Oct. 15, 1940. H. PITSCH 2,218,094

RECEIVER OR AMPLIFIER WITH MEANS FOR SAVING CURRENT AT LOWER VOLUME

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Fig. 1

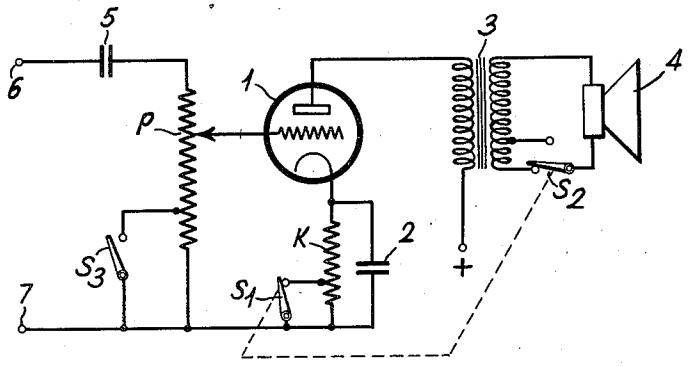


Fig. 2

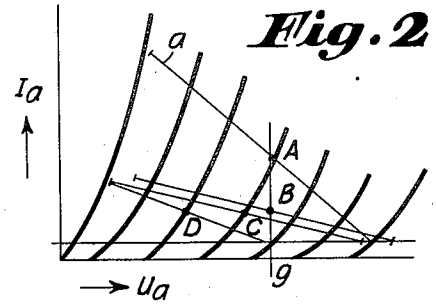
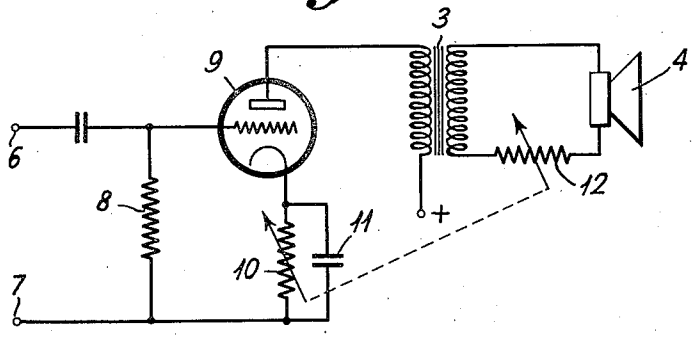


Fig. 3



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RECEIVER OR AMPLIFIER WITH MEANS FOR SAVING CURRENT AT LOWER VOLUME

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3 Claims. (Cl. 179—171)

The present invention relates to an arrangement for operating a power amplifier which is designed for operation at high level at a lower level with reduced power expenditure and without causing any increase in the distortion of the output thereof.

It is known that power or current may be saved in operating a power amplifier by decreasing the operating current or voltage of a tube of the power amplifier. Such a reduction of the current or of the voltage may be obtained automatically in dependence upon the amplitude of the input energy or manually by operation of a suitable switching means. In the case where the manually operable switch is provided distortion is readily produced since in the position of the switch in which current will be saved the power tube may easily become overloaded as when the volume control is operated to increase the volume. This is also true for the operation of a receiver without means for increasing the voltage at lower line voltage.

In accordance with the present invention the disadvantages mentioned above are overcome and as a matter of fact the use of the invention has an additional advantage in that distortion may be reduced at lower volume levels.

According to the present invention a power amplifier designed for operation at high level is provided with means for operating the amplifier at low level with reduced power expenditure but without causing any increase in the distortion of the output. For this purpose variable means are utilized for reducing the amount of power supplied to the tube and at the same time variable means are provided for increasing the load impedance. The two variable means are operated simultaneously by a suitable uni-control device.

The present invention is applicable to both single grid tubes and to multi-grid or screen grid tubes. In the case of screen grid tubes the shape of the characteristic of the tube determines whether the load resistance is to be maintained at a predetermined value with decrease of the direct current power or whether it should be increased or decreased. Due to the nature of a screen grid tube (pentode) matching for a constant and highest alternating grid potential is not possible. Accordingly, in accordance with the invention, under such circumstances the applied alternating grid potential will be decreased. With single grid tubes it is advantageous to increase the load resistance as the direct current is decreased. However, this is not required when the alternating grid potential is reduced so that an advantage is obtained in that the distortion remains constant or even becomes smaller as the load resistance is increased. This is especially true when the load resistance is increased to such an extent that the uncontrolled residual current remains the same as before.

An additional feature of the invention is that variations in the load resistance can be utilized entirely for controlling the volume.

The invention will be more readily understood from a consideration of the following detailed specification when read in conjunction with the drawing, wherein

Fig. 1 illustrates schematically the embodiment of the invention providing step adjustments;

Fig. 2 is a curve sheet used to explain certain characteristics of the invention; and,

Fig. 3 is a preferred embodiment of the invention using variable impedance devices for providing more complete control.

In the embodiment of the invention shown in Fig. 1 a tube 1 having an anode, a cathode and a grid is coupled to an input circuit comprising condenser 5 and resistor P in series connected between input terminals 6 and 7. These terminals may be connected to any suitable source of signal. The grid of tube 1 is connected to a point of resistor P while the cathode is connected to the terminal 7 through a bias resistor K shunted by a by-pass condenser 2. The anode of the tube is connected to a suitable source of positive potential through the primary of transformer 3. The secondary of the transformer 3 is connected to a utilizing device represented herein as a loudspeaker 4 through a switch S_2. The switch S_2 is arranged so that in one position (the position shown) the full voltage across the secondary of transformer 3 is impressed across the loudspeaker 4 whereas in another position only a portion of that voltage is impressed upon loudspeaker 4. Uni-controlled with the switch S_2 is a switch S_1 which in the closed position short-circuits a portion of the bias resistor K.

In addition to the above an additional switch S_3 is provided which in the closed position short-circuits a portion of resistor P. The switches S_1 and S_2 are arranged so that switch S_1 is closed when switch S_2 is placed in its upper position and opened when S_2 is in its lower position.

From a consideration of Fig. 1 it will be seen that the operation of switches S_1 and S_2 is such that the negative grid bias voltage is increased at the same time that the transmission ratio of the transformer is increased and vice versa. If desired, any undesirable increase in the plate

potential applied to the tube can be prevented by inserting a further resistance in the plate circuit.

Reference is now made to Fig. 2 which represents a series of plate-current, plate-voltage characteristics. Each of the curves represents the characteristic for a different grid potential.

For a working point A the most favorable load resistance may correspond to the working characteristic *a*. When the plate current decreases while the plate potential (according to the straight line *g*) remains constant up to the working point B, the load resistor according to the invention, will be increased for the control with the same maximum alternating grid potential, and suitably such that at the same alternating grid potential as before, the right hand part of the working characteristic is being divided by the individual characteristics into substantially equal parts so that a certain, minimum current is retained. The furnished volume has automatically become lower without the operation of a volume control. It is also possible in this case B (and at non-intended increase of the plate potential) to dimension the load resistance for a slightly higher alternating grid potential (up to the setting-in point of the grid current).

From the point of view of the circuit, the increase of the grid bias potential is the simplest way, since current saving simply by varying the plate potential can only be carried out by varying the entire voltage of the apparatus, or by utilizing a series resistor in the plate circuit of the end-tube.

However, a simultaneous change of the plate current and plate potential is advantageous alone for the reason of a lower heating of the end tube. Figure 2 shows the case that at decrease of the plate potential while the grid bias potential is maintained constant, the working point moves up to point C having lower plate current, and that at the same time the load resistor is being increased. A greater saving in current than in the case B can then only be achieved if the plate potential of the entire apparatus is being decreased, but this is not always favorable where a high sensitivity of the receiver is to be maintained. The case C is more favorable than the case B due to lesser distortions.

It is also possible to decrease at the same time the plate potential (for instance by re-switching the plate voltage winding of the line transformer) and the negative grid bias voltage, for instance, according to the working point D.

In the cases B and C it will be of the greatest advantage to choose the outer resistance with such a high value that there occurs a control with the same maximum alternating grid potential as existed before switching to the position of current saving. Otherwise (for instance, at constant outer resistance or in the case D) the alternating input potential must be automatically decreased correspondingly, at the same time with the switching to the current saving position (and increase of the outer resistance), such as indicated in Figure 1 by the switch S_3.

While in the case of Figure 1 the coupled switches serve for selective switching to full and low current consumption, and the desired value of the volume is set by means of the potentiometer P, in the example of Figure 3, a continuous control of the volume by increasing the load resistance for decreasing the volume is employed simultaneously with such a control of the grid bias potential of the single grid-end tube that at lower volume, the plate current decreases (in Figure 2 from point A to point B). Such control of the volume entails a reduction in the noise factor if care is taken that the average alternating grid voltage is constant, and the high alternating grid potential applied to the end tube is so dimensioned that an excessive control through the setting-in of grid current cannot occur when adjusting to the highest volume. A delimiting can be carried out to a certain degree in that a volume control potentiometer placed at the grid is furthermore coupled with the two variable resistors, or by utilizing a high quality volume control, more especially a forward and backward control. In the case of reproduction by record plates this is, however, not necessary since the highest volume is determined by the width of the grooves and by the thickness of the needle.

In the circuit according to Figure 3 also the case C in Figure 2 can be employed. Then, also the plate potential must be varied at the same time, for instance, by means of a coupled, variable series resistor.

In screen grid tubes the part of the invention relating to Figure 3 is not applicable, since at an increase, and also at a decrease of the outer resistance the distortions increase for a constant alternating grid potential as regards the respective, most favorable outer resistance.

I claim:

1. In a power amplifier circuit including an electronic tube which feeds into a load impedance, said tube being designed for operation at a comparatively high signal level, a source of direct current power for energizing the tube, means for operating said tube at low signal levels with reduced direct current power expenditure and without causing increase in the distortion of the signal energy output of the tube comprising operable means for varying the amount of power drawn by said tube from the direct current source, operable means for varying the load impedance, and single means for operating both of said operable means simultaneously in such a sense that the load impedance is increased as the amount of power drawn by the tube is reduced and decreased as the amount of power drawn by the tube in increased.

2. In a power amplifier including an electronic tube feeding into a load impedance said tube being normally biased for operation of the amplifier at high levels with predetermined power expenditure, means for operating the amplifier at low levels with reduced power expenditure comprising variable means for changing the bias supplied to the tube in a sense to reduce the amount of power supplied to the tube and variable means simultaneously operable with said first named variable means for increasing the load impedance to thereby prevent increase in distortion of the tube output.

3. In a power amplifier provided with an electronic tube having a variable biasing means, a translating device, an output transformer having a primary winding and a secondary winding, an output circuit for said tube including said primary winding, means including a variable impedance device for connecting the translating device to the secondary winding and single means for operating the variable biasing means and the variable impedance device simultaneously.

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