June 18, 1940. R. L. FREEMAN 2,205,007

METHOD OF COMPENSATION FOR DISTORTION IN SHARPLY TUNED CIRCUITS

Filed Oct. 28, 1936

FIG. 1.

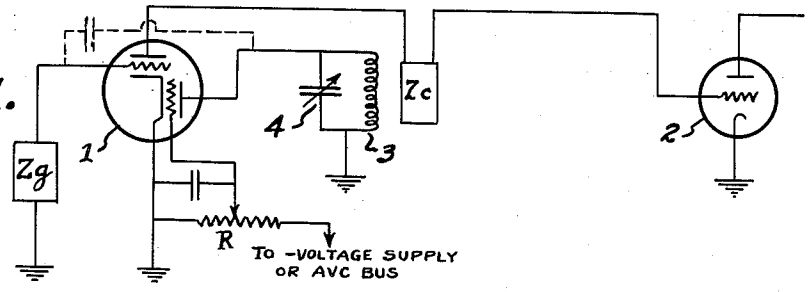


FIG. 2.

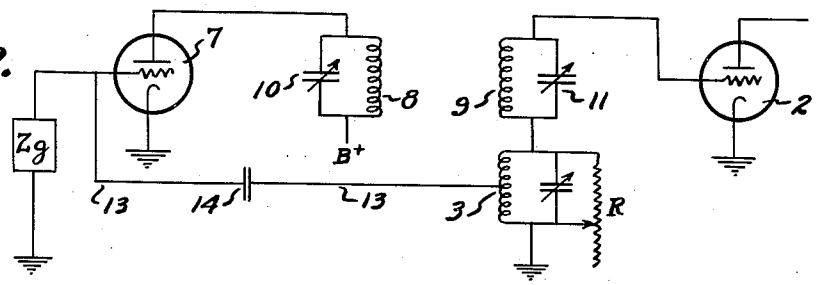


FIG. 3.

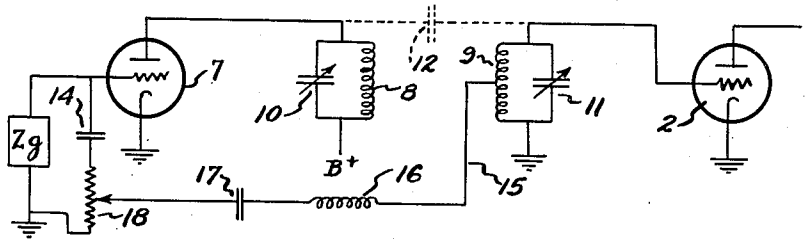
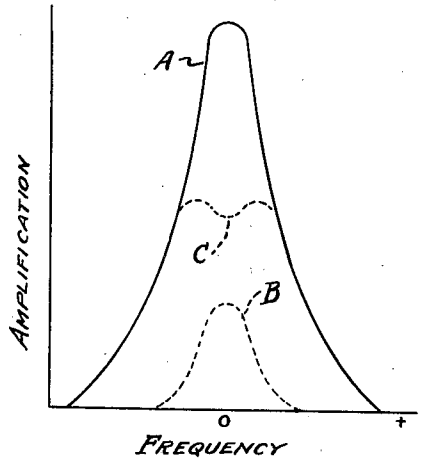


FIG. 4.



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METHOD OF COMPENSATION FOR DISTORTION IN SHARPLY TUNED CIRCUITS

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4 Claims. (Cl. 179—171)

The use of sharply tuned resonant circuits in the radio frequency or audio frequency stages of a radio receiving set is advantageous for sharpness of tuning and to avoid noise between stations. Yet it is known that circuits characterized by a sharply peaked resonance response curve produce a certain distortion, in that the higher audio frequencies become attenuated. This has lead the designers of radio receiving equipment to employ less sharply resonant circuits than they would otherwise employ for proper tuning, in an endeavor to strike a workable compromise.

It is an object of my invention to provide an automatically acting means for compensating for this distortion. I employ in my invention the principle of selective or tuned degeneration.

The various objects of my invention will be clear to one skilled in the art upon reading these specifications and I accomplish them by that certain construction and arrangement of parts of which I shall now describe certain exemplary embodiments. Reference is made to the drawing wherein:

Fig. 1 is illustrative of one form of my device and its principle of operation.

Fig. 2 shows another form of organization embodying my invention.

Fig. 3 shows still another way of applying my invention to a tuned circuit.

Fig. 4 gives representative voltage and response curves for the circuits of my invention.

Taking up first Fig. 1, 1 represents the input tube of a tuned radio or intermediate frequency stage in a radio set. 2 is an output tube. Zc is representative of a coupling device between the tubes such as an inductively and/or capacitively coupled radio or intermediate frequency transformer. I have shown at 3 a winding for feed back purposes, which winding will be coupled to Zc in some way, such as by mutual inductance between the winding 3 and the primary coil of the transformer Zc. It will be convenient in most instances to construct the coupling transformer with three windings, a primary, a secondary, and a tertiary winding, which is the coil 3. The circuit including the coil 3 may be tuned by a capacity 4, so as to be selective as to its effect on different frequencies.

In the particular embodiment shown, the tube 1 may conveniently be a dual purpose triode-pentode tube, say of the 6F7 type, the pentode section of which is employed as the first or input amplifier tube of the circuit illustrated. The triode section of the tube is connected to the coil 3 so as to shunt this coil. As the plate resistance of the tube varies, the effect of the shunt on the resonant circuit 3, 4 will vary. It is convenient to use a dual purpose tube as shown; but a separate tube for controlling the feed back circuit may obviously be employed. The plate resistance is caused to vary by varying the grid potential of the triode section of the tube, as will be readily understood. This may be done either manually or automatically, or automatically with a provision for manual adjustment. I have shown in Fig. 1 the grid lead of the triode section connected to the sliding contact of a potentiometer R, the one end of which is grounded and the other end of which is connected to a suitable source of automatically varying potential. For automatic control, it is possible to derive such potential in a number of ways, as for example, by rectifying a portion of the voltage in any preceding or succeeding stage of the radio set. Most modern radio sets, however, are provided with automatic volume control, a feature of which is the derivation of a D. C. potential which varies when the strength of the incoming signal varies. This is well known in the art and does not require description or illustration. I have therefor indicated in Fig. 1 only that the last mentioned arm of the potentiometer is connected to the automatic volume control lead. Of course, if manual control only is desired, the said arm may be connected to the negative terminal of a steady voltage source. The grid potential will be adjusted by moving the contact arm of the potentiometer. The grid potential will also vary due to variations of the voltage applied to the potentiometer.

Z_g represents the grid impedance of the circuit which feeds the grid of the pentode or amplifying section of the tube 1. In the system as illustrated there will be a capacitative coupling between resonant circuit 3, 4 and the grid of the pentode section of the tube 1, due to the inter-electrode and lead capacities. This may be sufficient for the purpose, although external capacitative or other coupling means may be employed.

My invention operates by making use of tuned degeneration in such a way that the carrier frequency of a signal and the low audio frequency side bands are fed back in proper phase to decrease the gain of the amplifier at such frequencies, while, due to the selectivity of the feed back means the higher audio frequency side bands are degenerated very little, if at all. The operation will be clear from the explanation given above. The amount of degeneration is controlled by the amount of damping applied to the resonant

feed back circuit 3, 4. It could of course also be varied by producing variations in an external coupling (not shown) between the resonant circuit 3, 4 and the grid circuit of the pentode section of the tube 1. The selectivity of the tuned circuit 3, 4 substantially confines the degenerative action to the desired frequencies.

The effect of the operation of my invention is substantially the same as that which would be secured by actual variation in the pass band of a radio or intermediate frequency. This may be understood by reference to Fig. 4 where amplification response is plotted against frequency. Curve A is a response curve obtaining when the degenerative effect does not exist or is at a minimum. It will be noted that the curve is sharply peaked, indicative of a condition which produces attenuation of the higher audio frequencies. Curve B shows a voltage frequency distribution of the voltage fed back. It will be appreciated that as this voltage increases, the amplification response will decrease due to the degenerative effect. As a consequence the overall response when degeneration is effective is represented by the curve C. This, it will be noted, is not a sharply peaked curve, but rather tends to be a double peaked curve characteristic of a broad band pass response.

Obviously it is desirable that the band pass width be proportional to the signal strength. Hence, the desirability of automatic control. If the voltage applied to the potentiometer R as indicated, is obtained from the automatic volume control system, or is obtained by some equivalent means, the amount of degeneration and hence the width of the pass band will be proportional to the signal strength.

In Fig. 2, 7 represents the input tube and 2 the output tube. 8 and 9 are respectively the primary and secondary of the coupling transformer. These windings are respectively tuned by variable capacities 10 and 11. The winding 3 is in this instance inductively coupled to the winding 9; and there is a direct feed back path indicated at 13, between the winding 3 and the grid of tube 7. This feed back pass contains a capacity 14. R in this figure may be considered either a manually operated potentiometer or the plate resistance of a vacuum tube, the connections for which will be clear from a consideration of Fig. 1, as will the operation of this circuit.

In Fig. 3 like numerals indicate like parts. In this figure, however, the feed back is derived from a tap in the secondary windings 9 as shown at 15. The feed back lead contains inductance 16 and capacity 17 for tuning purposes. There is also the feed back capacity 14; and the amount of feed back is controlled by the resistance 18, which again may be considered either a manually controlled resistance or the plate resistance of a vacuum tube.

Modifications may be made in my invention without departing from the spirit thereof. Having thus described certain embodiments of my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a radio set a tuned amplification stage comprising an input tube, an output tube and coupling means, separate inductive means for deriving from said coupling means a degenerative feed back voltage, means for tuning said last mentioned means so as to cause it to be effective for desired frequencies selectively, and resistance means shunting said inductive means.

2. In a radio set a tuned amplification stage comprising an input tube, an output tube and coupling means, separate inductive means for deriving from said coupling means a degenerative feed back voltage, means for tuning said last mentioned means so as to cause it to be effective for desired frequencies selectively, and resistance means shunting said inductive means and constituting the plate resistance of a vacuum tube together with means for controlling the grid potential of said tube.

3. In a radio set a tuned amplification stage comprising an input tube, an output tube and coupling means, separate inductive means for deriving from said coupling means a degenerative feed back voltage, means for tuning said last mentioned means so as to cause it to be effective for desired frequencies selectively, and resistance means shunting said inductive means and constituting the plate resistance of a vacuum tube together with means for controlling the grid potential of said tube which means is a source of direct current potential in said radio set varying in accordance with the strength of a signal passing through said amplification stage, and a connection between said source and the grid of said tube.

4. In a radio set, a tuned amplification stage comprising an input tube, an output tube and inductive coupling means, a separate coil inductively coupled with said coupling means, means forming with said coil a tuned circuit, means for deriving from said tuned circuit a degenerative feed back voltage, and means for causing said voltage to act upon said input tube to produce degeneration, said last mentioned means comprising an additional set of thermionic electrodes in the envelope of said input tube, in the plate circuit of which set said tuned circuit is located, the inter-electrode capacity in said tube serving as a means for applying the feed back voltage to the input portion of said tube.

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