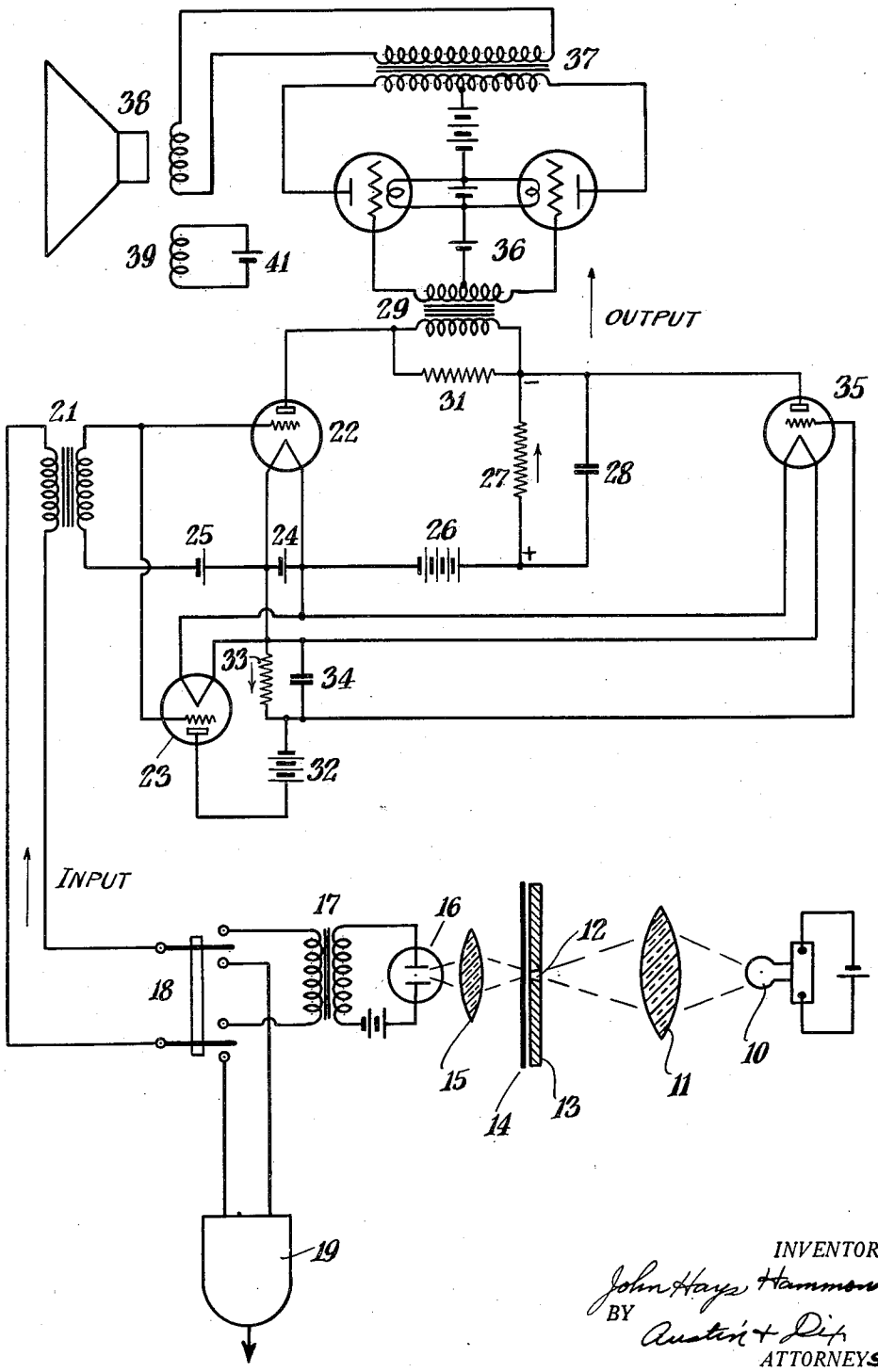
July 23, 1935. J. H. HAMMOND, JR 2,008,703

DYNAMIC MULTIPLIER CIRCUIT

Original Filed Nov. 1, 1930



INVENTOR.
John Hays Hammond, Jr
BY
Austin + Dix
ATTORNEYS

Patented July 23, 1935 2,008,703

UNITED STATES PATENT OFFICE

2,008,703

DYNAMIC MULTIPLIER CIRCUIT

John Hays Hammond, Jr., Gloucester, Mass.

Application November 1, 1930, Serial No. 492,660
Renewed September 28, 1933

16 Claims. (Cl. 179—100.1)

This invention relates to amplifying systems and more particularly to an improved system for controlling the amount of amplification in accordance with the strength of the applied energy.

The invention relates particularly to a system of amplification in which a greater ratio of amplification or gain is produced for impressed signals of high intensity than for impressed signals of low intensity.

The invention provides means for varying the plate voltage applied to a space discharge amplifier in accordance with the strength of the applied energy.

The invention also consists in certain 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 single figure illustrates diagrammatically the system as applied to the reproduction of the sound record of a talking moving picture projector or phonograph.

In the following description and in the claims, 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 more particularly to the accompanying drawing a source of illumination 10 is provided, the light from which is focused, by means of a lens 11, through an aperture 12 in an aperture plate 13 and upon the sound record of a moving film 14. The light which passes through this film is focused by means of a lens 15 upon a photo-electric cell 16. This cell is connected through a transformer 17 to one side of a double-pole double-throw switch 18, the other side of which is connected to a phonograph pick up 19.

The blades of the switch 18 are connected through a transformer 21 to the input circuits of two space discharge tubes 22 and 23 which are connected to parallel to a common filament battery 24 and a common biasing battery 25. The output circuit of the space discharge tube 22 (which may be called the amplifier tube) includes a plate battery 26, a resistance 27 shunted by a condenser 28 and a primary of transformer 29 which is shunted by a resistance 31. The output circuit of the space discharge tube 23 (which may be called the first control tube) includes a plate battery 32 of lower voltage than the plate battery 26, and a resistance 33 which is shunted by a condenser 34.

One side of the resistance 33 is connected to the grid of a third space discharge tube 35 (which may be called the second control tube), the filament of which receives its energy from the battery 24. The plate of the space discharge tube 35 is connected to a point between the resistance 27 and the primary of the transformer 29.

The secondary of the transformer 29 is connected to the input circuit of a push-pull amplifier 36, the output circuit of which is connected through a transformer 37 to the moving coil of a loud speaker 38. The field winding 39 of this loud speaker is energized by a battery 41.

In the operation of the form of the invention shown in the accompanying figure, when it is desired to use the photoelectric pick-up, the switch 18 is thrown to its upper position and when it is desired to use the phonograph pick-up, this switch is thrown to its lower position. In either case the energy received passes through the transformer 21 to the input circuits of the space discharge means 22 and 23. The amplified output from the space discharge amplifier tube 22 passes through the resistance 27, the primary of the transformer 29 and the resistance 31. The resistance 31 maintains the frequency characteristics independent of the amplitude characteristics. The energy from the secondary of the transformer 29 is amplified by the push-pull amplifier 36, the output of which passes through the transformer 37 to the moving coil of the loud speaker 38 where it is reproduced as speech or music in the usual way.

Due to the proper choice of voltages for the batteries 25, 26 and 32, the first control tube 23 will be caused to act as a detector, the output of which passes through the resistance 33 in the direction of the arrow. This causes a potential difference to be built up across the resistance, which is dependent on the strength of the current passing through it and, therefore, to the input signal strength. With low input signal strength, only a small current will pass through resistance 33 and, therefore, only a small negative bias will be applied to the grid of the second control tube 35, thus allowing a large plate current to flow through the tube 35 which also flows through the resistance 27 in the direction of the arrow. This causes a large potential drop across

this resistance which opposes the voltage of the battery **26**, and thus cuts down the plate voltage on the amplifier tube **22**, thus cutting down its amplification factor.

With increase of signal strength, the output of the first control tube **23** causes increase of current to flow in the resistance **33** and, therefore, increases the negative bias on the grid of second control tube **35**, which increases its impedance and, therefore, cuts down the current flowing in it and through the resistance **27**. This decreases the potential opposing the voltage of the battery **26** and, therefore, increases the plate voltage on the space discharge means **22**, thus increasing its amplification factor.

It is thus seen that, with low input signal strength, the amplification factor of the system will be low due to decrease of plate voltage on tube **22** and that, with high input signal strength, the amplification factor will be high due to increase of plate voltage on tube **22**.

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 from a record, an electron discharge device having an anode, a cathode and a control electrode, means for controlling the average direct current anode potential on the anode of said device comprising a resistance connected in series therewith and means for varying the current flow through said resistance in accordance with the average strength of the rectified input signal.

2. In a system for reproducing sound from a record, a space discharge device in the plate circuit of which is a resistance which is also in the plate circuit of a second space discharge device, the bias of which is determined by the potential drop across a second resistance which is in the plate circuit of a third space discharge device the control element of which is connected to the input circuit of said first space discharge device.

3. In a system for reproducing sound from a record, an electron discharge device having a resistance connected in the path of its space current, said resistance being also in the path of the space current of a second electron discharge device the control element of which is in series with a second resistance which is in the path of the space current of an electron discharge detector the control element of which is connected in parallel with the control element of said first electron discharge device.

4. In a system for reproducing sound from a record, an electron discharge device, means for varying the direct current potential on the plate of said device including a resistance connected in series therewith, means for passing a current through said resistance including a second electron discharge device and means for varying the potential on the control element of said second device in accordance with the average value of the rectified impressed signal.

5. In a system for reproducing sound from a record, an electron discharge device, means for varying the potential on the plate of said device including a resistance connected in series therewith, said resistance being also in series with the plate of a second electron discharge device, means for varying the potential on the grid of said second device including a resistance connected in series therewith, said second resistance being also in series with the plate of a third electron discharge device the control element of which is connected in parallel with the control element of said first electron discharge device.

6. In a system for reproducing sound from a record, an electron discharge device, means for varying the direct current potential on the plate of said device including a non-inductive resistance connected in series therewith which is also in series with the plate of a second electron discharge device, means for varying the potential on the grid of said second device including a second resistance connected in series therewith, means for varying the current flow through said second resistance in accordance with the average value of the input signal strength.

7. In a system for reproducing sound from a record, an electron discharge device having a control element, a source of signals, means for impressing said signals on said control element, a second electron discharge device, means for impressing said signals on said second device, a resistance in the path of the space current of said second electron discharge device, said resistance being so arranged that the voltage drop therein caused by said space current controls the potential of a third electron discharge device, a second resistance in the path of the space current of said third electron discharge device, said second resistance also being in the path of the space current of said first electron discharge device, said second resistance being so arranged that the voltage drop therein caused by the space current of said third device opposes the plate potential of said first electron discharge device thus varying the amplifying characteristics of said first device in accordance with the strength of the input signals.

8. In a system for reproducing sound from a record, an electron discharge device having a control element, a source of signals, means for impressing said signals on said control element, a second electron discharge device, means for impressing said signals on said second device, a resistance in the path of the space current of said second electron discharge device, means for so operating said second device that the value of said space current passing through said resistance is proportional to the average value of said signals, said resistance being so arranged that the voltage drop therein caused by said space current controls the potential of a third electron discharge device, a second resistance in the path of the space current of said third electron discharge device, said second resistance also being in the path of the space current of said first electron discharge device, said second resistance being so arranged that the voltage drop therein caused by the space current of said third device opposes the plate potential of said first electron discharge device thus varying the amplifying characteristic of said first device in accordance with the strength of the input signals.

9. In a system for reproducing sound from a record, an amplifier tube, first and second control tubes, each tube having an anode, a cathode and a control electrode, means for impressing a signal on the cathode-control electrode circuits of said amplifier tube and first control tube, a first resistance and a first source of B-voltage in the cathode-anode circuit of said first control tube, the cathode-control electrode circuit of said sec-

ond control tube being connected across said first resistance to place a negative bias on the control electrode of said second control tube, a second source of B-voltage and a second resistance in the cathode-anode circuit of said second control tube, said second resistance and second source of B-voltage together with an output device forming the anode-cathode circuit of said amplifier tube.

10. The method of reproducing sound from a sound record which comprises amplifying the energy of said record by a space discharge amplifier and varying the anode potential of the amplifier according to the indicated signal volume of said record.

11. The method of reproducing sound from a sound record which comprises amplifying the energy of said record by a space discharge amplifier and varying the external impedance in the output circuit of the amplifier according to the average input signal volume.

12. A system for reproducing sound from a sound record comprising a variable impedance amplifier, and means to vary the external impedance in the output circuit thereof in accordance with the average input signal strength.

13. The method of operating a space discharge amplifier for the reproduction of sound from a sound record which comprises controlling the average direct current anode potential of the anode of said amplifier according to the average signal strength of the selection reproduced from said record.

14. In a sound record system, a space discharge amplifier having a cathode, anode and control electrode, a pick-up device, means for feeding energy from said pick-up device to the cathode-control electrode circuit, an output device in the cathode-anode circuit, said cathode-anode circuit also including a control resistance, a control circuit receiving energy from said pick-up device, said control circuit including a rectifier to provide a sub-audio control current corresponding to the moving average of the volume of signal obtained from said pick-up device, and means for passing said sub-audio control current through said control resistance to vary the gain ratio of said amplifier.

15. In a sound reproducing system for use with a sound record, a pick-up device, an amplifier fed thereby and a translating device fed by said amplifier, said amplifier having a first control electrode fed by audio-frequency variations from said pick-up device, and a second control electrode fed by sub-audio frequency variations from said pick-up device for controlling the gain characteristics of said amplifier.

16. In a sound translating system for use with a sound record, a first translating device, a transmission channel fed thereby and a second translating device fed by said channel, a control circuit for varying the efficiency with which audio-frequency energy is transmitted through said channel, said control circuit being arranged to introduce variations into said channel solely by electronic coupling.

JOHN HAYS HAMMOND, JR.