

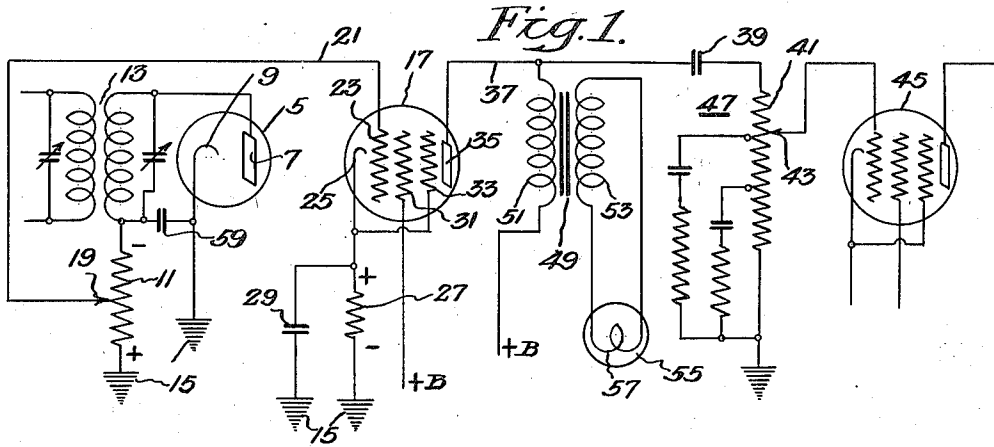
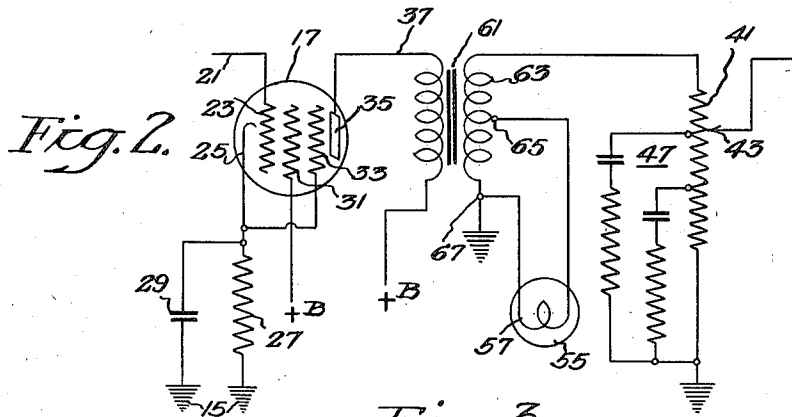
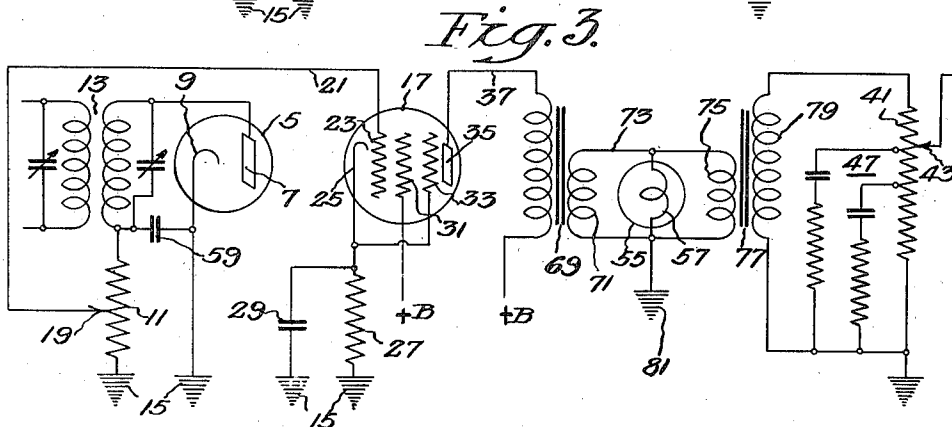
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AMPLIFIER

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AMPLIFIER

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5 Claims. (Cl. 250—20)

The present invention relates to amplifiers and more particularly to electric discharge amplifiers for radio receiving systems, phonograph amplifiers and the like, where for some reason the transmitting device is incapable of reproducing over more than a certain limited volume range or dynamic range. For this purpose, the volume or gain through the amplifier is arranged to increase with increase in the average amplitude of applied signals.

An object of the present invention is to provide an improved amplifier of the above type for radio receiving apparatus, phonograph amplifiers and the like, wherein the volume range is expanded or dynamically amplified without complicated circuits or apparatus.

It is a further object of the present invention to provide a dynamic amplifier or volume expander circuit for radio receiving apparatus, phonograph amplifiers and the like, which is of low cost and involves a minimum of apparatus.

It is a still further object of the present invention to provide an improved and simplified volume expander system for radio receiving apparatus, phonograph amplifiers and the like.

The invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Figure 1 is a schematic circuit diagram of a portion of a radio receiving system embodying the invention, and

Figs. 2 and 3 are similar schematic circuit diagrams of modifications of the circuit of Fig. 1 illustrating further embodiments of the invention.

Referring to Fig. 1, 5 is the second detector of a superheterodyne receiver and is provided by a diode rectifier having an anode 7 and a cathode 9 connected through a diode output resistor 11 with an intermediate frequency amplifier output transformer 13. The diode circuit is grounded as indicated at 15.

The rectified signals are applied to an audio frequency amplifier tube 17 through a tap connection 19 on the output resistor 11 and a lead 21 connected with the control grid 23 of the amplifier 17. The cathode of the amplifier tube indicated at 25 is connected through a source of biasing potential such as a self-biasing resistor 27 to ground 15. The resistor 27 is provided with a suitable by-pass capacitor 29.

The arrangement is such that the control grid 23 is provided with a direct current biasing potential from the source 27 as an initial bias and

additional direct current biasing potential from the diode output resistor 11. The rectified signal component is also applied to the amplifier from the resistor 11.

The amplifier device 17 is preferably of the high gain high plate impedance type having a screen grid 31, a suppressor grid 33, and an output anode 35. The output anode is connected through an output circuit 37 and a coupling capacitor 39 with a volume control potentiometer 41 to a movable volume control contact 43 of which a further amplifier device 45 is connected. The volume control device is preferably of the type having a tone compensating network 47 in connection therewith.

It will be noted that the diode output resistor 11 is provided with a by-pass capacitor 59 which serves to by-pass the intermediate frequency carrier. Likewise the by-pass capacitor 29 is of such low impedance value that it serves to by-pass the audio frequency currents tending to flow through the bias potential source 27.

The diode biased amplifier 17 is provided with a variable load device in addition to the fixed loading of the volume control device 41 through an audio frequency transformer 49, the primary 51 of which is utilized as a coupling choke coil in connection with the output circuit 37 as shown and the secondary 53 of which is connected with a device 55, the impedance of which increases when the wattage dissipation in the device increases. The plate circuit of the amplifier tube 17, is, therefore, loaded through a suitable matching transformer with the device 55 which provides an increasing impedance with increased power consumption.

With this arrangement the amplification of the combined detector amplifier will vary approximately proportionally to the load impedance provided by the device 55 and it will be seen volume range expansion will be provided. In other words, the increased signal strength provides an increased audio frequency output, greater wattage dissipation, which in turn causes the impedance of the load 55 to increase, resulting in a magnified gain, and a dynamically amplified signal is applied to the volume control device 41. The transformer 49 together with load 55 initially or normally provides a relatively low impedance for reduced signal gain or volume level.

The volume expansion circuit will introduce no distortion if the variable impedance 55 is arranged to have a time constant of such a magnitude that the impedance of 55 remains substantially constant over the time required to go

through one-half cycle of the lowest useful frequency which it is desired to amplify. With the time constant of the impedance device 55 will be understood the time required for 55 to substantially adjust its impedance from the value corresponding to the wattage dissipation to the impedance corresponding to a suddenly applied different wattage dissipation. It will be noted that this time constant will express how fast the expanding device is going to work, and that by a suitable choice of the device 55 may make the operation of the expander fast or slow at will, within the limitations outlined above.

Measurements of a 2 volt, 60 milliamperere pilot lamp have shown that the resistance varies as much as 6.4 to 1 for various dissipations of energy in the filament and this has led to the use of such a device at 55 with the filament 57 directly connected across the secondary 53 of the matching transformer. In this circuit the load of the filament 57 changes the amplification in accordance with the wattage dissipation. However, it will be seen that the action is somewhat dependent upon the effective series resistance of the transformer 49 which will be found to be inserted in series with the variable impedance thereby lessening its effects. Accordingly, a circuit is shown in Fig. 2 wherein the same reference numerals designate the same parts as in Fig. 1.

Referring to Fig. 2 it will be seen that the amplifier output circuit 37 is provided with a coupling transformer 61, the secondary 63 of which is connected with the volume control potentiometer 41 and is further provided with a low voltage tap 65 between which and the low potential terminal 67 the filament 57 of the lamp 55 is connected.

This arrangement effectively eliminates the primary load impedance of the transformer in the load circuit but it still leaves the secondary load impedance in series therewith. The output circuit of the diode biased amplifier 17 is therefore effectively variable loaded without introducing the impedance of the transformer to any appreciable extent since the portion of the secondary included between the lamp terminals is relatively low. In other words a step down ratio is obtained between the anode circuit of the amplifier and the variable wattage dissipation device while at the same time the secondary is utilized as a coupling means for the succeeding fixed load provided by the volume control device.

Referring now to Fig. 3 in which the same reference numerals are used for similar circuit elements as in Figs. 1 and 2, the diode biased amplifier 17 is provided with a coupling transformer 69 in the output circuit 37, the secondary 71 of which is connected through a link circuit 73 with a primary winding 75 of a second coupling transformer 77, the secondary 79 of which is connected with the volume control device 41 whereby it is loaded.

The secondary 71 of the input coupling transformer and the primary 75 of the output coupling transformer for the link circuit 73 are both of relatively low impedance adapted to match the impedance of a low resistance variable loading device 55 which may be any suitable device of the type referred to hereinbefore and which is shown again in this embodiment, as a lamp, the filament 57 of which is connected directly across the link circuit 73. One side of the link circuit may be grounded as indicated at 81.

With this arrangement, the use of the addi-

tional transformer 75-79 makes it possible to utilize the full impedance variation of 55, inasmuch as only the voltage across 55 is transmitted to the succeeding amplifier and the transformer impedance adds only to the plate impedance of the preceding amplifier 17.

When utilizing a circuit as shown in Fig. 3 and a lamp of the 2 volt 60 milliamperere type having a cold resistance of approximately 5.5 ohms and a hot resistance of 35 ohms, it was found that the relation between the input voltage to the grid of 17 and the output wattage to the volume control device 41 was as follows:—

Input level DB	Output level DB	
20	34	15
16	26.8	
12	19.2	
8	10.2	
4	4.2	
0	0	20

from which will be seen that effective volume range expansion or dynamic control of 14 DB is obtained.

It will further be noted that the contact 19 on the diode output resistor 11 may be variable whereby the input signal to the amplifier may be controlled and adjusted to a desired level to initially obtain at the terminals of the volume control device 41 a predetermined signal strength with a given input signal voltage in the diode resistor 11.

The system also preferably may include automatic volume control means preceding the diode rectifier. However, as such systems are now substantially universally used in connection with radio receivers it may be assumed that the signals apply to the intermediate frequency output transformer of substantially constant amplitude.

From the foregoing description, it will be seen that in a radio receiver channel or the like, an amplifier wholly or partially diode biased and directly fed from the diode is provided with a variably loaded output circuit. Furthermore, the amplifier is of the high gain high impedance type, and the output circuit thereof is suitably loaded by a variable impedance device, the impedance of which increases with the wattage dissipation. With an increase in applied signal amplitude, the higher impedance across the circuit thereby secures an increase in the gain of the amplifier stage.

The combination of a low impedance variable load in connection with an amplifier tube having a high anode impedance permits the signal voltage transmitted through the load circuit to vary in accordance with the impedance of the load. Accordingly, the load circuit of Fig. 3 is particularly desirable for use as a volume expander circuit. In other words, the load circuit gives poor regulation of voltage in response to increasing load because of the series impedance of the plate and transformer which is relatively high with respect to the load impedance.

By utilizing a lamp having a suitable filament the time constant of the expanding function may be controlled, that is, the time of change from one impedance value to another may be adjusted to preventing too rapid change in volume by adjusting the time constant of the load device.

The advantages in the use of a system embodying the invention may be shown by reference to a preferred application to radio receivers and phonograph amplifiers. As is well known, phonograph records and radio programs are so

monitored that the output volume level may not exceed certain limits to cause over-modulation of radio programs or damage to the recording groove of a record. This may result in appreciable limitation of the actual volume range variation of a symphony orchestra being broadcast or recorded.

With the present system, it is possible to obtain the benefit of volume range expansion whereby the dynamic range of the original reproduction is restored to a considerable extent without involving in the receiving or amplifying apparatus a complicated circuit or costly means, since the cost of radio receiving apparatus must be kept at a low level. This system provides means for including the benefits of volume expansion in commercial apparatus of that character. In addition a relatively wide range of expansion control is obtainable.

I claim as my invention:

1. A volume range expander system including in combination an electric discharge amplifier device of the pentode type having a relatively high anode impedance, an output circuit for said amplifier and means coupled with said output circuit providing a variable low impedance load therein which decreases with wattage dissipation, the impedance of said load being normally relatively low and in shunt relation with the output circuit and said anode impedance providing a series high impedance in said output circuit and effectively in series with the load, and said impedance being of such high value in series with said load that the signal output voltage transmitted through the load circuit is permitted to vary in accordance with the impedance of the load, and said load comprising a filamentary resistance device.

2. In a radio receiving system, the combination with a diode signal rectifier, of a high gain, high anode impedance electric discharge amplifier device and a control grid connected with said diode to receive biasing and rectified signal potentials therefrom, a volume control circuit coupled to said amplifier to receive amplified signals therefrom, said circuit having an impedance of such low value and said high anode impedance being of such high value and being effectively in series therewith as a single controlling impedance that a variable load thereon effectively varies the potential across said circuit, variable load means connected with said circuit comprising a filamentary resistor, the impedance of which increases with increased signal energy applied thereto from said circuit, and means providing a high impedance output circuit for deriving a signal from said amplifier device.

3. In a radio receiving system, the combination of an audio frequency amplifier stage including an electric discharge amplifier device having a con-

trol grid, a cathode and an output anode, said amplifier device being of the high gain, high impedance type, means providing a low impedance load circuit transformer coupled with said anode and including an impedance which increases with increased wattage dissipation therein and said amplifier device having an anode impedance sufficiently high to provide a series regulating impedance in said load circuit whereby the signal voltage transmitted through the load circuit may vary substantially proportionally to the load impedance without distortion, and said load impedance having a time constant effective to cause the impedance to be substantially constant over one half cycle of the amplified alternating current signal.

4. In a radio receiving system, the combination of an audio frequency amplifier stage including an electric discharge amplifier device having a control grid, a cathode and an output anode, an output circuit connected with said anode, means providing a load circuit coupled with said output circuit including an impedance which increases with increased wattage dissipation therein, said anode impedance being effectively in series with the load circuit and being of such relatively high value that the signal voltage transmitted through the load circuit may vary substantially proportionally to the load impedance, said load impedance having a time constant effective to cause the impedance to be substantially constant over one half cycle of the amplified alternating current signal, and means for applying signals to said control grid comprising a diode signal rectifier, an output resistor therefor and means providing a direct connection between said control grid and cathode and said output resistor whereby said amplifier is biased in accordance with signal strength variations to vary the effect of said load impedance.

5. In an audio frequency signal transmission circuit, the combination of an electric discharge amplifier device of the pentode type, means for applying signals thereto, a signal output circuit therefor wherein the anode impedance of said device provides a relatively high series output impedance, a low impedance load circuit coupled to said output circuit whereby the high anode impedance of said device is applied serially therein as a single regulating impedance, means providing a load in shunt with said load circuit, the impedance of which increases with increased wattage dissipation therein, the impedance relation between said anode impedance and the load impedance being such that the high anode impedance in series with the load permits a signal output voltage transmitted through the load circuit to vary in accordance with the impedance of the load.

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