Dec. 3, 1929. L. G. BOSTWICK 1,737,992

VOLUME CONTROL SYSTEM

Filed March 6, 1925

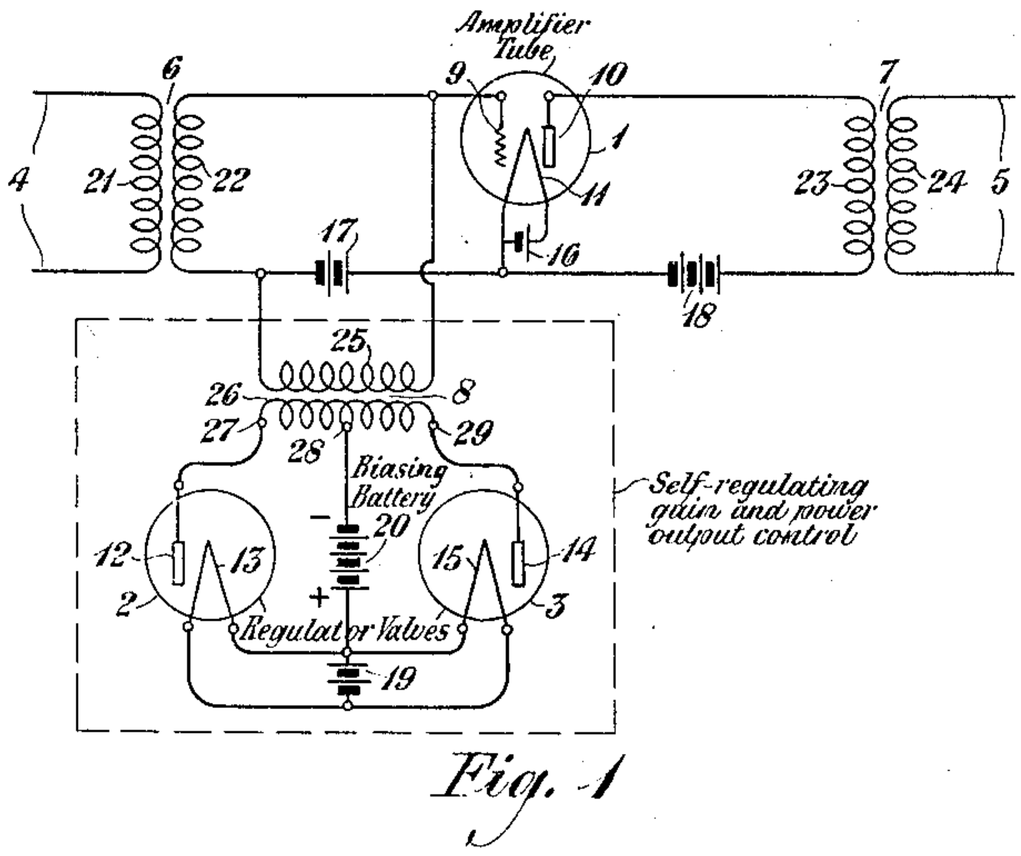

Fig. 1

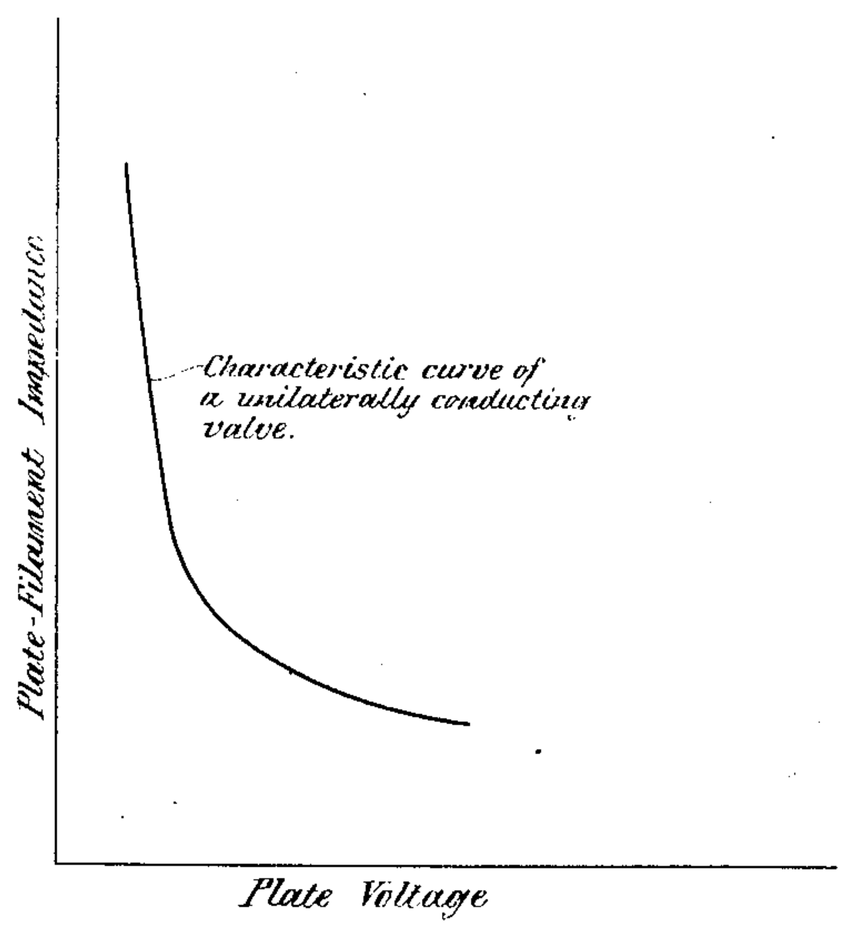

Fig. 2

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UNITED STATES PATENT OFFICE

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VOLUME-CONTROL SYSTEM

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This invention relates to volume control systems and especially to arrangements which are adapted to be used for controlling the power which may be transmitted to a receiving instrument in communication systems. The invention is more particularly adapted to arrangements in which such controlling action is obtained by utilizing the properties of thermionic or equivalent discharge devices.

It is an object of this invention to provide self-adjusting means by which an upper limit is set upon the power which may be communicated to a receiving circuit or apparatus, while power below a fixed limit may be transmitted substantially without interference, the adjustment occurring according to a definite law and in a predetermined manner so that, if necessary, any wave form distortion caused by said adjusting means may be compensated for at another place in the system by a suitable arrangement having an equal and opposite effect.

The ability to secure such limitation is desirable in certain systems to reduce the detrimental effects due to voltages of too high a magnitude resulting from extreme or abnormal conditions.

The objects of the invention may be accomplished by the apparatus herein disclosed wherein unilaterally conducting elements placed in opposition across a receiving circuit limit the voltage which may be applied to the circuit. Additional elements associated with the unilateral devices secure certain improvements in operation which will be explained hereinafter.

In the invention there are employed two electric valves each consisting of an electron emitting cathode and an anode enclosed in an evacuated tube connected in multiple to a source of constant electromotive force applied to the valves. The anodes of the valves are connected to one winding of a transformer, and the other winding of the transformer is connected to the circuit to be regulated.

The invention will be more fully understood by reference to the accompanying drawings in which Figure 1 represents a preferred embodiment of the invention, and Fig. 2 a characteristic curve of a unilaterally conducting tube. Referring to Fig. 1, the vacuum tubes 2, 3 each enclose heated filaments 13, 15 and electrodes 12, 14. The filaments are heated in the usual manner by the current from battery 19. The electric valves are connected in multiple to a biasing battery 20 or other suitable source of constant electromotive force. The cathodes 13, 15 are electron emitting cathodes preferably, and the anodes are, for example, metallic plates. Such vacuum tube devices have the well known property of acting as valves, permitting the flow of current in one direction and not in the other, viz, when the filaments are heated current flows through the tube only when the filaments are acting as the cathodes.

The anodes 12 and 14 are connected to the opposite terminals of a winding 26 of a transformer 8. One pole of the biasing battery 20 is preferably connected to the middle of the winding 26, and the other pole to the cathodes. Thus a symmetrical arrangement is provided in which the two valves 2 and 3 are connected in multiple to a source of battery current, each branch of the multiple circuit including one-half of the winding 26 and an electric valve.

The winding 21 of the transformer 6 and the winding 24 of the transformer 7 are included in the circuits 4 and 5, respectively, which are inductively connected through transformers 6 and 7 to the amplifying tube in such a manner that the regulating arrangement may be employed for controlling the amplifier power output to circuit 5.

A voltage impressed upon the grid of the amplifier tube 1 is also impressed through transformer 8 upon the plates of the valves in the regulating arrangement. As will be explained hereinafter, this voltage on the plates of the valves in the regulating arrangement causes the plate-filament impedance of the tubes to be reduced. The reduced plate filament impedance reduces the voltages impressed on the grid of the amplifier tube 1 and the impedance facing said grid and thus reduces the power output of the amplifier.

The regulating arrangement may be con-

nected between the grid and filament of the amplifier tube as represented, or it may be connected across the terminals of winding 21 of the input transformer 6, or in any other place where a variable resistance may be employed to regulate the voltage, taking care that the proper impedance relations exist. One valve with two separate plates may be employed in the regulating arrangement in place of the two valves represented in the drawing.

Fig. 2 represents graphically a characteristic of a unilaterally conducting tube such as is employed in the arrangements described. The nature of the curve indicates that the plate filament impedance varies inversely with the voltage applied to the plate of the tube. The shape of the curve may be greatly changed by suitably proportioning the parts of the tube.

The regulating arrangement operates only when the level of the incoming signal is above a predetermined level. When the voltage of the circuit across which the regulating arrangement is connected is high enough to overcome the voltage of the biasing battery, the plates of the regulating valves 2 and 3 will become positive, and the plate filament impedance of the valves will be greatly reduced. Thus, the voltage impressed on the grid of the amplifier tube and the impedance facing the grid will be reduced. Consequently, the gain and power output of the amplifier tube will be reduced, the extent of the reduction being proportional to the magnitude of the voltage of the incoming signal. When the voltage of the incoming signal is insufficient to overcome the voltage set up by the biasing battery, the plate filament impedance of the regulating valves will remain very high, and the effect of the regulating arrangement on the circuit will be practically negligible.

By properly fixing the winding ratio of the transformer 8 and by suitably adjusting the voltage of the biasing battery 20, thus giving the plates either a positive or a negative bias, it is possible to control the degree of regulation effected by the arrangements described in Fig. 1 and fix the level of incoming signals at which the regulating arrangement becomes effective. When a signal that appears in the input circuit of the transformer 6 is of low voltage, the plates of the regulating arrangement remain negatively biased, and the plate filament impedance remains practically infinite. The regulating arrangement is therefore ineffective for signals of low voltage. However, when the voltage of an incoming signal is sufficiently high the negative potential of the biasing battery 20 is overcome and the potential of the plates becomes positive with respect to the filament. The regulating arrangement then becomes effective and limits the power output of the amplifying means.

While this invention has been described in one particular arrangement which is deemed desirable, it is to be understood that it is capable of embodiment in many and widely varied organizations without departing from the spirt of the invention and the scope of the appended claims.

What is claimed is:

1. In combination, an amplifier of the three-electrode type having an input and an output circuit, a source of direct potential, two electric valves which may be connected in multiple to said source of potential, each valve consisting of an electron-emitting cathode and an anode enclosed in an evacuated tube, and a winding connecting said anodes, the negative terminal of said source of direct potential being connected to the middle of said winding connecting said anodes and the positive terminal to said cathodes, said winding being inductively connected to a winding in the input circuit of said amplifier.

2. In an amplifying system, the combination of two electric valves each consisting of an electron-emitting cathode and an anode enclosed in an evacuated tube, a source of constant electromotive force, and a transformer, one winding of which connects the anodes of said electric valves and the other winding of which connects the input circuit of an amplifier inductively to the winding of said anodes, the positive pole of said source of constant electromotive force being connected with the cathodes of said valves, the negative pole of said source of constant electromotive force being connected to the midpoint of the winding connecting said anodes so that the impedance between each cathode and the corresponding anode may be infinite when normal current flows through the system.

3. In combination, amplifying means connecting a source of power and a receiving circuit, and a device associated with said amplifying means for limiting the power output of said amplifying means and the power output to said receiving circuit, said device comprising two unilaterally conducting thermionic valves each having an anode and a cathode connected in multiple to the terminals of a biasing battery, said battery biasing the anode of each valve negatively with respect to its cathode so that the impedance between each anode and the corresponding cathode may be infinite when the current flowing through said amplifying means does not exceed a predetermined value.

4. The method of reducing the detrimental effects of disturbing waves superimposed on waves to be received by an audion tube at a receiving station with apparatus consisting of two unilaterally conducting thermionic

elements and a biasing battery, the positive terminal of which is connected to the cathodes of these elements, and the negative terminal to their anodes, which comprises utilizing the energy of received waves to produce a current which reduces substantially from an infinite value the plate-filament impedance of the two unilaterally conducting thermionic elements connected in multiple to the biasing battery, and impressing the received waves on the audion tube so that the impedance facing the grid of the tube is reduced, the output circuit of said audion tube being negligibly affected by the detrimental effects of disturbing waves.

5. A system for amplifying alternating current energy comprising an amplifier, input and output circuits therefor, and means associated with the input circuit tending to reduce the amplitude of currents in excess of a predetermined value, said means comprising a pair of valves of the two-electrode type and a biasing battery in common with the circuits of said valves, the positive terminal of the biasing battery being connected to the cathodes of these valves and the negative terminal to the anodes of these valves.

6. In combination, an amplifier comprising an electrical discharge tube, input and output circuits therefor, and a device associated with the input circuit of said amplifier to control the power output thereof, said device comprising two unilaterally conducting valves symmetrically and oppositely disposed with respect to a biasing battery, said device functioning to reduce the impedance facing the grid of said discharge tube when currents in excess of a predetermined value are impressed on the input circuit of said amplifier.

7. In combination, an amplifier comprising an electrical discharge tube, input and output circuits therefor, and a device associated with the input circuit of said amplifier to control the power output thereof, said device comprising two valves each having one anode and one electron-emitting cathode, and a biasing battery, said battery rendering each anode highly negative with respect to the corresponding cathode, said device functioning to reduce substantially from an infinite value the impedance facing the grid of said discharge tube when currents in excess of a predetermined value are impressed on the input circuit of said amplifier.

8. The method of regulating the voltage of signals above a predetermined level with two unilaterally conducting valves and a battery, the positive terminal of the battery being connected to the filaments of these valves, and the negative terminal to the plates of these valves, which consists in impressing the signals on the plates of the two unilaterally conducting valves so that the plate filament impedance of said valves is reduced substantially from an exceedingly high value when the potential set up by the signals is greater than the potential set up by the biasing battery connected in multiple with said valves.

9. In combination, two unilaterally conducting valves, each valve having an anode and an electron emitting cathode, and a biasing battery, the positive terminal of said battery being connected to said cathodes and the negative terminal to said anodes, the plate filament impedance of said valves being infinite until signals above a predetermined value are impressed on the plates of said valves.

10. In combination with a source of power and a receiving circuit, a device for controlling the voltage of signals above a predetermined value comprising a source of constant electromotive force, two unilaterally conducting thermionic valves, and circuit means connecting said source of power with the circuits of said thermionic valves, said valves being arranged in multiple with said source of constant electromotive force, the positive terminal of said source of electromotive force being connected to the cathodes of said thermionic valves, the negative terminal of said source of electromotive force being connected to the anodes of said thermionic valves.

In testimony whereof, I have signed my name to this specification this 4th day of March, 1925.

LEE G. BOSTWICK.