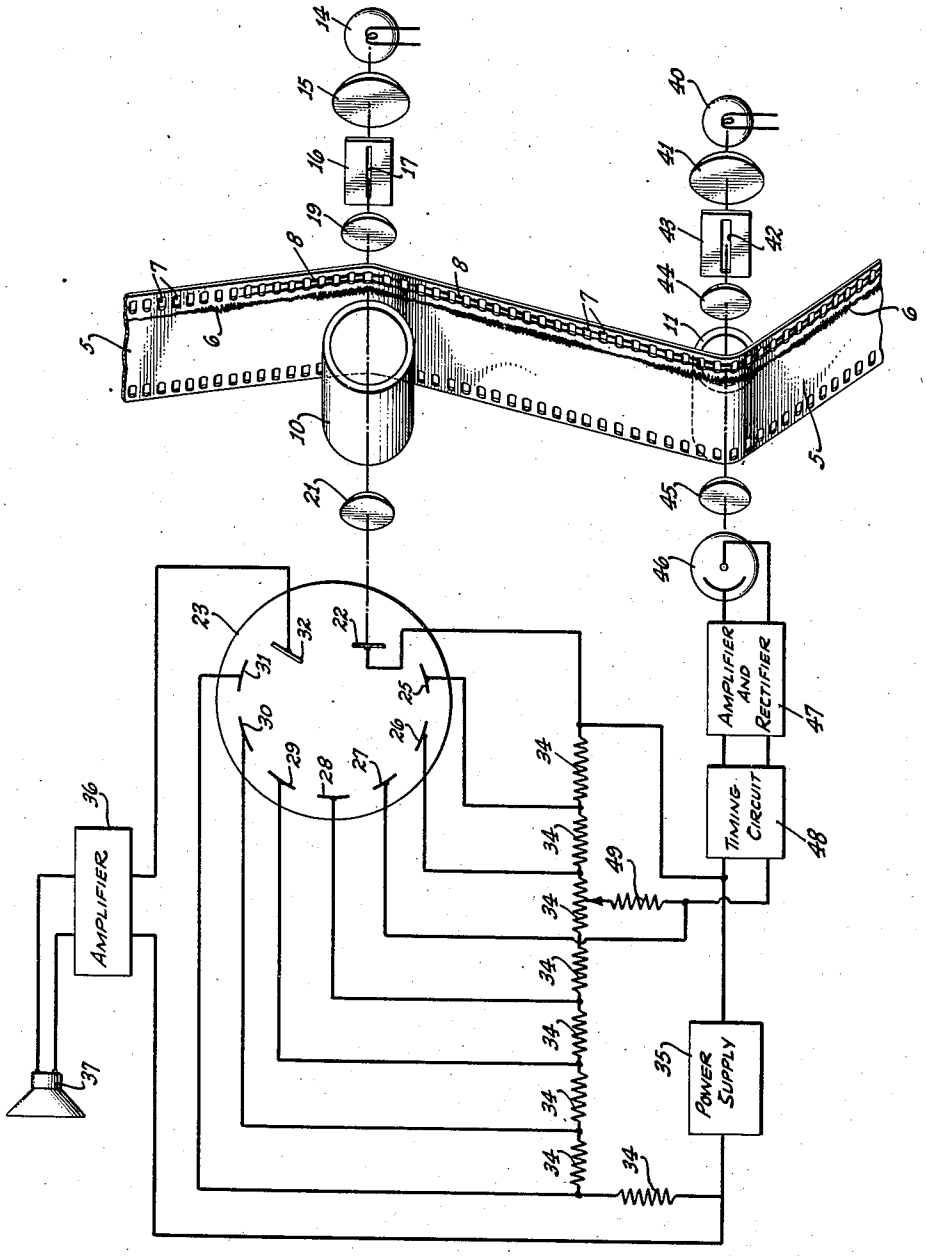
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SOUND FILM SYSTEM

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SOUND FILM SYSTEM

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10 Claims. (Cl. 179—100.3)

This invention relates to motion picture sound apparatus and particularly to a sound film reproducing system.

In the art of sound recording and reproduction, variations are frequently made between the original signal amplitudes and the recorded amplitudes, and also between the reproduced amplitudes and the recorded amplitudes. It is well known that the film sound track range is much less than many signal ranges, such as those of an orchestra, and to record the entire signal range on the film, compression is employed. This is accomplished by decreasing the higher signal amplitudes to a certain degree before impression on the recording medium, the lower amplitudes being decreased proportionately or in some definite predetermined ratio. This method also accomplishes the reduction of ground noise since the lower amplitudes may be recorded at a relatively higher level than would otherwise be possible.

In the reproduction of a sound record which has been compressed to any appreciable extent, the reverse of compression or expansion is required in order to restore the respective amplitudes of the signal to their original relationships. It is also desirable in many instances to expand a normal or linearly recorded signal to increase the dramatic effect thereof.

Various types of compressors and expanders are known in the art, the most successful at present being of the electronic type wherein the amplification factor of a vacuum tube is varied under control of the average amplitude variations of the signal. By the use of a variable mu vacuum tube in the variable gain amplifier, a variation in amplification is obtainable without the introduction of any substantial distortion in the compressed or expanded signal. The present invention is directed to an electronic type of variable gain amplifier which may be utilized for either compression or expansion, the device being the electronic multiplier type of tube which combines a photoelectric cell and amplifier. By the use of this device, a particularly wide range of variations is obtainable while maintaining a linear relationship between the control voltage variations and the amplified signal output. Such an electron multiplier for the normal reproduction of sound records is disclosed and claimed in copending U. S. application Serial No. 332,632, filed May 1, 1940.

Although the present invention is described as embodied in a sound reproducing system, it is to be understood that the system is also suitable for the introduction of compression in the sound record during recording.

The principal object of the invention, therefore, is to facilitate the amplitude control of a reproduced or recorded sound record.

Another object of the invention is to vary the amplitudes of a signal to or from a sound record.

A further object of the invention is to increase the controllable range of sound reproduction from a sound record without distortion.

A further object of the invention is to utilize an electron multiplier as a variable gain amplifier for reproducing or recording a sound record.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the appended claims, the manner of its organization and the mode of its operation will be better understood by referring to the following description read in conjunction with the accompanying drawing forming a part thereof, in which the single figure is a schematic and diagrammatic arrangement of a sound reproducing system embodying the invention.

Referring to the drawing, a film 5 has positioned thereon a sound record 6 of either the variable area or variable density type. Positioned within the area intermediate the sprocket holes 7 and longitudinally of the film 5 is a control record 8, such a control record being disclosed in copending U. S. application Serial No. 181,634, filed December 24, 1937. The film 5 is advanced through the reproducing apparatus in any suitable manner such that it passes over a roller 10 and a roller 11. Light is passed through the sound record 6 as the film passes over the roller 10, the light being generated from a source such as a lamp 14. The light is gathered by a collecting lens 15 projected on a slit mask 16 having a slit 17 therein and then projected on the sound track area of the film 5 by a lens 19. The emergent light from the film is collected by a lens 21 and projected upon the photocathode 22 of an electron multiplier 23.

The electron multiplier is of the type shown in the above-mentioned copending U. S. application Serial No. 332,632, wherein its function and operation are described in detail. In brief, the electron multiplier has the photocathode 22, a plurality of dynodes 25, 26, 27, 28, 29, 30 and 31 and a collector 32. Graduated voltages are impressed upon the series of dynodes and collector from potentiometer resistors 34, the operating voltage being supplied from a power supply

35. Connected between the power supply 35 and the collector 32 is a power amplifier 36 which may feed a sound reproducer 37. In the present multiplier there are seven stages of amplification, each stage having an amplification factor determined by the voltage impressed thereon.

The above-described portion of the system will reproduce the sound record 6 as recorded—that is, the reproduced amplitudes will have the same relationships as exist on the film. This relationship is varied, however, by the remainder of the system, which will now be described.

As the film passes over the roller 11, a beam of light from a light source 40 is projected on the control track 8 after passing through collective lens 41, slit 42 of a mask 43 and projection lens 44. The emergent light is then projected by a lens 45 upon a photoelectric cell 46. It will be noted that the slit 42 is considerably wider or higher than the slit 17. This provides the control track reproducing system with increased efficiency and attenuates the harmonic components of the 96 carrier frequency. The output of the cell 46 is impressed upon a rectifier-amplifier combination 47, then on a timing circuit 48 and then on dynode 27 of the electron multiplier 23. A variable tap coupling resistor 49 is employed for properly coupling the photocell 46 to the electron multiplier circuit, the voltage developed across the coupling resistor 49 being proportional to the average value of the light on the photocell 46.

In operation of the above-described circuit, the electron multiplier 23 detects and amplifies the light passing through the sound track 6 of the film 5, the amplified energy being impressed upon the amplifier 36 and reproduced by the loudspeaker 37. In normal operation, the output energy variations will be proportional to the light variations impressed on the photocathode 22. However, this proportionality is varied by the voltage variations impressed on dynode 27. These voltage variations are obtained from the reproducing system 40—48 which reproduces the control track positioned intermediate the sprocket holes, although it is to be understood that this control track may be a track similar to sound track 6 and may be on a second film or other sound recording medium. The two tracks have been so positioned on the film that corresponding points are longitudinally displaced for convenience in reproduction.

The control track system is one wherein the sprocket holes are advanced at a speed of 96 per second, which produces a carrier frequency modulated by the varying opacity of the area between the sprocket holes as described in detail in the above-identified application. Thus, the amplifier-and-rectifier 47 detects the modulated carrier while the timing circuit 48 controls the rate at which the variations in gain are increased and decreased so that the minimum amount of distortion is introduced at these points. Although the control track record may be recorded so that the variations in density and consequent light variations are at a predetermined rate to introduce the minimum amount of distortion, as disclosed and claimed in applicant's copending U. S. application Serial No. 366,590 filed Nov. 22, 1940, it may be desirable to further control the rate of change in voltage on the multiplier to insure optimum operating conditions.

Although an individual light source is shown for each film track, a split beam system with a single light source may be employed. Furthermore, the stabilizing features disclosed in the above-mentioned copending application Serial No. 332,632 may be embodied in the circuit, thus providing a more stable system than heretofore known.

I claim as my invention:

1. Motion picture apparatus comprising means for producing a light beam, means for modulating said light beam in accordance with sounds to be reproduced, a photoelectric electron multiplier responsive to said modulated light beam and provided with a photoelectric cathode, a plurality of multiplying electrodes and a collecting electrode connected to the output circuit, a source of power supply connected to the electrodes of said multiplier, a second light beam, means for modulating said second beam, and a photocell responsive to said second modulated light beam and connected to said power supply and to one of said multiplying electrodes for varying the output of said electron multiplier irrespective of the modulations of said first-mentioned light beam.

2. A sound reproducer in accordance with claim 1 in which said first modulating means includes a film sound track and said second modulating means includes a film control track.

3. In combination with an electron multiplier having a cathode, a collector and a plurality of intermediate dynodes, a source of potential connected to said collector, said cathode and said dynodes, one of said dynodes being connected to said source of potential through an amplifier-rectifier circuit, and a photoelectric cell in the input circuit of said amplifier-rectifier, the variations in light impressed on said photocell varying the potential on said one dynode.

4. A sound reproducing system comprising a sound track on a film, a control track on said film, means for modulating a light beam in accordance with said sound track, means for modulating a light beam in accordance with said control track, an electron multiplier having a photocathode, a plurality of dynodes and a collector, a reproducer connected to said collector, means for impressing the light modulated by said sound track on said photocathode, a photoelectric cell connected to one of said plurality of dynodes, and means for impressing the light modulated by said control track on said photoelectric cell.

5. A reproducing system in accordance with claim 4 in which an amplifier-rectifier and timing circuit is connected intermediate said photoelectric cell and said one dynode.

6. A system for expanding the reproduction of a film sound track record comprising means for generating a light beam, means for modulating said light beam with said sound record, an electron multiplier for translating said light beam into electrical voltages and amplifying said voltages in substantially equal steps, means for generating a second light beam, means for modulating said second beam, a photocell for translating the modulations of said second beam into corresponding electrical voltages, and means for varying the amplification of one of said amplification steps irrespective of the variations in the amplitude of said sound record.

7. A system for varying the reproduced amplitudes of a film sound record by a control record of predetermined variations in amplitude comprising means for translating the amplitude variations of said sound record into voltage vari-

ations and increasing said voltage variations in a series of electronic steps, said means including an electron multiplier having a photocathode and a plurality of dynodes, means for translating said control record into voltage variations corresponding therewith, said last-mentioned means including a source of light and a photocell, and means for impressing the output of said photocell on one of said dynodes for varying the voltage variations of one of said electronic steps by said control record variations.

8. A system for controlling the reproduced amplitudes of a sound record by a control record comprising means for translating the variations of said sound record into voltage variations and increasing said voltage variations in a plurality of substantially equal electronic steps, said means including an electron multiplier having a photocathode and a plurality of dynodes, means for translating said control record into voltage variations corresponding therewith, said last-mentioned means including a source of light and a photosensitive device, and means for connecting the output circuit of said photosensitive device to one of said dynodes for varying one of said electronic steps of sound track voltage variations, and means connected intermediate said device and said one dynode for varying the rate of change of said variations.

9. A sound record expansion system comprising a film having thereon a sound track and a control track disposed intermediate the sprocket holes of said film, an electron multiplier having a photocathode, a plurality of dynodes and a collector, a sound reproducer connected to said collector, means for modulating a light beam with the sound record on said film, means for impressing said modulated light upon the photocathode of said electron multiplier, a photoelectric cell, means for modulating a second light beam by said control track and the sprocket holes of said film for impression on said photoelectric cell, means for amplifying and rectifying the output of said photoelectric cell, and means for impressing the output of said rectifier on one of said dynodes for varying the amplification of the detected sound record irrespective of the normal variation of said sound record.

10. A sound recording system in accordance with claim 9 in which a timing circuit is interposed between said rectifier and said dynode for varying the rate of change of the variations in amplitude of said sound record.

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