June 22, 1943. I. R. GOSHAW 2,322,435

MOTION PICTURE SOUND RECORDING AND REPRODUCING SYSTEM

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Fig. 1.

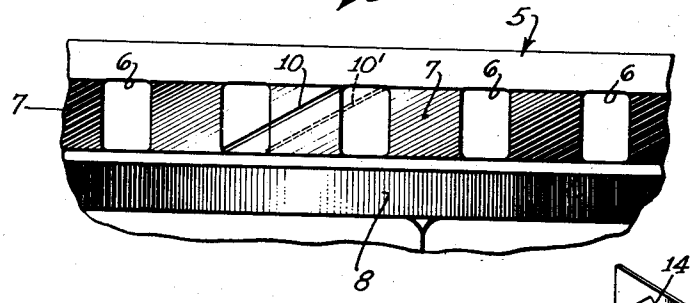


Fig. 2.

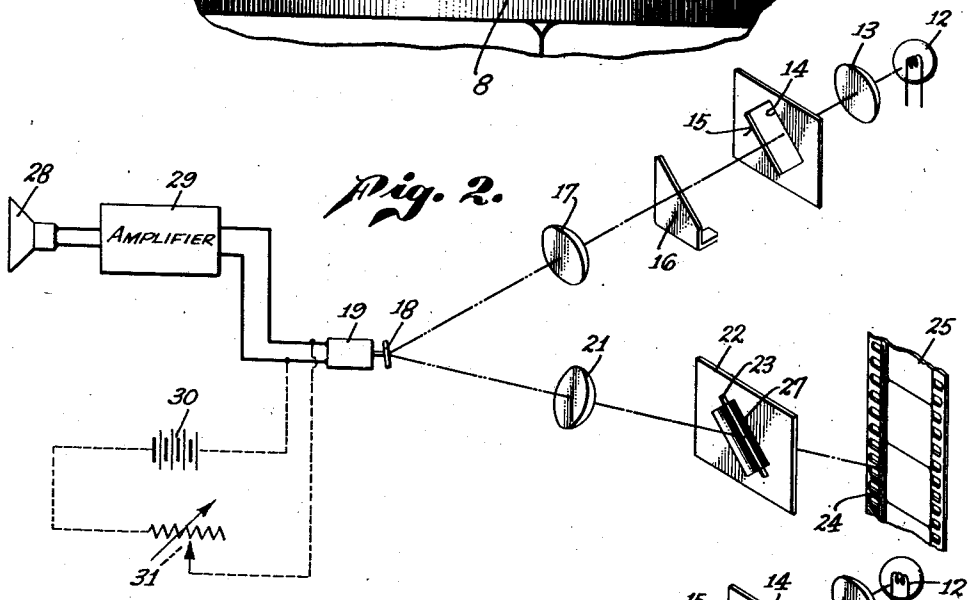
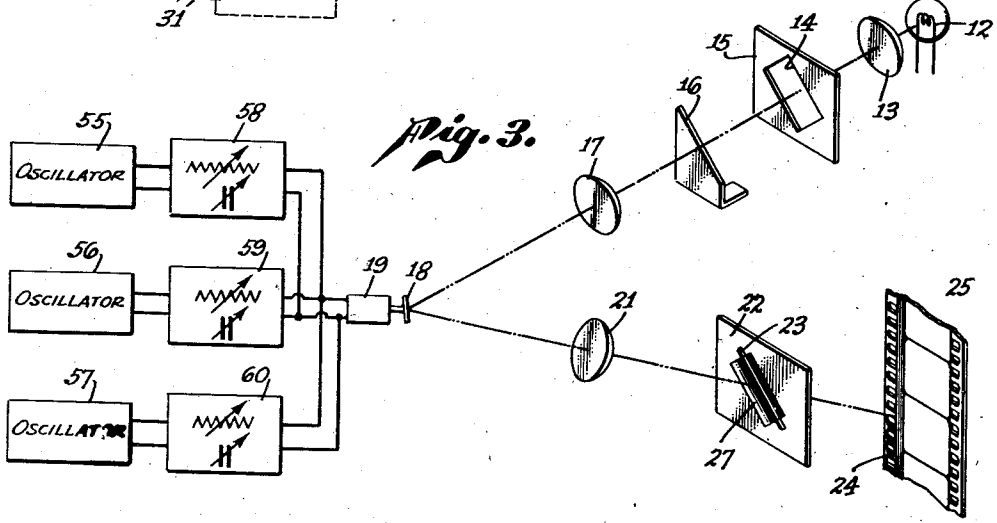


Fig. 3.



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Fig. 4.

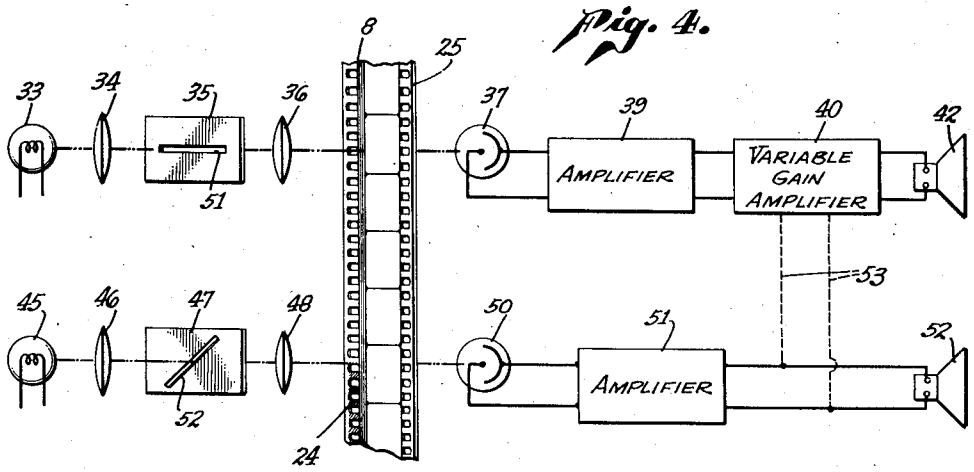
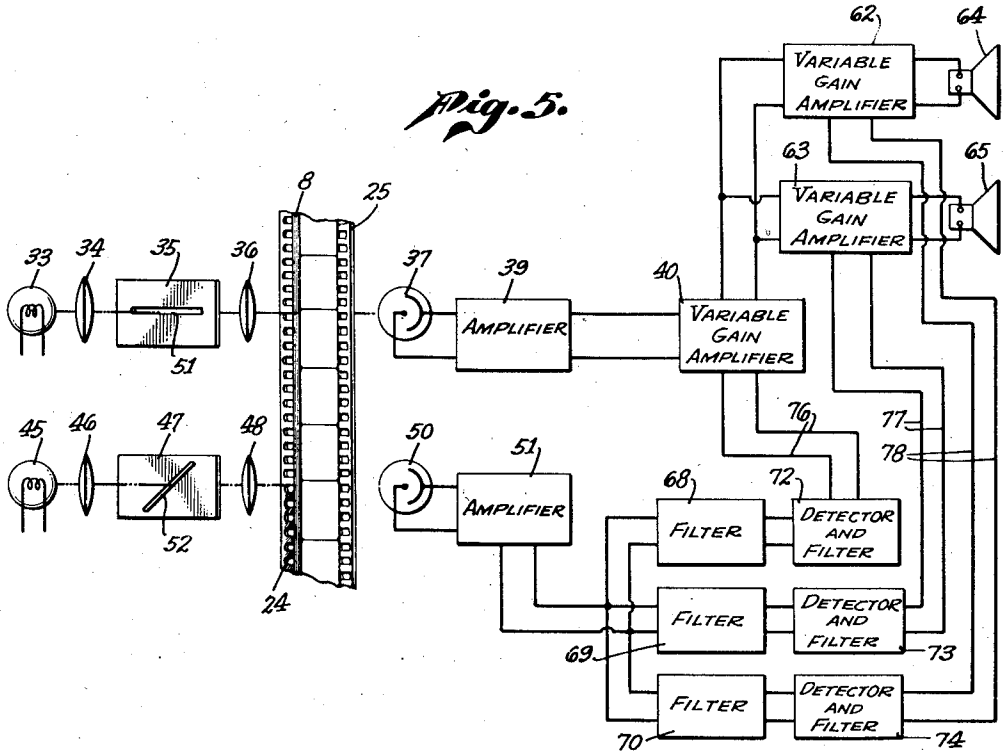


Fig. 5.



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2,322,435

MOTION PICTURE SOUND RECORDING AND REPRODUCING SYSTEM

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Application August 2, 1941, Serial No. 405,239

15 Claims. (Cl. 179—100.3)

This invention relates to sound recording and particularly to a method of and means for utilizing a film area having regularly occurring discontinuities, such as sprocket holes, for a sound or other signal track.

The areas of a motion picture film lying between the sprocket holes longitudinally of the film has been heretofore used for the recording of modulated tracks for various purposes. For instance, in U. S. Patent 1,921,494, dated August 8, 1933, to Wildhaber, there is shown a track in this area or areas for controlling the speed of a motor, while U. S. Patent 2,199,599, dated May 7, 1940, to Dawson, discloses a signal amplitude control track in this area. Copending application Serial No. 181,634, filed December 24, 1937, shows a type of control track system similar to Dawson's.

In each of these disclosures, however, the discontinuity of the sound track caused by the sprocket holes has been taken into consideration. For instance, in Patent 1,921,494 only the intermittent or absolute value of the light passing the photoelectric cell during the stationary periods of the film is utilized to operate a solenoid in a mechanical control system. This is perhaps the simplest form of utilization of the sprocket hole areas since the amount of light passing to the cell during the stopping time of the film controls the armature of the solenoid. It is obvious that such a system will not produce a smoothly varying control current.

In Patent 2,199,599 and the above-mentioned copending application the sprocket holes have been utilized to produce a carrier frequency which is modulated by the varying opaqueness of the areas between the sprocket holes, it being necessary, of course, to pass the modulated carrier through a detector or rectifier before impression upon an amplitude control element such as a variable gain amplifier in the signal current transmission channel. Such a system requires smoothing filters after detection or rectification, as is well known in the art. Furthermore, Patent 2,199,599 has emphasized the necessity of a filter network between the pickup photoelectric cell and the detector for reducing the wave to an approximately sinusoidal form. Similarly, in the above-mentioned copending application the modulated carrier current is modified by the use of either selective circuits or a transformer tuned to the sprocket hole frequency, the selective circuits and transformer being connected between the photoelectric cell and a detector or preamplifier. Furthermore, such systems are limited in the rapidity of their control action to less than 96 cycles per second, the sprocket hole frequency.

The present invention, however, utilizes this sprocket hole region of the film but with the regular sound recording and reproducing elements without the additional filters, networks, detectors or rectifiers mentioned above. In other words, this sprocket hole area may be recorded upon and reproduced in exactly the same manner as any solid or uniform sound track area not having discontinuities. Thus, a signal or control current as exactly recorded can be reproduced with a simple amplifying system without the above-mentioned additional elements.

This is accomplished by rotating the recording and reproducing slits at an angle which at all times impresses light on the same amount of recordable film area during recording, and upon the same amount of recorded film area during reproduction. That is, the invention may be used for film having other types of regular discontinuities such as a series of opaque areas, as well as sprocket holes, it being necessary in every case that the slit see the same amount of recordable or recorded film at any instant. Thus, in the standard type of 35 mm. sound film, the slit will be positioned at an angle of approximately 60° to its normal position or 30° to the direction of movement of the film, since the distance between similar points on the sprocket hole area longitudinally of the film is in the neighborhood of .187 inch, and the width of the sprocket hole is .110 inch, the tangent of this angle thereby being substantially 59.5°. When the sprocket hole area is narrowed by opaquing a strip of film on each side of the sprocket holes to eliminate the rounded corners, this angle, of course, will vary accordingly.

It is realized that slit rotations for other purposes are well known. For example, copending application Serial No. 330,813, filed April 22, 1940, to A. C. Blaney, discloses and claims a rotated slit system for reproducing Class B sound tracks, while Patents 1,917,653 and 1,928,953 show rotated slits for recording normal sound track areas and claim certain advantages therefor. None of these disclosures, however, discloses the utilization of the sprocket hole region of the film as evidenced by the slit angles suggested therein.

The principal object of the invention, therefore, is to facilitate the recording of signals on motion picture film.

Another object of the invention is to increase the utilization of a motion picture film for signal recording.

A further object of the invention is to utilize for signal recording a film region having a series of nonrecordable areas therein.

A further object of the invention is to utilize the areas between the sprocket holes of motion picture film without the use of any additional apparatus other than that required for normal sound recording and reproduction.

A further object of the invention is to utilize the areas between the sprocket holes of motion picture film for one or more control records.

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 drawings forming a part thereof, in which

Fig. 1 shows a sound track of the variable density type recorded in the areas between the sprocket holes of a motion picture film;

Fig. 2 is a diagrammatic of a sound recording system for recording sound in the areas between the sprocket holes and also showing how the system may be utilized for control track recording;

Fig. 3 is a diagrammatic view of a recording system for a multiplicity of control signals;

Fig. 4 is a diagrammatic arrangement of a reproducing system for a signal record and also showing how the sprocket hole record may be used for controlling the signal record; and

Fig. 5 is a reproducing system for the recording system of Fig. 3.

Referring now to Fig. 1, this figure is a partial view of the sprocket hole and sound track regions of a sound and motion picture film 5 showing the sprocket holes 6 and the portions or lands 7 between the sprocket holes upon which a variable density control track has been recorded. The regular signal record is shown at 8. To illustrate the angle at which the recording and reproducing slits for the sprocket hole track are positioned, a normal width slit 10 has been shown superimposed upon the film 5. It will be realized that as the film 5 passes the slit 10, there will at all times be the same amount of recordable film area presented to the recording or reproducing light. Thus, the sprocket hole region will correspond to a solid film portion of a width proportional to the ratio of the film area between the sprocket holes to the sprocket hole area. Aside from this reduction, this portion of the film may be treated as any solid film portion, the sprocket holes being ignored as far as recording and reproduction are concerned.

To further illustrate, the slit shown at 10 extends across one hole and one land. When the film moves along to a point shown by the dotted slit 10', it will be observed that the same amounts of hole and land are across the slit but reversed in location along the slit. As the film is advanced in either recording or reproducing, this same ratio will be maintained. When the film reaches a position so the slit is midway between the position 10 and 10', the land portion will occupy the center portion of the slit and there will be equal amounts of hole at the opposite ends of the slit, which, when combined, equals the amount of hole area at opposite ends of the slit in positions 10 and 10'. Thus, the recordable film area shifts back and forth across the slit but is always of the same length or value regardless of its position along the slit. In reproduction, therefore, the light reaching the photocell is modulated by the same amount of film at any instant.

Referring now to Fig. 2, a normal recording system is illustrated wherein light from a lamp 12 is collected by a lens 13, projected through aperture 14 of a mask 15 past a penumbra shutter 16 and through a lens 17 to a mirror 18 of a galvanometer 19. The light is reflected from the mirror 18 through a lens 21 to a slit mask 22 having a slit 23 therein, from which it is projected upon the sprocket hole area 24 of a film 25. The penumbra shutter 16 forms a graduated light beam 27 on the slit mask 22, as is well known in the art. For normal sound recording, the galvanometer mirror 18 may be vibrated by a signal picked up by a microphone 28 and impressed on the galvanometer 19 through an amplifier 29. Such a recording system will provide a variable density sound track as shown in Fig. 1 when the slit 14, galvanometer mirror 18, and slit 23 are tilted to an angle of approximately 30° to the direction of motion of the film 25. Recording in accordance with the invention may also be accomplished by leaving the optical recording element in their regular position for normal sound recording and rotating the direction of film motion substantially 60°. Furthermore, other types of light modulators and variable density recording systems may be used, such as light valves, glow tubes and the like.

If it is desired to record on this sprocket hole area a comparatively low frequency control track for various purposes such as the amplitude control of a signal record, it is only necessary to connect the galvanometer 19 to a source of potential 30 which may be varied in its impression on the galvanometer by a rheostat 31 as shown by the dotted lines. The potential may be manually varied or automatically varied in accordance with the type of system employed. An oscillator whose frequency is varied in accordance with the amount of control desired may also be used.

Referring now to Fig. 4, there is shown a reproducing system for the simultaneous reproduction of the regular sound track and the sound track in the sprocket hole area. This system utilizes a lamp 33, a lens 34, a slit mask 35, and a lens 36 which projects a narrow beam of light transversely through the sound track area to a photoelectric cell 37 in a manner well known in the art. The cell output is amplified by a standard amplifier 39 and may or may not be impressed upon a variable gain amplifier 40 before impression on a loudspeaker 42. This is the normal sound reproducing system well known in the art wherein the variable gain amplifier 40 may be varied in amplification to control the output amplitude of the sound at 42.

For reproducing the signal track in the sprocket hole area, a similar optical system including a lamp 45, a lens 46, a slit mask 47, and a lens 48 is utilized to project light through the sprocket hole region to a photocell 50. It is to be noted, however, that wherein the slit 51 scanning the regular sound track area is positioned transversely of the film, the slit 52 scanning the sprocket hole region is at an angle, as described in Fig. 1, which is the same as the angle of the slit 23 in Fig. 2. The output of the cell 50 is impressed upon an amplifier 51' and then to a loudspeaker 52'. It is realized that a variable gain amplifier may also be positioned in this channel as in the first-described reproducing channel for controlling the amplitude of reproduction. Thus, the sprocket hole area reproducing system may

be the exact duplicate of the regular signal channel portion of the system except for the angle of the slit 52. If the sprocket hole film region has been recorded as a control record for the amplitude of the regular sound track signal by manipulation of the rheostat 31 in Fig. 2, it is only necessary to connect the output of the amplifier 51' to the variable gain amplifier 40, as shown by the dotted lines 53.

As mentioned above, systems utilizing the sprocket holes to produce a carrier current for the control record are limited to control current variations below the frequency of the carrier current and also limited to the number of control currents which may be recorded and reproduced. The present system is not so limited.

In Fig. 3, a multiple signal film recording system is illustrated wherein the same recording optical elements of Fig. 2 are shown. Since the sprocket hole area now operates in the same manner as the solid film area, any type of track may be recorded on this portion of the film. Thus, it is possible to record a plurality of carrier frequencies on this area, each carrier being individually modulated for controlling a plurality of functions or characteristics of a signal. This is accomplished by the use of carrier frequency oscillators shown at 55, 56 and 57, each of which has a different frequency. The output of each oscillator may be modulated as diagrammatically shown at 58, 59 and 60, respectively. The modulation may be either by amplitude or frequency, as illustrated by the variable resistances (amplitude modulation) and variable condensers (frequency modulations), the output of each modulator being impressed upon the galvanometer 19, the track thus recorded containing each modulated carrier frequency.

Referring now to Fig. 5 in which the reproducing system for the recorder of Fig. 3 is illustrated, the same optical systems as shown in Fig. 4 may be employed for scanning the signal and control tracks. The signal reproducing system is composed of the photoelectric cell 37, the standard amplifier 39 and the variable gain amplifier 40, the output of which is now divided and impressed upon two variable gain amplifiers 62 and 63 for impression upon respective loudspeakers 64 and 65. Although this type of signal system is illustrated, it is to be understood that other combinations of controls for the signal output may be employed such as one wherein the control signals simply operate relays for connecting one or more speakers to the output of the variable gain amplifier 40.

Referring now to the control track system, the output of the amplifier 51' is impressed upon a plurality of filters 68, 69 and 70 which are bandpass filters tuned to their respective oscillator frequencies and of a band width sufficient to take care of the modulation side bands. The output of each filter is impressed upon its respective detector and filter units 72, 73 and 74, these units including the required smoothing filters well known in the art. The combination control system illustrated in Fig. 5 utilizes the output of detector 72 for controlling the gain of variable gain amplifier 40 over conductors 76, this control current simultaneously varying the gain in both loudspeakers 64 and 65. The output of detector filter unit 73 is impressed upon a variable gain amplifier 63 over conductors 77 and individually controls the amplitude of loudspeaker 65. The output of detector and filter unit 74 is impressed over conductors 78 upon the variable gain amplifier 62 for individually controlling the amplitude of the signal current reproduced at loudspeaker 64. This reproducing system therefore provides a multiple system of control wherein the loudspeaker 64 may represent the center speaker or speakers in a theatre, and the loudspeaker 65 may represent the speakers located at the sides of the stage or along the sides of the listening area to enhance the reproduced sound. By manipulation of the modulator unit 58, the volume of all speakers may be raised or lowered, while manipulation of modulator 59 may control the center speaker, and manipulation of the modulator 60 may control the side speakers separately from the center speaker.

The above-described recording method and system thus permits not only the recording of normal signals in the areas between the sprocket holes of a motion picture film, but permits these areas to be used to record control signals without the use of filter networks. It is realized, however, that in case of mutilated film, random 96-cycle impulses may be generated and although this would be immaterial in a carrier frequency control track system as shown in Fig. 5, it might be desirable to insert a 96-cycle elimination filter in an amplitude modulated system such as shown in Fig. 2, although it is not necessary as the amplitude of these impulses would be comparatively low whenever they occur. With frequency modulation of the control current mutilated sprocket holes will cause no deleterious effects.

It will be observed that a variable density track has been illustrated in the above system, but variable area tracks may also be recorded and reproduced with the slit tilted at the same angle, it being desirable in this event to increase the slit width so as to have its dimension longitudinally of the film comparable to the sprocket hole height and the modulating shutters operating transversely of the slit.

What I claim as my invention is:

1. A sound recording system for recording a signal on a film having a series of discontinuities interposed along a recordable film area comprising means for producing a light beam, means for modulating said beam with a signal to be recorded, and means for impressing the same amount of recordable film area with light regardless of the position of said discontinuities with respect to said light beam.

2. A sound recording system in accordance with claim 1 in which said last-mentioned means includes a slit mask having a slit therein positioned at such an angle with respect to the direction of motion of said film past said slit that the same amount of said recordable film area is being light-impressed at any instant.

3. The method of sound recording on a film area having a series of discontinuities distributed along a recordable film area comprising modulating a light beam and impressing the same amount of recordable film area with said light beam.

4. The method of recording a continuous signal record on a series of recordable film areas separated by non-recordable areas comprising modulating a light beam in accordance with the signal to be recorded and light-impressing the same amount of said recordable areas at all times by said light beam.

5. The method of utilizing the areas of a film lying between the sprocket holes for the recording of a signal comprising forming light into a narrow beam, modulating said beam with said signal and impressing said beam on said areas be-

tween said sprocket holes at an angle to the direction of motion of said areas so that said beam is impressed on the same amount of said sprocket holes and said areas between said sprocket holes at each instant of recording.

6. A film sprocket hole region recording system comprising a source of light, means for forming said light into a beam, means for modulating said beam, and means for impressing said beam on said film at an angle to the direction of motion of the film, said beam always striking the same amount of film during recording.

7. A film sprocket hole area recording system in accordance with claim 6 in which said beam angle is approximately 30° to the direction of motion of standard 35 mm. motion picture film.

8. A sound reproducing system for reproducing a signal recorded on the film areas interposed between the sprocket holes comprising a source of light, means for forming said light into a beam, means for translating said light into electrical currents, means connected to said translating means for amplifying said currents, means connected to said amplifying means for translating said currents into sound waves, and means for interposing the same amount of film area between said light beam and said light-to-current translator during passage of said film through said system.

9. A sound reproducing system in accordance with claim 8 in which said last means includes optical means for impressing said light beam at an angle of substantially 30° to the direction of movement of said film.

10. The method of reproducing a signal recorded in the areas between the sprocket holes of a motion picture film comprising forming light into an elongated beam and impressing said light beam at an angle to the direction of motion of said film so that said beam impresses the same amount of film area during passage of said film past said beam.

11. The method of utilizing a film area having a plurality of discontinuities distributed along a recordable film area comprising continuously light-impressing constant amounts of said film area and said discontinuities at any instant during said light impression.

12. A multiple signal recording system for recording in the sprocket hole area of a film comprising a plurality of sources of signals of different frequencies, means for individually modulating the signals from each of said sources, means for simultaneously varying a light beam in accordance with said signals, and means for impressing said beam on the sprocket hole areas of said film so that said beam impresses a constant amount of recordable film area.

13. A multiple signal recording system in accordance with claim 12 in which said film has recorded thereon a sound track, said signals being adapted to control the reproduced sound from said sound track.

14. A system for translating signal records of different frequencies recorded in the sprocket hole area of a film into electrical currents comprising means for scanning said sprocket hole area with a beam of light, means for translating said light into electrical currents, means for dividing said multiple signals into separate electrical circuits in accordance with the frequencies of said signals, and means for interposing the same amount of film area between said light beam and said translation means during passage of said film past said light beam.

15. A system in accordance with claim 14, in which means are provided for reproducing a sound track on said film simultaneously with the translation of said signal records into electrical currents, and further means are provided for controlling the reproduction of said sound track by said electrical currents.

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