

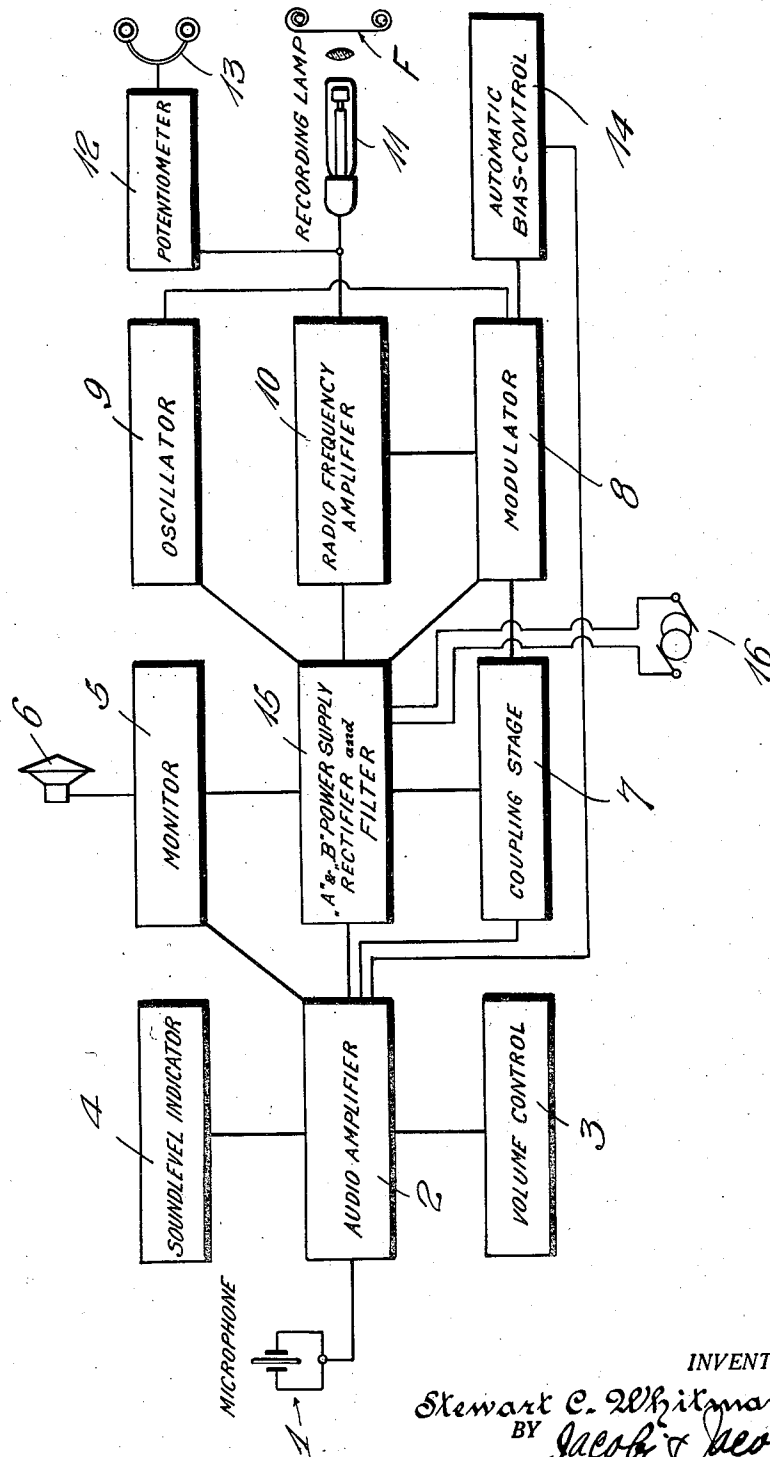
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APPARATUS FOR RECORDING SOUND ON FILM

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APPARATUS FOR RECORDING SOUND
ON FILM

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7 Claims. (Cl. 179-100.3)

The invention relates to new and useful improvements in the art of recording sound on film and more particularly to an apparatus and method for producing the desired result.

5 An object of the invention is to produce an apparatus for recording sound on film over the full range of audio frequencies.

A further object of the invention is to produce an apparatus to record sound on film in such
10 manner that only the desired sounds result upon reproduction.

Another object of the invention is to provide an apparatus, the component parts of which can be fully supervised and controlled at all times
15 during operation.

Still another object of the invention is to provide an apparatus which makes possible the saving of film in sound recording.

A still further object of the invention is to produce an apparatus which can be operated directly from an alternating current power supply.

20 With these and numerous other objects in view, my invention consists in the novel features of construction, combination, and arrangement of parts as will be hereinafter referred to and more particularly pointed out in the specification and
25 claims.

In the drawing, forming a part of this application:

30 The figure is a schematic diagram showing the arrangement and coupling among the various component elements of my improved apparatus utilized in my system of recording sound on film.

35 In describing the invention, I shall refer to the drawing in which the numeral 1 designates a microphone; 2 is an audio amplifier for the microphone signals; 3 is an instrument for regulating the amount of amplification to be obtained by means of 2. The numeral 4 designates a device which supplies a continuous visual indication of the power level measured in decibels.
40

The numeral 5 designates a small output amplifier feeding the loudspeaker 6. The signal operating 5 is tapped from 2 and is reproduced in
45 6 thereby affording the operator a continuous audible check on sound quality and volume. The volume level of monitor 5 is variable.

50 The numeral 7 designates a coupling stage through which the amplified signal from 2 is conducted to the modulator stage 8. The numeral 9 designates a radio-frequency vacuum tube oscillator, the output of which is introduced into the modulator 8 and is therein modulated by the audio signal introduced from 7.

55 The numeral 10 designates a radio frequency

amplifier. The modulated radio frequency signal from 8 is amplified in 10 and fed to the recording lamp 11. The numeral 12 designates a potentiometer by means of which the output of 10 may be tapped to operate the earphones 13
55 thereby affording the operator means of checking the signal, when and if desired, arriving at the recording lamp 11. The numeral 14 designates a device whereby the grid bias of the modulator tube in 8 may be automatically determined
10 and controlled by the strength of the audio signal in 2, as hereinafter and more particularly set forth.

The numeral 15 designates a rectifier and filter system for supplying the necessary potentials to
15 the various component parts, the power being derived from the alternating current source 16. The connecting lines indicate coupling means among the various component parts.

I shall now more particularly describe the operation of my invention. There are two general methods used at present in recording sound on film: the "light-valve" method and the "glow lamp" method. In the light-valve method, light
25 from a constant source falls upon the film after being modulated by passing through a mechanical light shutter. This mechanical shutter is operated electrically by the audio signal. In the glow lamp method, a constant direct current actuates a gaseous-conduction lamp and the steady
30 light emitted thereby is modulated by superimposing the audio signal voltage thereupon.

Inherent faults are recognized in these systems. The frequency range of the light-valve system is limited due to the inertia of the moving
35 mechanism. In the case of the glow lamp method the steady D. C. exciting current produces exposure on the film with no signal modulation.

On the positive print the unmodulated track transmits light and "ground noises" result upon
40 reproduction. The irregularities in the battery circuit actuating the lamp are reproduced on the film record and further aggravate the ground noise effect.

The extinction voltage of a glow discharge lamp
45 is considerably lower than the ignition voltage. Thus if the audio-modulating voltage rises sufficiently high the glow lamp is extinguished and the modulating voltage must be lowered considerably before the lamp relights. Overloading of
50 this kind occurs frequently in recording and this lag in the glow lamp constitutes a serious drawback.

It has been proposed to utilize radio-frequency
55 alternating current to activate the glow lamp.

This would eliminate the battery noise and cut down the exposure in the case of zero modulation. If say 20 volts modulation signal is to be used, the excitation voltage across the lamp must be at least 20 volts above the extinction voltage of the lamp; otherwise, the lamp would be extinguished. The voltage is the important consideration in the case of modulation whereas the total current through the lamp determines the light output. It can be readily seen that an alternating current of sufficient peak voltage can be impressed across the lamp which would be less than direct current of corresponding voltage. Some improvement in ground noise is thus obtained.

I propose to describe here a method of glow lamp recording and an apparatus which eliminates all the undesirable features. The sound to be recorded is transmitted through a microphone and amplified. The resulting signal is used to modulate a radio frequency carrier generated in a separate oscillator. I have found a frequency of about 200 K. C. to perform best. It is important that this modulation be accomplished through the medium of a modulator tube. Another important feature in this modulation process is the utilization of a coupling tube stage between the audio amplifier and the modulator stage for the purpose of properly matching the input and output impedances. In this manner, no distortion is introduced.

By using a separate modulator tube stage an essential improvement can be introduced. The grid bias on the modulator tube is determined so that after subsequent amplification, which will be described later, the resultant, unmodulated radio-frequency voltage impressed on the recording lamp is just sufficient to ignite the lamp. A small portion of the audio modulating signal is tapped from the output of the audio amplifier. This signal is amplified and rectified and impressed upon the modulator tube grid bias supply in such fashion that this variable impressed voltage acts in an opposite direction to the grid bias voltage and tends at all times to reduce the grid bias voltage. This reduction in the grid bias voltage results in higher radio frequency voltages being generated in the plate circuit of the modulator tube. With the grid bias chosen originally, the recording lamp is just brought to the ignition point. It can be seen that even the smallest audio-frequency signal voltage entering the modulator stage would extinguish the recording lamp if the grid bias applied to the modulator tube were maintained at a fixed value. However, by means of the automatic bias changing device just described any audio signal must increase the radio frequency carrier voltage in the modulator tube. By adjusting the amplification of the tapped audio signal properly, the bias is varied so that the carrier voltage is just sufficient for complete modulation at all times. By complete modulation is meant that degree of modulation which varies the radio frequency carrier voltage almost to the extinction voltage of the recording lamp. In other words, for the purpose of this discussion, the extinction voltage of the lamp is considered the zero limit for modulation. This statement takes into account the fact that the modulated carrier is later amplified before being impressed upon the recording lamp.

To summarize, then, we have the following conditions during operation. The primary advantages of using radio frequency excitation of the recording lamp are obtained. In addition, the

unmodulated excitation current results in light of minute value, thus producing practically no sound track without modulation. With modulation of the radio frequency current taking place, practically all the light emitted by the recording lamp is a result of the audio signal. On the positive print therefore the unmodulated track is opaque and the modulated track transmits in direct proportion to the recorded sounds. In the reproducing system therefore no light can activate the photocell except that due entirely to the desired recorded sound. Reproduction results which is entirely free from extraneous noises.

From actual experience in the operation of my apparatus, I find the following ratings preferable.

The audio amplifier has an overall gain of approximately 80 decibels. The oscillator used for generating the radio frequency excitation current has a power rating of about 7.5 watts. A 50 watt modulator is used and feeds into a 50 watt amplifier stage. I have found that this high power is necessary in order to properly match all the various components without distortion and still deliver sufficient power to the recording lamp. The amplifier stage following the modulator is necessary in transforming the modulated radio frequency output of the modulator to the proper voltage for transmission to the recording lamp. This amplifier stage also serves as a coupling stage between the modulator and the recording lamp wherein the proper impedance match can be accurately accomplished.

By arranging the apparatus with the audio amplifier, oscillator, modulator, modulator bias control, and radio frequency amplifier, as separate units, complete control and accurate adjustment of every operation is obtained. The audio amplification can be monitored and varied at will. The frequency of the oscillator can be raised and lowered. The coupling to the modulator can be adjusted to produce any radio frequency voltage from zero to maximum at the recording lamp. The automatic modulator grid bias control can be varied in any proportion to the fixed bias by adjusting the amplification of the control signal tapped from the main audio amplifier.

In order to allow the automatic bias control time to operate before the arrival of the principal portion of the audio signal a delay device is included in the audio amplifier. This consists of a by-pass condenser which causes the main audio signal to lag behind the control audio signal by about 1/50 second. Thus, at no time can any main signal frequency greater than 50 cycles arrive at the modulator grid before the proper adjustment of grid bias has been made. As a result of this, a wide range of signal intensities can be handled by the recording lamp with no possibility of extinction due to overload and with no possibility of unnecessary exposure due to unmodulated light.

I have successfully recorded frequencies as high as fourteen thousand cycles—the practical limit of the amplifying equipment—with the apparatus disclosed. These records show a clear cut delineation between adjacent cycles under the magnifying glass. Using the high power available in the present invention in connection with a specially constructed radio-frequency recording lamp, which is described in my co-pending application, Serial No. 605,990, filed of an even date herewith, using a specially constructed optical system which is described in my copending application, Serial No. 605,992, filed of an even date herewith, and utilizing the maximum photo-

graphic contrast obtained by my automatic modulator grid bias control, excellent sound records can be made at film speeds of 60 feet per minute. Since this film speed is satisfactory for pictorial photography, a tremendous saving in film stock is made possible. The present sound recording film speed is usually 90 feet per minute.

In the present invention, all power used by the tubes may be supplied from a rectified and filtered alternating current line source. This is a great aid in preserving uniformity since voltages and currents may be checked and easily adjusted at all times with no danger of power diminution or failure such as is frequently encountered with battery power.

While I have particularly described the elements best adapted to perform the functions set forth, it is obvious that various changes in form, proportion and in the minor details of construction may be resorted to, without departing from the spirit or sacrificing any of the principles of the invention.

Having thus described the invention, what is claimed is:

1. In an apparatus for recording sound on film, means for providing a high frequency current, a sound pick-up device, an amplifier therefor, a separate modulated tube stage wherein the high frequency current is modulated by the output of the sound amplifier, a source of fixed grid bias potential for said modulator tube stage, means for tapping a portion of the sound amplifier output current, means for rectifying and amplifying the said tapped current, means controlling said amplification to obtain a balanced relationship of substantial equality between the last mentioned current and the rectified output current of the sound amplifier, and means for impressing the balanced tapped current subtractively upon the fixed grid bias potential of the modulated tube.

2. In a sound recording system using a glow lamp wherein substantially no light is emitted from said glow lamp when no sounds are delivered to the input of the system, in combination, a microphone, a speech input amplifier, a source of radio-frequency current, a separate modulator tube, the output of said source of radio-frequency current being delivered to said modulator tube, the output of said speech input amplifier being delivered to said modulator tube for modulating said radio-frequency current, a recording glow lamp, means for delivering the output of said modulator tube to said glow lamp, means for applying a fixed grid bias potential to the grid of said modulator tube, and rectifying and amplifying means connected between said speech input amplifier and said modulator tube for applying to the grid of said modulator tube a varying unidirectional potential varying in magnitude with the output of said speech input amplifier and in opposition to said fixed bias potential, said means for applying a fixed grid bias potential to the grid of said modulator tube being primarily adjusted so that when no sound energy is applied to said microphone and speech input amplifier the energy delivered to said glow lamp from said modulator tube is just sufficient to ignite said glow lamp.

3. In a sound recording system using a glow lamp wherein substantially no light is emitted from said glow lamp when no sounds are delivered to the input of the system, in combination, a microphone, a speech input amplifier, a source of radio-frequency current, a separate modulator tube, an adjustable coupling tube unit connected

between said speech input amplifier and the input of said modulator tube, a recording glow lamp, means for delivering the output of said modulator tube to said glow lamp, means for applying a fixed grid bias potential to the grid of said modulator tube, and rectifying and amplifying means connected between said speech input amplifier and said modulator tube for applying to the grid of said modulator tube a varying unidirectional potential varying in magnitude with the output of said speech input amplifier and in opposition to said fixed bias potential, said means for applying a fixed grid bias potential to the grid of said modulator tube being primarily adjusted so that when no sound energy is applied to said microphone and speech input amplifier, the energy delivered to said glow lamp from said modulator tube is just sufficient to ignite said glow lamp.

4. In a sound recording system using a glow lamp wherein substantially no light is emitted from said glow lamp when no sounds are delivered to the input of the system, in combination, a microphone, a speech input amplifier, a source of radio-frequency current, a separate modulator tube, the output of said source of radio-frequency current being delivered to said modulator tube, the output of said speech input amplifier being delivered to said modulator tube for modulating said radio-frequency current, a recording glow lamp, means for delivering the output of said modulator tube to said glow lamp, means for applying a fixed grid bias potential to the grid of said modulator tube, and rectifying and amplifying means connected between said speech input amplifier and said modulator tube for applying to the grid of said modulator tube a varying unidirectional potential varying in magnitude with the output of said speech input amplifier and in opposition to said fixed bias potential, said means for applying a fixed grid bias potential to the grid of said modulator tube being primarily adjusted so that when no sound energy is applied to said microphone and speech input amplifier, the energy delivered to said glow lamp from said modulator tube is just sufficient to ignite said glow lamp, the level of amplification of said rectifying and amplifying means being so adjusted that the potential delivered to said glow lamp at no instant goes below the extinction potential.

5. In a sound recording system using a glow lamp wherein substantially no light is emitted from said glow lamp when no sounds are delivered to the input of the system, in combination, a microphone, a speech input amplifier, a source of radio-frequency current, a separate modulator tube, the output of said source of radio-frequency current being delivered to said modulator tube, a recording glow lamp, means for delivering the output of said modulator tube to said glow lamp, means for applying a fixed grid bias potential to the grid of said modulator tube, rectifying and amplifying means connected between said speech input amplifier and said modulator tube for applying to the grid of said modulator tube a varying unidirectional potential varying in magnitude with the output of said speech input amplifier and in opposition to said fixed bias potential, and electrical impulse delay means connected between the output of said input speech amplifier and the input of said modulator tube for imparting a slight time delay to the output directly delivered to said modulator tube from said input speech amplifier with reference to the potential applied to the grid of said modulator tube

by said rectifying and amplifying means, said means for applying a fixed grid bias potential to the grid of said modulator tube being primarily adjusted so that when no sound energy is applied to said microphone and speech input amplifier the energy delivered to said glow lamp from said modulator tube is just sufficient to ignite said glow lamp.

6. In the recording of sound on film employing a recording glow lamp and a separate modulator tube, the method of recording sound with minimum background noise which consists in applying to the grid of said modulator tube a fixed grid bias potential of such magnitude that said glow lamp just ignites when no speech input electrical energy is delivered to said modulator tube, and amplifying, rectifying and applying to the grid of said modulator tube a portion of the speech input electrical energy in opposition to said fixed grid bias potential, the level of amplification of said portion of the speech input electrical energy being such that the potential delivered to said glow lamp at no instant goes below the extinction potential.

7. In the recording of sound on film employing a recording glow lamp and a separate modulator tube, the method of recording sound with minimum background noise which consists in applying to the grid of said modulator tube a fixed grid bias potential of such magnitude that said glow lamp just ignites when no speech input electrical energy is delivered to said modulator tube, amplifying, rectifying and applying to the grid of said modulator tube a portion of the speech input electrical energy in opposition to said fixed grid bias potential, the level of amplification of said portion of the speech input electrical energy being such that the potential delivered to said glow lamp at no instant goes below the extinction potential, and imparting a slight time delay to the speech input electrical energy directly delivered to the input of said modulator tube with reference to the amplified and rectified portion of the speech input electrical energy applied to the grid of said modulator tube.

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