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METHOD AND APPARATUS FOR RECORDING AND REPRODUCING SOUND WAVES

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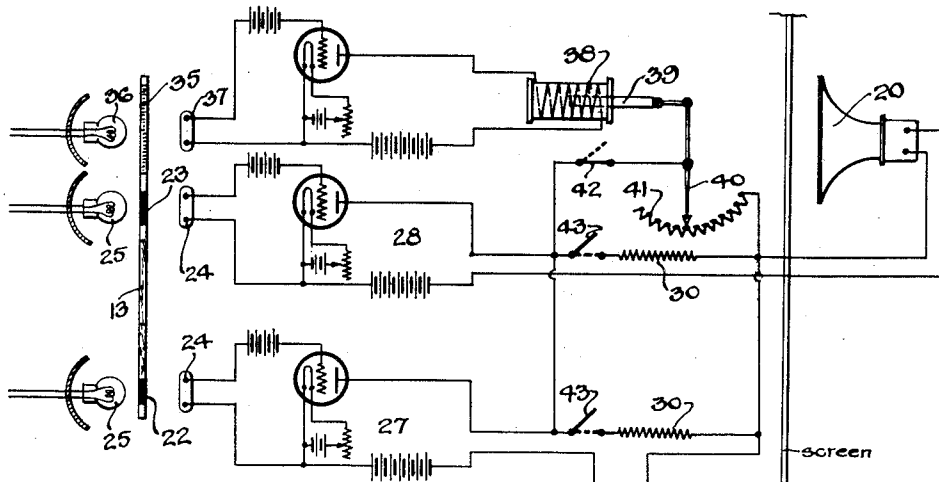


Fig. 3.

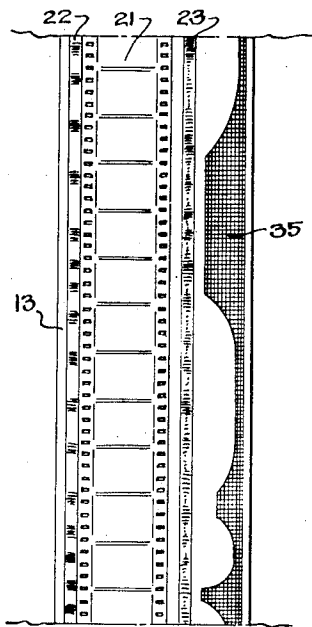


Fig. 2.

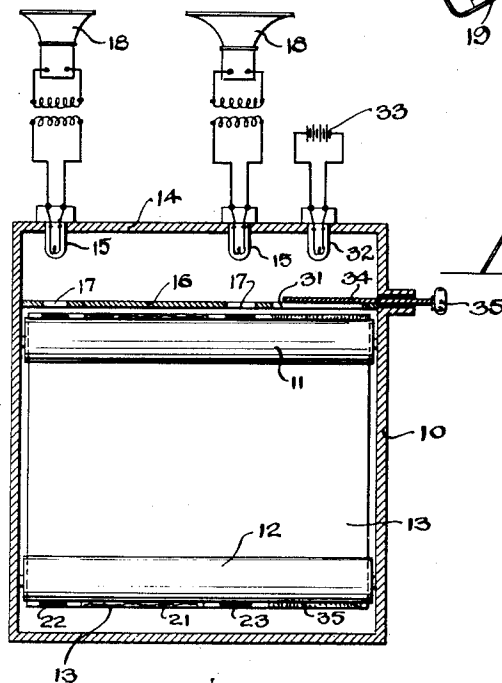


Fig. 1.

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METHOD AND APPARATUS FOR RECORDING AND REPRODUCING SOUND WAVES

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This invention relates generally to improvements in the art of recording and reproducing sounds and more particularly to an apparatus for and method of improving the character of reproduction of sounds which have been photographically recorded upon a photographic film.

In the production of "talking pictures", this being the commonly accepted term used where picture and sound records are recorded simultaneously upon a photographic film or the like, many serious difficulties have been encountered in the various attempts to faithfully record and reproduce the sound impressions, one of the chief difficulties being that it has not been possible heretofore to reproduce the photographically recorded sounds in such manner that the reproduction was in accord with the sounds as originally produced so far as the expressive emphasis and dynamic shading of the latter were concerned. This difficulty has been present, of course, irrespective of whether or not the photographic sound record was produced simultaneously with the picture and accordingly it will be understood that the present invention is particularly concerned with the photographically produced sound record as distinguished from the picture record. It is well known that the character of any musical, vocal or similar rendition depends largely upon proper accentuation of the various passages, certain of which must be played or sung in crescendo and others in diminuendo or decrescendo.

That department of musical science which relates to, or treats of, the variation and contrast of loudness or power in tones and in the expressive emphasis and dynamic shading of the various passages is known as the dynamics of music and it is one of the primary objects of this invention to take into consideration this field of dynamics in the recording and reproduction of photographically recorded sounds such that the musical or vocal selections when reproduced will be properly accentuated.

In furtherance of this primary object the present invention contemplates the provision of an apparatus for photographically pro-

ducing upon the sound record film an auxiliary record which I have termed the "dynamic" record, the purpose of which is to impart automatically to the reproduced sounds the necessary variations and contrasts of loudness or power. Although this variation and contrast in power is originally put into the music during the recording process, much of it, if not all, is lost in the usual sound record with the result that when the music is reproduced from the record the various passages thereof are minus all expressive emphasis and dynamic shading. It is to supply the reproduced music with the character and expression which has been lost in the sound record that the "dynamic" record is employed.

A still further object of the invention is the provision of a photographically produced sound record, irrespective of and apart from its applicability for talking pictures, including as an auxiliary part thereof a "dynamic" or sound shading record.

A still further object of the invention is the provision of an apparatus for and method of utilizing this "dynamic" record for affording the various passages in the reproduced selection with that expressive emphasis and dynamic shading following closely the particular emphasis and shading which the composition originally called for. In this connection it will be understood, of course, that the "dynamic" record and the sound record are operated in synchronism, suitable means being employed for effecting the necessary inter-relation between the records for the purposes specified.

While in the recording process the sound shading record is obtained by manual control of a suitable shutter operated in accordance with and by one familiar with the score of the composition, in the reproducing process this same record is employed to automatically impress upon any particular tone or passage that emphasis and shading which the score originally called for.

A still further object of the invention is the provision of an arrangement for reproducing the beat of a drum the sounds from which were originally recorded upon a pho-

tographic film, this film record being in turn employed to establish electrical variations corresponding to the original sound variations as produced by the recording drum for mechanically operating a separate drum during the reproducing process. This arrangement differs from the usual in that in the present reproduction of the drum record a regular drum is employed for operation in the natural manner (that is, it is arranged to be struck by a drum stick); while in the usual photographic sound record reproduction the electrical variations are converted into sound variations by loud-speakers or other such sound reproducing apparatus. Experience has shown that these loud-speakers have been incapable of faithfully reproducing drum sounds with the result that those passages in a musical composition in which a drum is called for have been lacking in character in the reproduction. The present arrangement obviates this difficulty by employing a regular drum arranged to be struck in the natural manner by a drum stick, the photographic film record of the original drum sounds being utilized for effecting the mechanical operation of the drum stick.

Other objects and objects relating to details of construction and operation will appear more fully hereinafter.

The invention consists substantially in the combination, location, construction and relative arrangement of parts, as well as in the method of using the same, as will appear more fully hereinafter, as shown in the accompanying drawings, and as finally pointed out in the appended claims. In the accompanying drawings, it being understood that said drawings are merely illustrative of the invention and that the latter may be varied without departing from the spirit or principles thereof:

Figure 1 is a more or less diagrammatic view showing a form of recording apparatus for producing the sound record and the corresponding sound shading record in accordance with the principles of this invention;

Figure 2 is a fragmentary view of a record produced by the apparatus shown in Figure 1; and

Figure 3 is a diagrammatic view illustrating an arrangement for reproducing the sound record shown in Figure 2 in accordance with the principles of this invention.

Referring to the drawings and more particularly to Figure 1 which shows an apparatus for photographically recording motion pictures and sound effects upon a film, it will be seen that this apparatus comprises a main casing or box 10 having the rollers 11 and 12 over which the film 13 is arranged to travel. A suitable lens (not shown) may be arranged at the front end of the box for taking the desired pictures, while mounted upon the rear wall 14 of the box are a plurality of record-

ing lamps 15 for throwing light rays of varying intensities upon the film, these recording lamps being energized by electrical variations produced through the use of microphones in the manner well known in the art. Extending transversely across the box and positioned between the recording lamps 15 and the film 11 is a quartz or similar opaque plate 16 provided therein with a plurality of small slits or openings 17 corresponding in number to the recording lamps 15. In the particular instance, two lamps 15 and a corresponding number of openings 17 are employed, each lamp being positioned directly behind its respective opening such that the fluctuating light rays emanating from the lamps will produce individual records upon the film of the sounds influencing the respective lamps. Preferably, the openings 17 are arranged to either side of the space normally occupied by the picture so that the individual sound records will be produced with the light picture therebetween, but it will be understood that the particular arrangement of sound and picture records upon the film is immaterial and may be varied as desired. By properly proportioning the openings 16 the width and length of the beams of light that are directed on the film by the several recording lamps may be rigidly held to the proper limits.

It will further be seen that the provision of a number of recording lamps arranged to be individually energized makes it possible to produce upon a common film a corresponding number of sound records, each of which records is produced by the action of different sound waves upon a number of microphones 18. In this connection it may be that the subject positioned in front of the recording apparatus is a group of artists playing a number of instruments in ensemble, among them one or more drums. Were all of the sounds produced by these instruments to be collected for subsequent translation into electrical variations through the use of a single microphone, the record as produced upon the film would not be true and faithful to the sounds as originally produced by the various instruments, this for the reason that the single microphone is not well adapted to take with equal efficiency a number of different sounds of different tonal values. Conversely, the same holds true in the simultaneous reproduction of these various instruments.

The drum is an instrument which requires particularly careful treatment both in the recording and reproducing processes, experience having shown that unless careful attention be given to this instrument its sound will be lost in the reproduction. It is for this reason that the recording apparatus is provided with a number of recording lamps 15 for producing upon a single photographic film a corresponding number of sound rec-

ords, one of these records being of the sounds produced by a drum. In the production of this drum record a microphone is used which is best suited for the purpose, while in the reproduction thereof, instead of using a loud speaker, a drum 19 is employed (see Figure 3). For reproducing the music produced by instruments other than a drum, a loud speaker 20 may be employed, it being understood, of course, that as many loud speakers are employed as there are individual sound records (exclusive of the drum record) upon the film.

Figure 2 shows one form of record as produced by the arrangement hereinbefore described, this record comprising a single strip of photographic film upon which have been simultaneously recorded the motion pictures 21 and the sound records 22 and 23, the record 22 being of the drum while the record 23 may be of another instrument or group of instruments. If desired, a number of records similar to 23 may be had upon the same film depending entirely upon the number of microphones and recording lamps employed.

Referring to Figure 1, it will be seen that the multiple sound record hereinbefore described is reproduced by means of photo-electric cells 24 which are influenced by the several sound records 22 and 23 passing their respective light sources 25. A separate cell is employed for each record, each cell being operative to convert the light variations into electrical variations. It will be observed that the photo-electric cell 24 corresponding to the drum record 22 is connected to a solenoid 26 through an amplifying circuit 27, while the other cell 24 corresponding to the record 23 is connected to the loud speaker 20 through a separate amplifying circuit 28. As the sound wave impressions of the drum record 22 influence its respective photo-electric cell the solenoid 26 is correspondingly energized with the result that the striker arm or drum stick 29 is caused to beat the drum 19. At the same time, the other sound record 23 influences its respective photo-electric cell, with the result that the loud speaker 20 is operated to reproduce the sounds of the record 23. It will be observed that each of the circuits 27 and 28 include a suitable amount of resistance 30 for limiting the amplified current to a predetermined value.

That portion of the invention which is concerned with the dynamics of sound reproduction will now be considered. As has already been stated, one of the main difficulties encountered in the art to which this invention appertains has been to reproduce the photographically recorded sounds in such manner that the reproduction was in accord with the sounds as originally produced so far as the expressive emphasis and dynamic shading of the latter were concerned. Inasmuch as the character of any musical, vocal or similar rendition depends largely upon proper ac-

centuation of the various passages, certain of which should be played or sung in crescendo and others in diminuendo, it is essential to give careful consideration to that department of musical science which relates to, or treats of, the variation and contrast of loudness or power in tones. In furtherance of this, the present invention contemplates the provision of apparatus for photographically producing upon the sound record film an auxiliary sound shading record, described hereinafter and defined in the claims as the "dynamic" record, the purpose of which is to supply the reproduced music with its intended character and expression. Although this variation and contrast in power is originally put into the music during the recording process, much of it, if not all, is lost in the sound record with the result that when the music is reproduced therefrom the various passages are minus all expressive emphasis and dynamic shading.

Referring again to Figure 1, it will be observed that the transversely extending opaque plate 16 is provided to one side thereof with a relatively wide opening 31 (that is, as compared with the opening 17), the vertical dimension of which is the same as that of the openings 17. Mounted in the rear wall of the casing 10 and in registry with the opening 31 is a lamp 32 energized from a constant source of supply 33. A shutter 34 which is preferably arranged to slide through the side wall of the casing 10 operates to cover the opening 31 to greater or lesser extent, the exteriorly projecting portion of the shutter being provided with a suitable handle or knob 35' for manual operation thereof. The amount of light rays emanating from the lamp 32 which are directed through the opening 31 and upon the film 13 is governed entirely by the extent to which the shutter 34 covers said opening, it being observed that when the shutter is moved all the way in the opening 31 will be entirely covered and no portion of the film will be exposed to the lamp 32. On the other hand, when the shutter 34 is pulled all the way out the opening 31 will be entirely uncovered with the result that a portion of the film 13 corresponding in transverse width to that of opening 31 will be exposed to the lamp 32. Intermediate positions of the shutter will result in more or less of the film being exposed to the lamp 32, but in no case will any other portion of the film be exposed to this lamp than that which passes by the opening 31.

As the film 13 passes through the casing 10, the several transverse regions thereof are exposed to the lamps 17 and 32 to produce the sound records 22 and 23 and the "dynamic" or sound shading record 35 (see Figure 2). This dynamic record is produced upon the film 13 simultaneously with the sound records by means of the shutter 34, said

shutter being operated to expose more or less of the film to the lamp 32 by an operator who is familiar with the score of the particular composition being recorded.

Inasmuch as the records are originally formed upon a master film from which the actual sound reproducing films are in turn produced, it will be understood that in the master film the dark areas or markings in both the sound records and in the dynamic record are produced by the more intense light and correspond to the louder sounds while the lighter areas or markings, which are produced by less intense light, correspond to the weaker sounds. Conversely, in the reproducing films the darker areas or markings produce the weaker sounds while the lighter areas or markings produce the stronger or louder sounds. Accordingly, when it is desired to give particular emphasis to any passage of the composition being recorded, the operator will, by moving the shutter 34, uncover to the necessary extent the opening 31, or when a passage is to be subdued in power or loudness the shutter is moved into a position which leaves a smaller portion of the opening uncovered. This movement of the shutter back and forth to intercept more or less of the light rays emanating from the lamp 32 is continued throughout the entire recording process with the result that a dynamic record 35 is obtained upon the film.

Referring now to Figure 3, which illustrates diagrammatically an arrangement for reproducing the sound records 22 and 23 and for imparting thereto the shading in tones which the composition originally called for, it will be seen that in addition to the light sources 25 for influencing the photo-electric cells 24, there is employed an auxiliary light source 36 by means of which a corresponding photo-electric cell 37 is influenced by the dynamic record 35 passing said light source 36. The light variations produced as the record 35 passes its light source influence the cell 37 and the latter in turn converts these light variations into corresponding electrical variations for operating a solenoid 38. Connected to the armature 39 of the solenoid is a rheostat arm 40 which is arranged to cut-in or cut-out portions of the resistance 41 depending upon the extent of energization of the solenoid.

As appears clearly in Figure 1, the variable resistance 41 is connected in parallel with the resistances 30 of the circuits 27 and 28. Suitable switches 42 and 43 are employed for respectively connecting the resistance 41 in series in each of the circuits 27 and 28 simultaneously as the resistances 30 are disconnected therefrom, this being the procedure when "sound shading" is desired. When, however, the dynamic record is not to be used the switch 42 is opened and the

switches 43 are closed. It will be seen that with the circuit arranged as in Figure 1, the photo-electric cell 37 will be subjected to more or less light from the lamp 36 depending upon the degree of shading in the dynamic record 35. Where a passage requires that the music be played with force and emphasis, the portion of the dynamic record 35 corresponding to this passage will permit a greater intensity of light from the lamp 36 to influence the cell 37 with the result that the solenoid 38 will be energized to a corresponding degree. Consequently, the solenoid armature 39 will actuate the rheostat arm 40 in such manner as to decrease the resistance 41 and thereby permit a greater flow of current in each of the circuits 27 and 28. Conversely, where less emphasis is desired in any particular passage the dynamic record will cause the photo-electric cell 37 to be less influenced by the light from the lamp 36 with the final result that the resistance 41 will be increased and thereby decrease the flow of current in the circuits 27 and 28. It follows that any degree of shading may be given to the reproduced tones and that the character and expressive emphasis of the reproduced composition as a whole is governed entirely by the dynamic record 35 without the attention of an operator.

It will be understood, of course, that various changes may be made from time to time in the invention described herein without departing from the spirit or principles thereof and accordingly it is intended to claim the same broadly as well as specifically as indicated in the appended claims.

What is claimed as new and useful is:

1. In an apparatus for photographically recording sounds, in combination, means for converting sound waves into corresponding electrical variations, means for recording said electrical variations upon a photographic film, and means operable manually to photographically produce simultaneously as said sound waves are recorded upon the film, an auxiliary sound shading record upon the same film or upon another film operable in synchronism with the sound record film.

2. In an apparatus for photographically recording sounds, in combination, means for converting the sounds into corresponding electrical variations, means for recording said electrical variations upon a photographic film, and manually operated means operable independently of said first mentioned means to photographically produce upon a photographic film, simultaneously as said sound waves are recorded an auxiliary sound shading record which is in accord with the dynamic shading of the sounds as originally produced.

3. In an apparatus for photographically recording sounds, in combination, means for photographically recording upon a film the

sounds as originally produced, and means operable manually to photographically produce upon the photographic film, simultaneously as said sounds are recorded thereon, a record of the dynamic shading of the sounds as originally produced.

4. In an apparatus for photographically producing sounds, in combination, a microphone circuit including a lamp the intensity of which varies in accordance with the sound variations whereby to produce upon the film a record of the sound variations, means for photographically influencing the film independently of said sound recording lamp to produce a sound shading record thereon, and means operable manually for varying the intensity to which the film is influenced by said last mentioned means.

5. In an apparatus for photographically recording sounds, in combination, manually operated means for photographically producing upon the sound record film or upon a separate film operating in synchronism therewith a sound shading or dynamic record corresponding to the variations in power or loudness of the sounds as originally produced, said latter record being entirely independent of the sound record.

6. In an apparatus for photographically recording sounds, in combination, a light source, means influenced by the sound variations to vary the intensity of said light source whereby to photographically produce a record of said sound variations, a second and constant source of light, and manually operated means for intercepting to a greater or less extent the light rays emanating from said second source of light whereby to produce a photographic record corresponding to the variations in power or loudness of the sounds as originally produced.

7. In an apparatus for photographically recording sounds, in combination, a plurality of light sources arranged to independently influence separate portions of a photographic film or films, one of said light sources being operatively associated with a sound responsive device for producing light rays which vary in intensity in accordance with the variations of the sounds as originally produced and another of said light sources being operable to produce light rays of substantially constant intensity, and manually operated means for intercepting to greater or less extent the light rays of constant intensity to produce upon the film a sound shading or dynamic record corresponding to the variations in power or loudness of said originally produced sounds.

8. The method for producing a sound shading record upon a photographic film having a sound record thereon, said sound shading record being incapable of reproducing the recorded sounds which consists in subjecting a separate portion of the film to a constant

source of light and then manually varying the degree to which said portion of the film is subjected to said light by exposing more or less of the film in accordance with the variations in power or loudness of the sounds as originally produced.

9. The method for photographically producing a sound shading record, the latter being separate and distinct from the sound record itself, which consists in subjecting the film to a constant source of light and then manually varying the extent to which said film is subjected to said light by exposing more or less of the film to said light accordingly as the sounds are increased or diminished in power or loudness.

10. The method of photographically producing a dynamic record as distinguished from a sound record upon a film which consists in causing a certain portion of the film to traverse the light rays emanating from a constant source of light and in manually increasing or decreasing the exposed width of said portion of the film whereby to produce areas of exposure varying accordingly as the sounds are increased or diminished in power or loudness.

11. In an apparatus for photographically reproducing sounds, in combination, means for producing a photographic sound record, manually controlled means for photographically producing a sound shading record simultaneously as said sound record is produced, said records being synchronously operable to independently influence separate photo-electric cell circuits whereby to establish current variations in said circuits, means incorporated in that one of said circuits which is influenced by the sound record for reproducing the sounds recorded thereon, and means incorporated in the other of said circuits for automatically increasing or decreasing the power or loudness of the reproduced sounds in accordance with the current variations produced by said sound shading record.

12. In an apparatus for reproducing sounds, in combination, means for concurrently producing upon a film photographically recorded sound and sound shading records, said records being independent of each other and the latter being incapable of reproducing sounds in accordance with those as originally produced, a plurality of independent light sources arranged to one side of the film, a plurality of light responsive devices arranged to the opposite side of said film selectively responsive to the light rays emanating from said sources of light, each of said light responsive devices being included in a separate electrical circuit, means for individually passing said sound and sound shading records between said light sources and their respective light responsive devices whereby to set up in the several circuits electrical variations corresponding in intensity to the

light variations influencing the several light responsive devices, and means operable in accordance with the current variations set up by the sound shading record to vary the current variations set up by the sound record.

13. In an apparatus for reproducing sounds, in combination, means for producing a photographically recorded sound record, means for converting the recorded sound variations into corresponding electrical variations, means operable concurrently with said first-mentioned means for producing a photographically recorded sound shading record obtained independently of the recorded sounds, and means influenced by said sound shading record to change the value of the current variations established by said sound record.

14. In an apparatus for photographically reproducing sounds, in combination, means for concurrently producing a photographically recorded sound record and an independent photographically recorded sound shading record, means respectively influenced by said records for establishing separate circuits of varying current, means incorporated in the sound record circuit for reproducing the sounds recorded photographically, and means incorporated in the sound shading record circuit and operable to automatically vary the resistance of the other circuit whereby to produce sounds which vary in power or loudness.

15. The method of producing a sound shading record for governing the dynamic shading of reproduced sounds which consists in manually exposing more or less of a photographic film to a constant source of light simultaneously as the sounds to be reproduced are being recorded whereby to produce varying areas of exposed film surface, said varying areas being in correspondence with the variations in power or loudness of the sounds as originally produced.

In testimony whereof, I have hereunto affixed my signature.

BERNARD KWARTIN.

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