

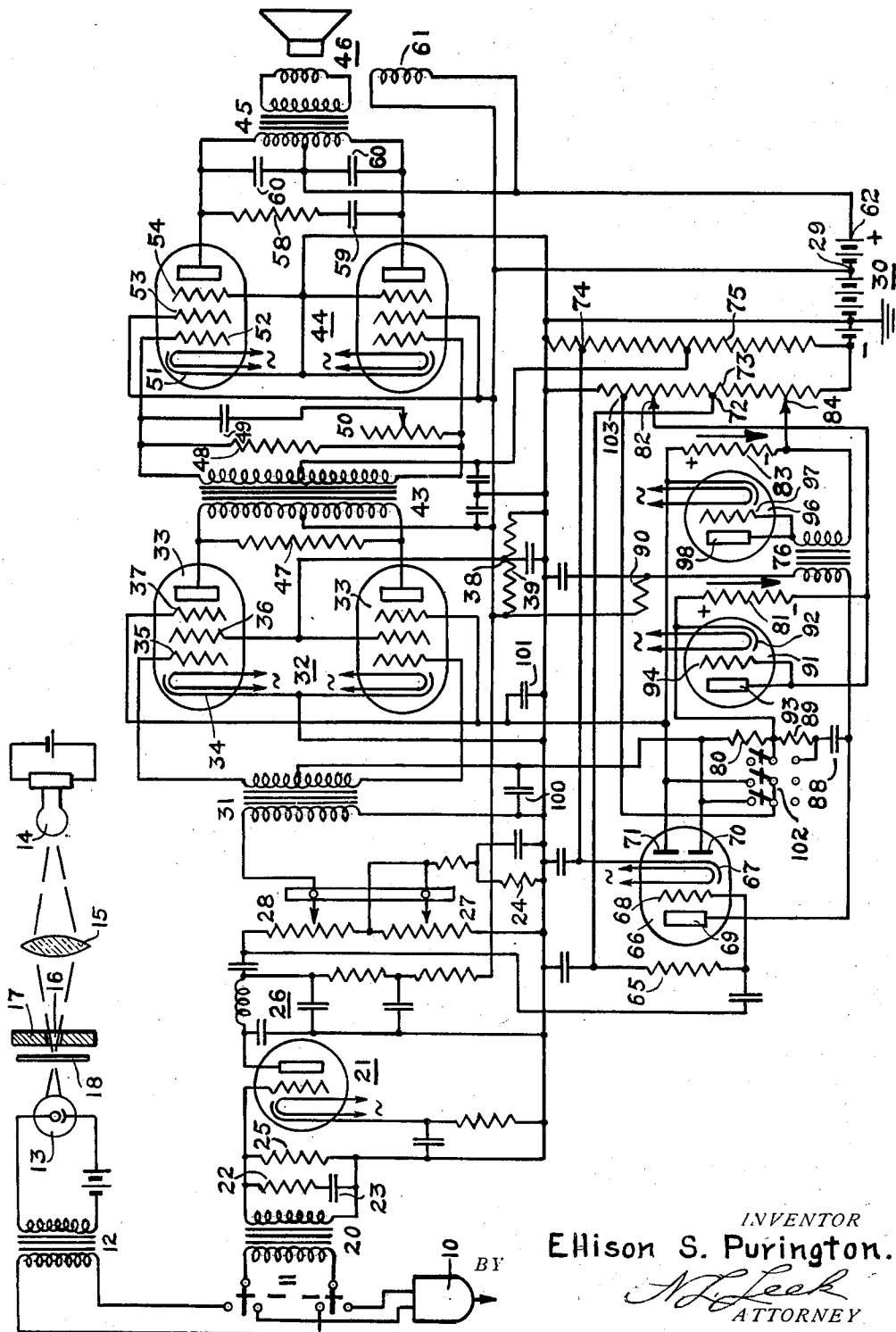
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DYNAMIC MULTIPLIER

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DYNAMIC MULTIPLIER

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This invention relates to sound reproducing systems, and more particularly to an improved system for automatically expanding or multiplying the dynamic range of sound energy. The invention provides more specifically for obtaining the desired dynamic expansion or multiplication in a single stage of amplification.

In one embodiment tubes having a plurality of control elements are used to produce the desired dynamic range in a single stage of amplification without critical adjustments. The tubes may be of the triple grid type in which case the dynamic control is preferably applied to the first or control grid and the third or suppressor grid, the plate voltage and second or screen grid voltage being fixed at their normal rated values with respect to the cathodes. In the absence of signals, the control grid may be biased to, for example, about -7 to -10 volts, and the suppressor grid may have a potential of from -30 to -40 volts. With increase of signal the negative bias on these grids is decreased as an increasing function of the signal strength up to a predetermined maximum by the action of a control circuit. The control circuit may comprise an auxiliary amplifier tube of the duplex-diode triode type (commercial type 55, for example) feeding a network including a pair of rectifiers and resistances so as to build up a voltage drop across the resistances proportional to the signal strength. The resistances are connected in circuit respectively with the control grids and the suppressor grids of the main amplifier so that the voltage drop therein opposes the normal negative bias of said grids. The diodes of the auxiliary amplifier tube may be used to limit the voltage drop across the resistances to a predetermined value so as to prevent the biasing potential on the control and suppressor grids from dropping to a value such that distortion would result.

By applying control to the two sets of grids it is possible to obtain sufficient control in one stage of amplification without necessitating critical adjustments of the initial bias settings. By using for the main amplifier a type of triple grid tube with remote cut off on the control grid (commercial type 58, for example) the control on this grid will be smooth and uniform, determining the dynamic range of the amplifier, while the control on the suppressor grid may be made abrupt so as to suppress noise, for example, in periods of small or zero signal strength. However, the abrupt cut off type of triple grid tube (commercial type 57) may be also used to advantage in some instances, especially for sound on film

and for records requiring rapid expansion at low volume.

The invention also provides tone control means to discriminate against the higher frequencies, particularly when the volume control is set for high input values. Manual adjusting means may be included to effect the necessary control for different records.

The invention also consists in the various new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof, in which:

The figure illustrates diagrammatically the system as applied to the reproduction of sound from the sound record of a talking moving picture projector and phonograph.

In the following description and in the claims, various parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the accompanying drawing more in detail, a phonograph pick up 10 is shown which is connected to two contacts of a double-pole double-throw switch 11, the other contacts of which are connected through a transformer 12 to a photoelectric cell 13. Light from a lamp 14 is focused, by means of a lens 15, through an aperture 16 in an aperture plate 17, upon the sound record of a moving photographic film 18. The light which passes through this film then impinges on the photoelectric cell 13.

The blades of the switch 11 are connected through a transformer 20 to the input circuit of a space discharge amplifier 21. Connected across this input circuit is a tone control filter comprising parallel branches, one containing a resistance 22 and a condenser 23 in series, and the other containing a resistance 25. This tone control filter is a compensating device adapted to compensate for the undercutting of the bass tones in a sound record. The filter emphasizes the bass tones by loading the transformer 20 more for high frequencies than for low frequencies. It is to be noted that this filter can be omitted provided a compensated pickup or transformer is employed.

It is useful, however, when a transformer or pick-up having flat characteristics is employed and its value will depend upon the transmission characteristics of the transformer or pick-up and the characteristics of the record which is to be compensated. The output circuit of the amplifier 21 includes a scratch filter 26 and two potentiometers 27 and 28 in series. The scratch filter 26 is used to cut out excessive high tones, such for example as all tones above a frequency of 6000 cycles and may be of any well known design adapted to produce the desired characteristics. The amplifier 21 is supplied with plate power from a tap 29 on a battery assembly 30. The potentiometer 27 is connected to a tone circuit 24 comprising a high pass filter network adapted to shunt more of the high frequencies than the low frequencies, the effect being determined by the position of the movable contact of the potentiometer 27. When this contact is raised (as viewed in the drawing) a greater proportion of the higher frequencies are shunted and vice versa. The potentiometers 27 and 28 provide a constant impedance output for the amplifier 21 while permitting adjustment of the energy fed to the next stage of amplification and to the tone circuit.

The potentiometer 28 is connected through a transformer 31 to the input circuit of a push-pull amplifier 32 comprising two tubes 33 having a plurality of control elements, such for example as triple grid tubes of the type known commercially as 57 or 58, and having cathode 34, control grids 35, screen grids 36 and suppressor grids 37. The secondary of the transformer 31 may be connected to the control grids 35 and the cathodes 34 may be grounded. The screen grids 36 may be connected to a tap 38 on a resistor 39, which is connected between the tap 29 on the battery assembly 30 and ground.

The output circuit of the amplifier 32 is connected through a transformer 43 to the input circuit of a push-pull power amplifier 44, the output circuit of which is connected through a transformer 45 to the moving coil of a loud speaker 46.

A resistance 47 may be connected across the primary of the transformer 43 to maintain the frequency characteristics substantially independent of the gain ratio characteristics. This resistance 47 has a value such that the combined impedance of this resistance and the internal output impedance of the tubes 33 in parallel approximates the impedance for which the transformer 43 is designed to effect uniform transmission on all frequencies within the desired range. If the transformer 43 is designed to operate across an input impedance corresponding to the internal output impedance of the tubes 33 this resistance 47 can be omitted.

The tubes 33 may be supplied with plate power from the tap 29 on the battery assembly 30. A filter network comprising parallel branches, one containing a resistance 48 and the other containing a condenser 49 and potentiometer 50 in series, may be connected across the secondary of the transformer 43 for tone control purposes. The resistance 48 is of a value adapted to correct for the lack of fidelity of the transformer 43 and may be omitted provided the transformer is designed to operate satisfactorily without the same. The condenser 49 and potentiometer 50 are used for tone control purposes and provide a partial shunt for the high frequencies, the characteristics of which depend upon the value of the condenser 49 and the setting of the po-

tentiometer 50. These elements may be adjusted to effect the desired frequency transmission characteristics or, in the event that the transformer 43 is designed to produce the desired fidelity, these elements may be omitted.

The tubes of the power amplifier 44 are preferably of the triple grid type, having a cathode 51, control grids 52, screen grids 53, and suppressor grids 54. The control grids 52 may be connected to the secondary of the transformer 43. The cathodes 51 and suppressor grids 54 may be grounded and the screen grids 53 may be connected to the tap 29 on the battery assembly 30. A tone filter comprising parallel branches, one containing a resistance 56 and a condenser 59 in series, and the other containing two condensers 60, may be connected across the output circuit of the power amplifier 44. This tone filter is designed to dampen out resonant frequencies which are occasioned by the mechanical vibrating elements. The characteristics depend upon the resonance characteristics of the speaker. Compensation for the mechanical resonance of the speaker may also be effected in other well known ways in which case the tone filter will be modified accordingly or may be omitted in certain instances. The field coil 61 of the loud speaker 46 may be connected between the tap 29 and a tap 62 on the battery assembly 30.

Connected across the output circuit of the amplifier 21 by a coupling resistance 65 is a branch amplifier rectifier system including a duplex-diode triode tube 66, which may be of commercial type 55, for example, and may have a cathode 67, a grid 68, an anode 69 and a pair of diodes 70 and 71. The grid bias is applied to the tube 66 from a tap 72 on a control resistor assembly 73, which is connected between the negative terminal of the battery 30 and ground. The cathode potential of the tube 66 is determined by a tap 74 on a second resistor assembly 75, which is in parallel with the resistor assembly 73 and is designed to carry heavy currents. The plate 69 of the tube 66 may be connected through the primary of a transformer 76 and a resistance 80 to the tap 29 of the battery 30.

The control grids 35 of the tubes 33 are connected through a resistance 80 and a resistance 81, to an adjustable contact 82 on the resistor assembly 73. The suppressor grids 37 are connected through a resistance 83 to an adjustable contact 84 of the resistor assembly 73. The resistance 81, being in the output circuit of the tube 66, should have a value somewhat greater than the internal output impedance of said tube in order to operate most effectively therewith and may be varied in accordance with the design of the tube 66 to produce the most effective results. The resistance 80 is high as compared to the resistance 81 so that the parallel circuit including the resistance 80 and the condenser 100 will not interfere with the operation of the resistance 81. It should not be sufficiently high, however, to introduce excessive resistance in the grid return circuit in which it is connected. The resistance 83 has a value of the order of the rated secondary output impedance of the transformer 76 across which it is connected through the rectifier tube 96 to be described.

The output circuit of the auxiliary amplifier tube 66 comprises parallel branches, one including a stopping condenser 88, a resistance 89 and the resistance 81, the other including the primary of the transformer 76. The condenser 88

is used as a blocking condenser. The resistance 89 together with the resistance 80 and the condenser 88 determines in part the frequency response characteristics of the control circuit.

A rectifier 91 having a cathode 92 and anode 93 is connected across the resistance 81 in such manner that current passes through the resistance 81 only in the direction of the arrow, whereby the potential drop in the resistance 81 opposes the normal negative bias on the grids 35 derived from the tap 82. The rectifier 91 may comprise a three element tube having a grid 94 connected to the anode 93.

The secondary circuit of the transformer 76 may include a rectifier 96 and the resistance 83 in series, the rectifier 96 being adapted to pass current through the resistance 83 only in the direction of the arrow so that the voltage drop in said resistance opposes the normal negative grid bias applied to the suppressor grids 37 from the contact 84. The rectifier 96 may also comprise a three element tube having a grid 97 connected to its anode 98.

The diodes 70 and 71 of the amplifier tube 66 may be used to limit the voltage drop in the resistances 81 and 83 respectively. For this purpose they are connected to the positive ends of said resistances. The diode 70, for example, may be connected through the resistance 80 to the positive end of the resistance 81, and the diode 71 may be connected to the positive end of the resistance 83. When the potential drop across said resistances becomes such that the diodes become positive with respect to the cathode 67 of the tube 66 space current will flow between the cathode and the diodes and further increase in potential drop across said resistances is prevented. Condensers 100 and 101 may be connected between the diodes 70 and 71 and ground to control the timing of the control circuit. The condenser 100, in connection with the resistance 80, controls the time constant of the control circuit and is chosen to produce the desired effect of the crescendo and decrescendo of the reproduced signal. The condenser 101 serves a similar function in controlling the time constant of the suppressor grid. The condensers 100 and 101 may be designed to cause the signal grid and suppressor grid to operate at the same time constant although in certain instances it may be desirable to select these elements so as to cause the signal and suppressor grids to operate at different time constants depending upon the effect desired.

A triple pole double throw switch 102 is provided for controlling the dynamic operation of the circuit. When this switch is thrown up the two diodes 70 and 71 of the tube 66 are connected together and to a tap 103 on the resistor assembly 73. When the switch 102 is open, these electrodes are independent of each other, and when the switch is thrown down the resistance 89 is short circuited. The cathodes of the various tubes may be heated in any well known manner, as by separate heaters supplied from a convenient source of current, not shown.

In the operation of the form of the invention shown in the accompanying figure, the energy received by the transformer 20 passes to the amplifier 21 where it is amplified and fed through the filter circuit 26, which eliminates the extremely high frequencies, to the potentiometers 27 and 28. When the arm of the potentiometer 27 is in its lowest position the tone circuit 24 is short circuited. As this arm is moved up more and

more resistance is put in parallel with the tone circuit 24 thus causing more and more of the high frequency tones to be shunted and decreasing the proportion of high frequency supplied to the amplifier 32.

Energy is fed from the potentiometer 28 to the input circuit of the push-pull amplifier 32 the amount being determined by the setting of the potentiometer 28. This energy is amplified by the amplifier 32 and is fed through the transformer 43 to the push-pull power amplifier 44 where it is further amplified. The output of the amplifier 44 is then fed through the transformer 45 to the loud speaker 46 where it is reproduced as speech or music in a well known manner.

Some of the energy from the output circuit of the amplifier 21 passes to the branch amplifier rectifier system where it is amplified by the auxiliary amplifier 66 and is fed to the resistance 81 and to the transformer 76. A portion of the energy thus passes through the stoppage condenser 88, resistances 89 and 81 and rectifier 91, causing a flow of unidirectional pulsating current, through the resistance 81 in the direction of the arrow, thereby building up a pulsating potential difference across this resistance, which fluctuates in accordance with the envelope of the signal strength impressed on resistor 65, and opposes the negative potential which is normally imposed upon the control grids of the amplifier 32 from the contact 82 of the resistor assembly 73. The potential thus produced across the resistance 81 automatically increases the gain ratio of the amplifier 32 with increase of signal strength and vice versa. The rate of increase or decrease of the gain ratio or the time constant of the circuit is determined by the value of the condenser 100 and resistance 80 which may be selected in accordance with the effect desired.

The potential drop across the resistance 81 is limited by the action of the diode 70, which prevents this potential from increasing beyond a predetermined value, dependent upon the potential of the cathode 67 as determined by the position of the tap 74 on the resistor assembly 75. Any increase of potential above this amount will cause a flow of current from the diode 70 to the cathode 67, thus limiting the potential impressed on the grids 35 of the amplifier tubes 33 to a value within the range of efficient operation thereof.

The energy from the amplifier 66 which passes through the transformer 76 is rectified by the rectifier 96 and flows through the resistance 83 in the direction of the arrow. This produces a potential difference across the resistance 83 which opposes the negative bias, normally impressed on the suppressor grids 37 of the amplifier 32 from the contact 84 on the resistor assembly 73. In this way increase of signal produces a further increase in gain ratio of the amplifier 32. The time constant of this increase in gain ratio is determined by the value of condenser 101 and the associated circuits which may be selected to properly accentuate the change in gain ratio produced by the control grid.

The positive potential produced by the flow of current through the resistance 83 is limited by the action of the diode 71, which prevents this potential from increasing beyond a predetermined value, dependent upon the potential of the cathode 67 of the tube 66. In this way the potential impressed upon the suppressor grids of the amplifier 32 is also limited by the action of the tube 66.

With the switch 102 in the open position, as just described, expansion of a gradual nature is produced for high quality records, etc. If more abrupt expansion is desired, as for dance music and speech, the switch 102 is thrown down, thus short circuiting the resistance 89 which permits a greater amount of energy to be impressed upon the resistance 81, thus increasing the speed of its action upon the amplifier 32.

If non-dynamic or normal operation of the circuit is desired, the switch 102 is thrown up, thus connecting both the input circuit of the amplifier 32 and the suppressor grids to the tap 103 on the resistor assembly 75 which eliminates the action of the resistances 81 and 83 and allows the circuit to operate substantially as a normal amplifier.

It will be understood that there may be interlinking of controls, as for example, control of the low or initial bias settings of contacts 82 and 84 simultaneously with volume control of potentiometers 27 and 28 so as to provide less expansion when the potentiometer is set for less volume and vice-versa.

It will be noted that the above system provides for dynamic control on the control grid, and also on an additional control element of the tube. In this way, a great expansion is made possible in a single stage of amplification. The use of a duplex-diode triode amplifier tube permits the limiting action to be obtained with a minimum number of tubes. Obviously, this could be done in the amplifier 21 instead of in the amplifier 66, if desired.

The rectifying system embodies one possible arrangement in which two types of rectification are utilized; one in which the load is in series with the rectifier and the other in which the output voltage is developed in a resistor across the rectifier.

The tone control circuits used in connection with the various amplifiers and the constant impedance output of the amplifier 21 prevent tone distortion in the system. It is to be understood that the various filters referred to above may be selected in accordance with standard filter design and are determined by the characteristics of the cooperating elements of the circuit. For example, the filter requirements depend upon the mechanical and electrical characteristics of the record, the pickup and the reproducing device and upon the transmission characteristics of the various transformers and intertube coupling devices. It is to be understood that these devices are shown diagrammatically in their simplest form and that they may be constructed in accordance with the usual practice. The value of the various resistances and impedances which are used for control purposes will depend upon the characteristics of the particular tubes with which they are to operate and will be determined in accordance with the known internal output impedance of such tubes so as to produce the most desirable results. The timing of the control circuits is a matter of choice depending upon the results desired and the characteristics of the record. Expansion of a gradual nature may be required for high quality records, for example, whereas a more rapid expansion may be desired for dance music or for records having extreme volume ranges such as certain symphony records. A wide range of adjustment is possible by varying the different elements in the manner set forth above. It is also to be understood that only so much of the circuit has been set forth as is neces-

sary to an understanding of the present invention and that the circuit may include the usual sources of potential, controls, etc.

Although only a few of the various forms in which this invention may be embodied have been shown herein, it is to be understood that the invention is not limited to any specific construction, but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In a system for reproducing sound, an amplifier comprising a space discharge tube having a plurality of control electrodes connected to receive a biasing potential for controlling the transmission characteristics of the tube a source of audio frequency sound energy, means to supply said audio frequency sound energy to one of said control electrodes, and means to vary the biasing potential on said last control electrode and also on an additional control electrode in accordance with the envelope of the sound energy so that both control electrodes operate to vary the gain ratio of the tube as an increasing function of the sound energy whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal.

2. In a system for reproducing sound, an amplifier comprising a pair of space discharge tubes connected in push-pull relationship, said tubes each having a plurality of control electrodes the corresponding control electrodes of the two tubes being connected by a common return to a source of biasing potential for controlling the transmission characteristics of the tube, a source of audio frequency sound energy, means to supply said audio frequency sound energy to one of said control electrodes of each tube and means to vary the biasing potential on said last control electrode and also on an additional control electrode of each tube, in accordance with the envelope of the sound energy so that both control electrodes operate to vary the gain ratio of the tube as an increasing function of the sound energy whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal.

3. In a system for reproducing sound, an amplifier comprising a space discharge tube having a plurality of control electrodes connected to receive a biasing potential for controlling the transmission characteristics of the tube, a source of audio frequency sound energy, means to supply said audio frequency sound energy to one of said control electrodes, means to vary the biasing potential on said last control electrode and also on an additional control electrode, in accordance with the envelope of the sound energy so that both control electrodes operate to vary the gain ratio of the tube as an increasing function of the sound energy whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal, and means to limit the change in biasing potential on each control electrode so as to prevent signal distortion due to overloading.

4. In a system for reproducing sound, an amplifier comprising a space discharge tube having a plurality of control electrodes connected to receive a biasing potential for controlling the transmission characteristics of the tube, a source of audio frequency sound energy, means to supply said audio frequency sound energy to one of said control electrodes, a control circuit including an

amplifier, a resistor, means for passing a unidirectional current through said resistor proportional to the output energy of said last amplifier whereby a potential drop is developed thereacross, and means applying said potential drop to oppose the normal biasing potential on a plurality of said control electrodes in said tube whereby the additive effect of both control electrodes is utilized to cause the gain ratio of said tube to vary as an increasing function of the sound energy for expanding the dynamic range of the reproduced signal.

5. In a system for reproducing sound, an amplifier comprising a space discharge tube having a plurality of control electrodes, a source of audio frequency sound energy, means to supply said audio frequency sound energy to one of said control electrodes, a control circuit including an amplifier, a pair of resistances, means for passing a unidirectional current through said resistances proportional to the output energy of said last amplifier whereby a potential drop is developed thereacross, and means applying said potential drop to oppose the normal biasing potential on a plurality of said control electrodes in each tube whereby the gain ratio of said first amplifier varies as an increasing function of said sound energy, and means to limit the potential drop across said resistances to a value such that distortion of the amplified signal is prevented.

6. In a system for reproducing sound, an amplifier comprising a space discharge tube having a plurality of control electrodes, a source of audio frequency sound energy, means to supply said sound energy to one of said control electrodes, a control circuit including an amplifier tube of the duplex-diode-triode type, means supplying energy proportional to said sound energy to said triode, impedance means connected to receive energy from the output circuit of said triode, rectifier means associated with said impedance means to produce a potential drop thereacross proportional to the average sound energy, means whereby said potential drop opposes the normal bias on a plurality of said control electrodes, and a limiter circuit including said diodes to limit the change in said bias.

7. A system for reproducing sound comprising a source of audio frequency sound energy, an amplifier comprising a space discharge tube having a control grid and a suppressor grid, means supplying said audio frequency sound energy to said control grid, means to apply a biasing potential to both of said grids and means to vary said biasing potential as a function of the envelope of said sound energy so that both the control grid and the suppressor grid operate to increase the gain ratio of the tube with an increase in sound energy whereby the additive control effect of both grids is utilized for expanding the dynamic range of the reproduced signal.

8. A system for reproducing sound comprising a source of audio frequency sound energy, an amplifier comprising a space discharge tube having a control grid and a suppressor grid, means supplying said audio frequency sound energy to said control grid, means to apply a biasing potential to both of said grids, means to vary said biasing potential as a function of the envelope of said sound energy so that both the control grid and the suppressor grid operate to increase the gain ratio of the tube with an increase in sound energy whereby the additive control effect of both grids is utilized for expanding the dynamic range of the reproduced signal, and means to limit the

change in biasing potential to a predetermined value for preventing overloading of the tube.

9. In a system for reproducing sound, an amplifier having a control electrode connected to receive audio frequency signal energy, a control circuit fed by the signal energy and connected to control the biasing potential on said control electrode, said control circuit including an amplifier tube of the type having a limiting electrode therein and means connecting said limiting electrode to limit the control exercised by said control circuit on said biasing potential.

10. In a system for reproducing sound, an audio amplifier including a variable impedance device, a source of audio frequency sound energy, a control circuit adapted to vary the impedance of said device as a function of the envelope of said sound energy, said control circuit including a duplex amplifier-limiter tube having a limiter electrode connected to limit the impedance variations produced by said control circuit.

11. In a system for reproducing sound, an amplifier comprising a multiple grid tube, a source of audio frequency sound energy, means to impress said audio frequency sound energy on one of said grids, a control circuit also fed by said audio frequency sound energy and adapted to vary the bias on a plurality of said grids according to the average signal strength, said control circuit including a duplex-diode-triode tube, the triode electrodes being connected to amplify the energy in the control circuit, the diode electrodes being connected to limit the variation of bias produced by the control circuit.

12. In a system of reproducing sound, a space discharge amplifier having two control electrodes in one tube connected to a source of biasing potential, a control circuit for controlling the gain ratio of said amplifier, means for applying an audio frequency input signal to one of said electrodes and to said control circuit, said control circuit being adapted to vary the biasing potential to both of said control electrodes proportional to said input signal so that both control electrodes operate to vary the gain ratio of said amplifier proportionally to the average value of the input signal whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal.

13. A system for reproducing sound comprising a space discharge amplifier having a plurality of control electrodes for controlling the gain ratio thereof, a source of audio frequency sound energy, a control circuit for varying the biasing potential on both of said electrodes for increasing the gain ratio of the amplifier as an increasing function of said sound energy, means for applying said audio frequency sound energy to one of said electrodes and to said control circuit and means associated with said control circuit for limiting its action on said control circuit so that overloading of the amplifier is prevented.

14. A system for reproducing sound comprising a space discharge amplifier having a plurality of control electrodes for controlling the gain ratio thereof, a control circuit for varying said gain ratio comprising a second amplifier, a resistor connected in the output circuit of said amplifier and means controlled by said resistor for varying the biasing potentials on the control electrodes of said first amplifier in accordance with the average value of the input signal whereby the additive control effect of both control

electrodes is utilized for expanding the dynamic range of the reproduced signal.

15. A system for reproducing sound comprising a single stage space discharge amplifier having a plurality of control electrodes for controlling the gain ratio thereof, a control circuit for varying said gain ratio comprising a second amplifier, a network including a resistor and rectifier connected in the output circuit of said second amplifier and means controlled by said network for varying the potentials on the control electrodes of said single stage amplifier in accordance with the average value of the input signal whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal.

16. In a system for reproducing sound comprising a single stage space discharge amplifier having a plurality of control electrodes for controlling the gain ratio thereof, a control circuit having an impedance and means for passing a current through said impedance proportional to the average value of the input signal and means responsive to the voltage drop in said impedance for varying the biasing potentials applied to the control electrodes of said amplifier whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal.

17. In a system for reproducing sound comprising a single stage space discharge amplifier having a plurality of control electrodes for controlling the gain ratio thereof, a control circuit having an impedance, means for passing a current through said impedance proportional to the average value of the input signal and means responsive to the voltage drop in said impedance for varying the biasing potentials applied to the control electrodes of said amplifier whereby the additive control effect of both control electrodes is utilized for expanding the dynamic range of the reproduced signal, and means for limiting said action when loud signals are applied so that overloading is prevented.

18. In the operation of an amplifier circuit of the type including a space discharge tube having a plurality of grid elements one of which is supplied with audio frequency variations and having means for establishing different biasing potentials upon the several elements, the method of controlling the amplification which comprises simultaneously varying the biasing potentials of at least two of said elements as an increasing function of the strength of the signals applied to the input circuit of the amplifier.

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