagram, and Figs. 2 and 3 show two exemplified embodiments.

Inasmuch as screen-grid tubes invariably possess high internal resistance, it will be seen that in the above equation, without introduction of a short-circuit at the plate end, there results automatically a condition where the linearized plate current is independent of the plate resistance. Moreover, there is no need for providing a real termination for the linearized amplifying detector. On the contrary, it will be sufficient if the complex terminal impedance R_a in each case is small compared with the inner resistance of the tube. This is illustrated schematically in Fig. 1.

In the complex plane with imaginary axis i and the real axis r, the inner resistance R_i is shown a great distance from the origin and located on the real axis. Now, about the origin is described a circle whose area is shown by the shading and inside which the terminal resistance may fall without the above requirements failing of being fulfilled. All that is required for the terminal impedance is the condition that it should never assume an order of magnitude the same as R_i, regardless of the frequency.

As already pointed out in the specification of the above application, this linearizing scheme is particularly advantageous with push-pull circuit organizations. The exemplified embodiment of the present invention shown in Fig. 2 illustrates such a push-pull arrangement comprising the use of screen-grid tubes. Upon the control grids G_1 and G_1' of the tubes R and R', respectively, is impressed an alternating potential E. The cathode or filament lead of the tubes contains the linearizing resistances W_1 and W_1' which produce degeneration, while the plate circuit contains the resistance W_2 and W_2' which are low in contrast to the inner resistance. Across the terminals 1, 2, the linearized rectified potential is rendered available. The screen grids G_2 and G_2' serve to insure the requisite high inner resistances and the necessary slope. They are associated with a tap B of the battery or plate potential source of supply.

The invention is not limited to push-pull circuits only but is equally applicable to a single tube stage. In the latter instance the circuit connections will be identical to those shown associated with, for example, the tube R in Fig. 2.

Arrangements of the kind here disclosed will be found particularly suited for modulation and demodulation purposes. The exemplified embodiment shown in Fig. 3 is an embodiment of this idea. Referring to Fig. 3, the tubes are again denoted by R and R', while the linearizing resistances contained in the cathode lead are designated again by W_1 and W_1', respectively. Also the denotations for the grids are the same as in the case of Fig. 2.

Now, upon the control grids are impressed two potentials which are to be modulated with each other. One of the said potentials having frequency ω is impressed through the transformer U_1, the secondary winding terminals of which are directly connected with the control grids.

The impressing of the second modulation frequency Ω may be accomplished either through a third winding of the same transformer or else in a way as illustrated in Fig. 3 through a transformer U_2. In lieu of the resistances W_2 and W_2', respectively, is provided in the plate circuit a transformer U_3 which is in coupling relation with the line or the output load. Such a push-pull circuit organization permits the suppression of the carrier frequency as well as the harmonics thereof.

The present invention is not restricted to the use of simple or push-pull circuit schemes. In fact, substantially by the ways and means here disclosed also other circuit combinations are capable of being linearized. Moreover, it is not imperative that simple screen-grid tubes should be employed for any other type of tube comprising more than two grids may be employed, more particularly pentodes.

What we claim is:

1. A linear detector system comprising a screen grid tube of comparatively high internal resistance, an un-bypassed resistor connected to the cathode of said tube and included in both the input and output circuits of said tube whereby a degenerative effect is produced, and an impedance in the output circuit of said tube which has a value of small magnitude as compared to the internal resistance.

2. A detector system for obtaining a substantially linear response, comprising a pair of multi-grid tubes of high internal resistance connected in push-pull relation, a source of signal potential connected between the signal control grids of said tubes, an un-bypassed resistor connected to the cathode of each tube and included in both the input and output circuits of its respective tube whereby a degenerative effect is produced, an impedance in each of said output circuits which is low as compared to the internal resistance of said tubes, and a pair of output terminals connected to the anodes of said tubes.

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DISCLAIMER

2,156,649.—*Hermann Bendel* and *Adolf Schmid*, Berlin, Germany. AMPLIFYING DETECTOR. Patent dated May 2, 1939. Disclaimer filed November 27, 1941, by the assignee, *Siemens & Halske, Aktiengesellschaft.*

Hereby disclaims from the scope of claim 1 of said patent any linear detector system except wherein "the screen grid tube" constitutes the sole tube of the system.

[*Official Gazette December 23, 1941.*]