June 12, 1928.

1,673,217

J. L. WALKER

SOUND RECORDING AND REPRODUCING DEVICE

Filed Jan. 23, 1922

3 Sheets-Sheet 1

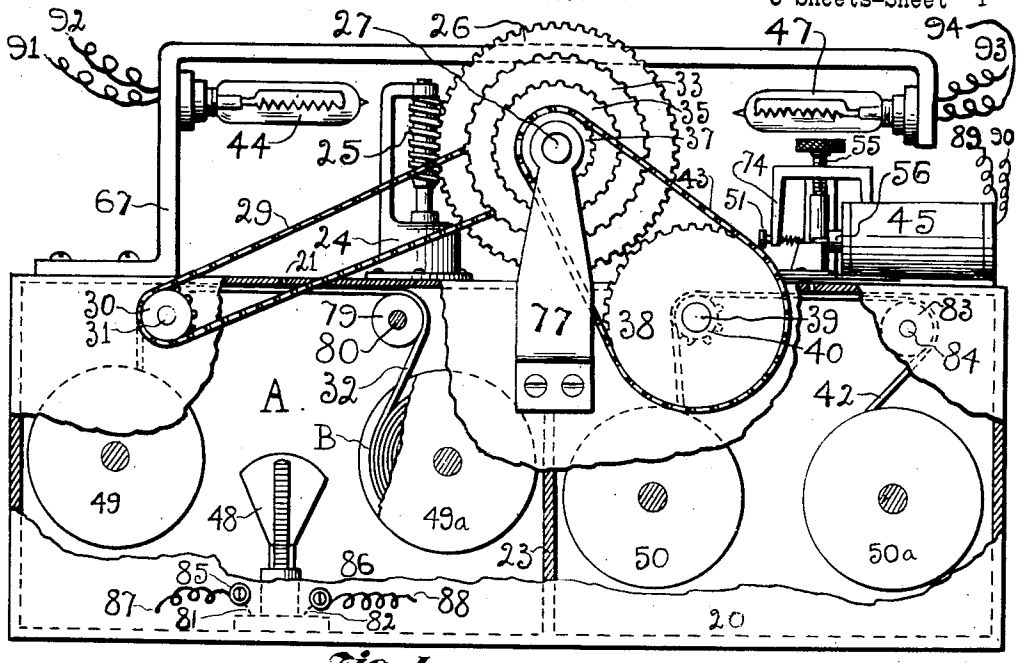


Fig. 1.

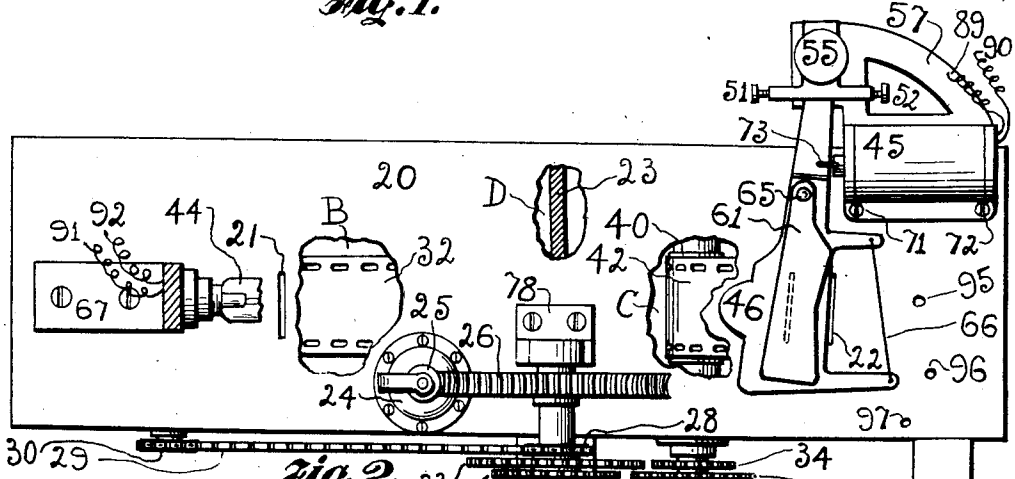


Fig. 2.

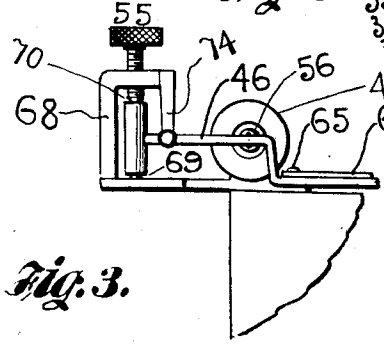


Fig. 3.

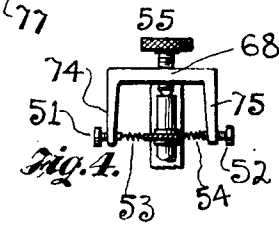


Fig. 4.

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June 12, 1928.

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SOUND RECORDING AND REPRODUCING DEVICE

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3 Sheets-Sheet 2

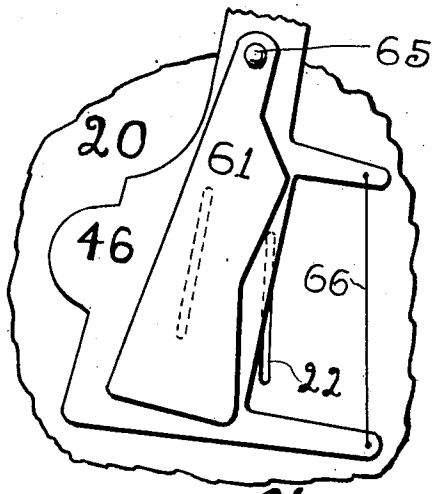


Fig. 5.

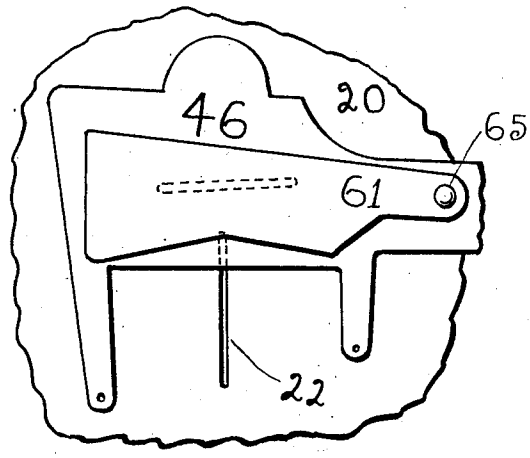


Fig. 7.

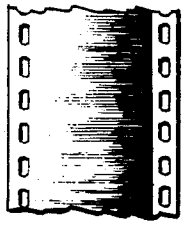


Fig. 6.

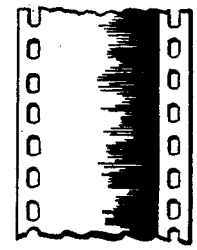


Fig. 8.

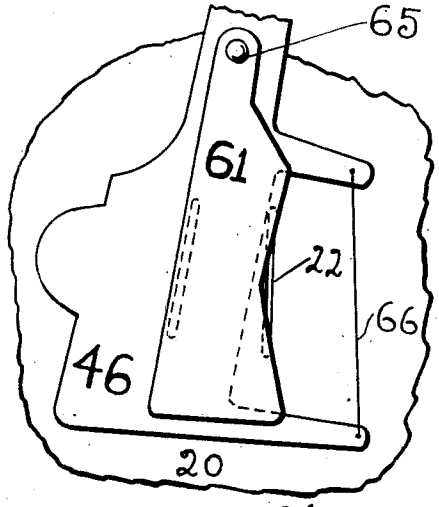


Fig. 9.

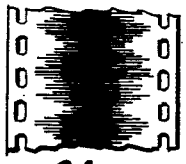


Fig. 10.

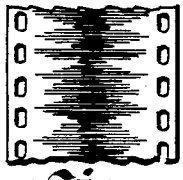


Fig. 11.

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SOUND RECORDING AND REPRODUCING DEVICE

Filed Jan. 23, 1922 3 Sheets-Sheet 3

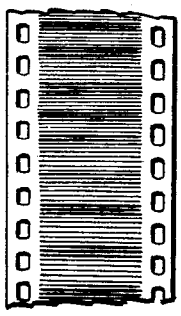


Fig. 12.

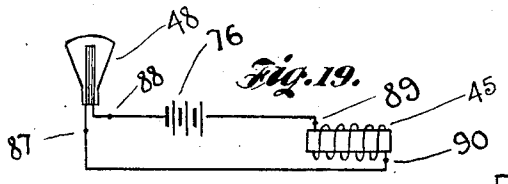


Fig. 19.

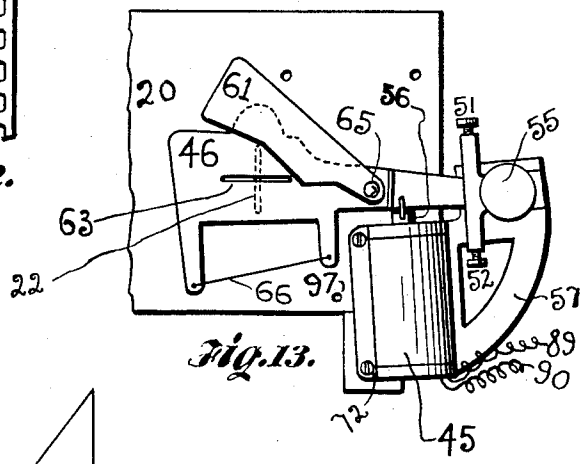


Fig. 13.

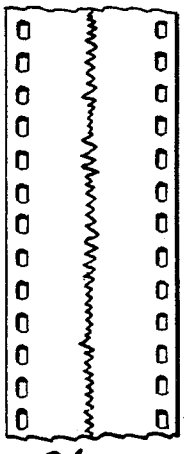


Fig. 14.

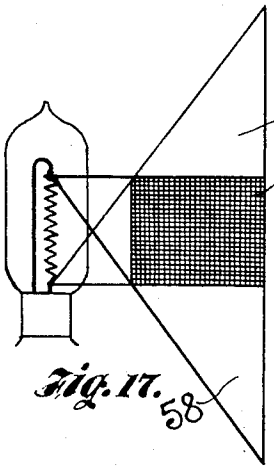


Fig. 17.

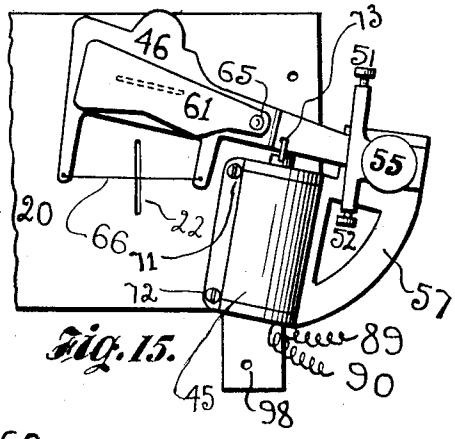


Fig. 15.

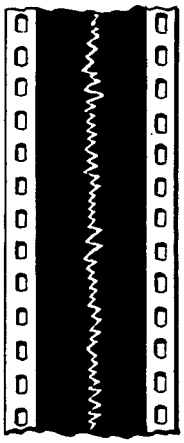


Fig. 16.

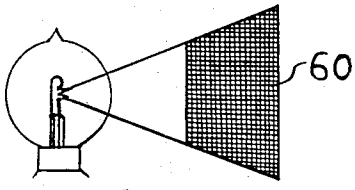


Fig. 18.

Inventor
Jack L. Walker

Patented June 12, 1928. 1,673,217

UNITED STATES PATENT OFFICE.

JACK L. WALKER, OF DALLAS, TEXAS.

SOUND RECORDING AND REPRODUCING DEVICE.

Application filed January 23, 1922. Serial No. 531,277.

This invention relates to new and useful improvements in recording and reproducing sound waves and other electrical vibrations.

The invention has to do with that class of recording and reproducing devices which involves the use of photography and electricity, and in which a record is transferred or transformed from another record and re-recorded upon a sensitized strip or film.

The object of the invention is to transfer or transform sound records from one film to another film or sensitized surface in an accurate manner. A further and important object is to amplify the record during the transferring or transforming process and to reduce to a minimum the tendency of the images photographed upon the film, to pile up or overlap. An advantage gained is that at comparatively high frequencies the variations of the sound or electrical vibrations will be recorded distinctly. Another object is to prevent distortion due to the grain of the emulsion upon the film, when enlarged or amplified. A further object is to prevent distortion due to mechanical and electrical inertia and momentum of moving parts. Another object is to produce a record that may be contained in a smaller space on the film and have all the volume or more than the original record from which it is transformed. A further object is to transfer the record from one film to another film at a speed slower than that at which the original sounds were recorded for allowing the use of different types of sources of illumination to be used to increase the quality of the record as well as the volume. A still further object of the invention is to make use of the most efficient type of recording means that is possible for securing the best possible record at the original recording of the sound waves regardless of its type or size, and transform it into a record which will be best suited for reproducing and take up a minimum space upon the film. A further object is to make use of a master film which contains all the volume and quality obtainable in a sound record and transfer or transform it into a record which might be desired for a certain type of reproducing machine and which it would be impossible to produce at the time of recording the original sounds. Thus we may make a record varying in width, varying in density, varying in width and density and varying in form in the exposed or the unexposed portions in accordance with the variations in opacity contained upon the original record. In this way records may be made for reproduction with an ordinary phonograph reproducer instead of the "photophone" method generally used with photographic records.

A still further object is to restrict the exposing aperture to the desired portion of the film that it is desired to expose and protect the remainder of the film so that the regular visual picture may be printed upon the same film and thereby insure synchronism. A still further object is to prevent damage to the sensitized film and record film due to heat waves, by using lamps of less intensity in the transferring device than were used in the recording device. An important advantage gained by the use of less intense illumination is that the light source may be very small or far removed from the recording shutter whereby an umbra with a negligible penumbra will be produced and the record improved, in the case of certain types of records.

A still further object is to change the speed relation between the developed film sound record and the sensitized film whereby the sensitized film when developed may be run at a different speed and synchronized with a picture film. Thus the original sound record might run at twice the speed of the finished record.

In carrying out the invention a beam of light is directed on a restricted opening thru which the developed film record is exposed to the rays of light, said developed film record stopping or controlling the light in accordance with its light varying qualities at the portion exposed at the said opening, the light after passage thru said film impinges upon a selenium cell or light-sensitive device capable of varying an electric current by a change in light rays impinging upon it. The selenium cell is acted upon by the variations in light rays controlled by the variations in the moving sound record film, moving past the aperture at a slow rate of speed. and causes the resistance of the said selenium cell to vary. The selenium cell is connected to battery and controls the amount of current passing thru a circuit which operates a shutter member capable of having its normal position changed to a degree depending upon the strength of the current passing thru said selenium cell. Thus movements of a shutter member may be produced, in strict accord-

ance with the variations in the sound record film, and at a slow speed. The armature of the solenoid which operates the shutter member is designed to amplify the movement of the free end of said shutter with a minimum amount of motion at the point of connection and it is also advantageous to use amplifying tubes or audions in the electrical circuit where greater amplification is desired. It is highly important that the movements of the shutter member be very slow in order to prevent over-travel of the said shutter when it should stop at a certain point and to prevent distortion due to mechanical and electrical inertia. It is pointed out in regard to this that an amplified shutter movement at high frequencies would be dampened by the inertia and in some cases the shutter might not respond to the finer or feebler vibrations recorded upon the original film and cause the common distortion noticeable in all phonograph records where a cutting point is used and the vibrations have to overcome the resistance of the wax record.

The developed film sound record has connected to its driving mechanism another mechanism for producing longitudinal travel of a sensitized film which is entirely inclosed in a light tight box which protects from light rays all portions of the sensitized film excepting a narrow portion underneath an exposing aperture. Means are provided for directing a source of light rays upon said sensitized film. The action of the light upon said sensitized film is controlled by intercepting part of the light rays by the before mentioned shutter member moving at a slow rate of speed and in accordance with the variations in the sound waves recorded upon the developed film sound record. Thus the shutter member is made to vary the light acting upon the sensitized film and amplify and transform without distortion the sound waves from one film to another film.

In carrying out the speed control of both films means are provided by sprocket wheels or gearing to allow a wide variation in the speed of the films relative to each other should it be desired to run the two films at different speeds but at the same speed ratio. It is important that the speed of the film used in recording the original sound record be such that no overlap may occur and may be twice as fast the speed of the picture taking film. In such cases the gearing in the transferring machine can be so set that the developed film sound record can be run at twice the speed of the sensitized film in order to reproduce the same rate of travel of both the sensitized film and the picture taking film made by the regular motion picture camera. It is pointed out that this machine is very flexible and due to the slowness of the speed of travel of the films it is well adapted to refining the transferred record to a finished product which can be used at different speeds as well as in different forms of records. As one example of the improved effect which is obtainable with this machine a record will be described in the process of making. We will say that the developed film record is in the form of a variable transparent line record and is contained in a space one inch trnsversely of said film record. This record is approximately nine hundred and ninety nine times stronger in its power to vary light rays than a variable width line record made by the same shutter at the time of recording when the shutter acts transversely across the film to vary the width of the line exposed through an aperture. Now if we use the variable transparent line record to control a shutter member as described and cause the movement of said shutter to be transversely of a sensitized film to vary the width of the line exposed upon said sensitized film we can cause the exposure of said sensitized film to vary in width with nine hundred and ninety nine times more amplitude than that which would be produced with the shutter acting direct at the time of recording the original sounds. Thus a record in the form of a variable width line may be produced which will occupy a minimum amount of space upon a film and leave more space for the addition of a picture upon said film and at the same time produce a record which will be as strong without amplification as the original variable transparent record.

In producing a variable width line record it is not absolutely necessary that the shutter itself have an amplified movement as great as the amplified change of exposure as it is possible, by setting the shutter member at the proper point, to cause a diagonal movement across the aperture by said shutter a great amount of closure of said aperture may be had with a small amount of movement of said shutter. While this machine is capable of transferring a variable transparent record into a variable width line record it is also very valuable in producing a variable transparent line record with amplification and refinment, by adjusting the shutter so as to move longitudinally of the sensitized film to vary the amount of light acting upon said sensitized film and prevent distortion due to enlarging the grain in the emulsion as is usually done in making enlargements photographically. It is also shown that the device is capable of producing what is known as an undulating line record and by using films with a sensitive emulsion many times thicker than the ordinary commercial films an undulating transparent line may be produced between two borders of light struck emulsion capable of guiding a reproducing point when developed and fixed in the usual way and suitable for

reproduction with an ordinary phonograph reproducer.

The shutter member is set or balanced by two contractile springs in opposition so as to cause the shutter to assume a certain position when at rest.

While the aperture in the drawings is shown full width between the sprocket holes to show that it is possible to use the full width of the film for containing the sound record where great amplification is desired, it is understood that the aperture may be limited to only that portion of the film which is to contain the sound record when it is desired to reserve space for the regular visual picture upon the same film.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown and wherein:

Fig. 1 is an elevation of an apparatus constructed for carrying out my invention.

Fig. 2 is a top view of my invention showing the two films thru a cutaway portion of the box, also showing the dividing partition thru another cutaway portion.

Fig. 3 is a detail view showing the pivoted shutter and an electric solenoid designed to impart movement to said shutter.

Fig. 4 is a detail showing the centering springs and adjusting screws.

Fig. 5 is another position of the shutter showing the shutter working diagonally across the recording aperture.

Fig. 6 is a view of a developed film sound record made with the shutter position shown in Fig. 5.

Fig. 7 is another position of the shutter when the movement is at right angles or transversely of the sensitized film.

Fig. 8 is a type of record made with shutter position shown in Fig. 7.

Fig. 9 is another position of the shutter showing the sliding cover moved to a position to act upon the aperture and cause a diagonal cut-off on two sides when the movement is longitudinal of the film.

Fig. 10 is a specimen of a type of record made with shutter position shown in Fig. 9, with a small point of illumination.

Fig. 11 is a specimen of a type of record made with shutter position shown in Fig. 9 when a wide angle light source is used.

Fig. 12 is a specimen of a type of record made with shutter position shown in Fig. 2 and is called the variable transparent or variable density line record.

Fig. 13 is a view showing the cover moved to uncover the aperture contained on the shutter for exposing only a small portion of the film.

Fig. 14 is a specimen of a type of record made with the shutter as shown in Fig. 13.

Fig. 15 is another position of the shutter showing the small wire or opaque portion shielding a small portion of the film from exposure and exposing the other portions not shielded by the box and shutter.

Fig. 16 is a specimen of a type of record made with shutter position shown in Fig. 15.

Fig. 17 is a wide angle source of illumination showing the penumbra and the umbra formed by the shutter.

Fig. 18 is a narrow angle source of illumination showing the formation of an umbra without a penumbra.

Fig. 19 is a diagrammatic view showing the detail of a simple wiring for my invention.

In the drawings numeral 20 designates a box constructed to exclude all light rays except at the exposing apertures 21 and 22 and containing a partition 23 to separate the films from each other and prevent the light used on one film from acting upon the other film. It is understood that two separate boxes could be used for the purpose and might be placed near each other or widely separated and in some cases it might be desirable. It is also pointed out that means of synchronism might be established between the two films by any known method. Numeral 24 designates a motor and a worm 25 and gear 26 imparts slow movement to shaft 27 and sprocket 28 and transmits motion thru chain 29 to sprocket 30 and shaft 31 which contains a film sprocket wheel for engaging the sprocket holes in a sound record film 32 without slipping. Shaft 27 has mounted upon it other sprocket wheels 33, 35 and 37 and are each connective to three other sprockets 34, 36 and 38 for changing the speed relation between the shaft 31 and shaft 39. Sprockets 34, 36 and 38 are attached to shaft 39 as well as another sprocket wheel 40 arranged with teeth for engaging film 42. A sprocket chain 43 is arranged to connect shaft 27 with shaft 39 and is shown connecting sprocket 37 with sprocket 38 and similarly connecting, when desired, sprockets 35 with 36 and 33 with 34. Thus the speed is variable in regard to the ratio between one box and the other or between the developed film record and the sensitized record. It is also shown that the motor 24 by means of the worm 25 and gear 26 produces a very slow speed of shaft 27. It is understood that the motor can be of any type suitable for producing the necessary driving force and the proper speed and could be controlled by a governor, and while the speed might vary it is of the utmost importance that the speed never be as high as the speed at which the original sound record film was made. The slow speed acts to prevent distortion due to mechanical and electrical inertia and to allow full time for exposure by a certain type of illumination which may be suited to pro-

ducing finer results than obtainable when recording sounds direct from the air.

An illuminating device or source of light 44 is shown mounted upon a supporting bracket 67 for illuminating a portion of the developed film sound record 32 thru aperture 21 and causes light rays passing thru said film 32 to impinge upon a selenium cell or other light sensitive device 48 which changes its resistance in proportion to the amount of light rays impinging upon it and is connected to a battery or other suitable steady source of electric current and also connected to a solenoid 45 or other device capable of changing the electric current into power for driving an arm 46 pivoted at one end upon bracket 68 at point 69 and point 70 and adjustable by pivot screw 55 for taking up any lost motion or play in the bearings and still permit movement of shutter arm 46 without undue friction. Bracket 68 is supported by frame or base plate 57 which has permanently fastened thereto the solenoid 45. The base plate 57 is provided with two screw holes 71 and 72 by which it is attached to the top of the box 20 and is movable thereon to any desired position in relation to the aperature 22. Solenoid 45 operates a plunger 56 which is attached to shutter arm 46 by suitable means at point 73. Thus it will be seen that the current flowing thru the coil 45 will attract the armature or plunger 56 and operate the shutter arm 46, connected thereto. Attached to shutter arm 46 are two contractile springs 53 and 54 and are connected in opposition to each other to arms 74 and 75 of bracket 68 by adjusting screws 51 and 52. The function of these springs is to center or adjust the shutter arm 46 and plunger 56 so that the light rays may be varied to a certain degree when a certain current value is flowing thru coil 46, thereby allowing a normal position of shutter arm 46 in relation to aperture 22 to be had to control the limits of motion of said shutter arm without damping the movements of it. It is pointed out that the purpose of these centering springs is to regulate the "rest" position of the shutter only after the base plate 57 is adjusted at proper relation to aperture 22. Shutter 46 at the free end is designed to intercept light rays from a source of illumination 47, supported by an arm of bracket 67, on their way to film 42 thru aperture 22. Lamp 47 is connected to any suitable steady source of current for illuminating it and will expose sensitized film 42 thru aperture 22 subject to the control of shutter 46. Thus images of light will be photographed upon the film in accordance with the different position of the shutter 46, controlled by the developed film sound record 32. Film reels 49 and 50 are provided with means for keeping the films taut between them and the sprockets and the take-up means is not shown as it is common in all machines using perforated film. The film is wound upon reel 49 from reel 49ª and upon reel 50 from reel 50ª during the transferring process. Referring to Fig. 19 a simple wiring diagram will be seen which shows the selenium cell 48 and the solenoid 45 connected in series with a battery 76. It is understood that any other suitable wiring might be used for accomplishing the purpose desired and audions might be used to amplify the current before reaching the solenoid 45. Thus it will be seen that the developed film sound record passing the aperature 21 regulates the light impinging upon selenium cell 48 from light source 44 and thereby regulates the resistance of the selenium cell 48 which regulates the current in an electrical circuit Fig. 19 and acts upon solenoid 45 and regulates the travel of shutter arm 46 which controls the light rays from light source 47 on their way to sensitized film 42 thru aperture 22 and re-records upon the sensitized film variation in accordance with the variations in the sound wave record in an amplified degree and in some cases an entirely different type of record.

The shaft 27 is supported by brackets 77 and 78 which form bearings for it.

In Fig. 1 a cutaway portion of box 20 is shown at A in which film reels 49 and 49ª carrying the developed film sound record are shown. A cutaway portion of reel 49ª shows the convolutions of film 32 thereon. Numeral 79 shows an idler roller for supporting film 32 bearing upon the shaft 80 for keeping film 32 parallel with the top of the box 20 under the aperture 21. Numeral 48 shows the selenium cell directly under aperture 21 and lamp 44. Dotted lines 81 and 82 show the connection leading from selenium cell 48 to terminals upon the outer casing of the box 20 which is of course made of some insulating material such as wood or fibre. Numeral 23 shows the dividing partition. Numerals 50 and 50ª show two reels similiar to reels 49 and 49ª for carrying the sensitized film 42 while idler roller 83 bearing upon shaft 84 in conjunction with sprocket 40 shown in the dotted lines serves to keep the film 42 therebetween parallel with the top of the box 20. Suitable means may be provided directly under film 42 and aperture 22 for absorbing the light rays which might penetrate thru the film. Terminals or binding posts 85 and 86 connected to selenium cell 48 are shown upon the outside of box 20 and conductors 87 and 88 are shown broken off a short distance from said binding post to which they are connected. Likewise terminals leading from the coils of solenoid 45 are shown by numerals 89 and 90 broken off. While a simple

diagram of connection between the selenium cell 48 and the solenoid 45 together with a source of electric current is shown in Fig. 19 other well known means of wiring may be used.

Referring to Fig. 2 letter B designates a cutaway portion of the top of box 20 showing a portion of the developed film sound record. Letter C designates a similiar cutaway portion showing the sensitized film 42 engaging a sprocket member 40. Letter D designates a cutaway portion of the top of box 20 showing the partition separating film 32 from film 42 by lightproof means.

Referring again to Fig. 1 terminals 91 and 92 leading from lamp 44 are shown broken off, these terminals are connected to any suitable steady source of electric current for heating to incandescence the filament of the lamp. Likewise terminals 93 and 94 of lamp 47 are to be connected to suitable source of current supply. In illuminating the film containing the developed film sound record 32 it is advantageous to use light from a comparatively wide angle for illuminating the cell 48 thru the aperture and film for getting the greatest efficiency or control from the record and it is also advantageous to use condensers and reflectors for intensifying the light when necessary all of which are old to the art. However the use of different types of illumination in the recording of the sensitized film is considered novel as well as vital inasmuch as the character and refinement of the recorded variations depend altogether upon the character or combination of a certain type of light source to coact with the shutter combination in the different types of records. Thus a great flexibility is had with this machine which allows the recording of sound waves in a manner which has heretofore been impossible with sound recording means. It is pointed out that while the lamp 47 is what might be termed a wide angle source of illumination in the position shown in relation to the aperture 22 it might also be called a narrow angle light source when farther removed and would then produce very different results upon the sensitized film. The different types of illuminating sources relative to the angle of illumination for the different types of shutter positions in relation to the aperture will be brought out separately when describing those positions.

While this system of enlarging and transforming sound or electrical wave records is, in my opinion, basic invention and for that reason all the different means of accomplishing the purpose, which might consist in improvements thereon, should not be shown in this application, it is, however, deemed necessary to show and claim a few examples of the usefulness and flexibility of the device and apply later for the individual improvements not disclosed. Such improvements might consist in different types of shutters which might be useful on this machine or useful on recording machines which record direct from the air at high frequency.

It is shown that uniformly spaced sprocket holes in the film engaging with uniformly spaced sprocket teeth on a sprocket wheel contribute to regain synchronism between the sound record film and the visual picture film when they are originally recorded upon separate films in combination with a speed controlling means.

By the term "varying in capacity" I mean any change in the character of the film which might affect its light passing quality, and fluctuate a beam of light. Thus a film varying in the width of its exposure at different points as well as a film of the same width of exposure at all points but varying in density of exposure might be called varying in opacity.

Referring to Fig. 2 it will be seen that screw holes are shown by numerals 95, 96, 97 and 98 for attaching base plate 57 at different points upon the top of box 20 as desired and it is understood that such holes do not extend through the box, and no light can enter the box excepting through the apertures 21 and 22. A suitable light-tight door is provided to allow opening the box when necessary to load or unload the film reels or for any other purpose and is not shown in the drawings.

Referring to Fig. 3 it will be seen that the connecting point 73 is not connected to solenoid 45 at an extremely close point in relation to the pivot point but it shows some amplification of movement of the free end of shutter 46 and it is understood that the point of connection in relation to the pivot point may be varied for varying the amplification of movement. The amplitude of travel of the shutter 46 may be further increased by amplification of the electric current and is too well known to need description.

Fig. 17 shows a light source of wide angle which produces a penumbra 58 and an umbra 59 behind a shutter 46 and shows diagrammatically that shutter 46 may control the intensity of light rays without entirely shutting off the rays at certain portions.

Fig. 18 shows the combination of a narrow angle light source in relation to a shutter member 46 and shows that an umbra 60 is formed without a penumbra thereby producing sharper shadows.

It will be seen from the following that a great variety of records may be made from a record varying in opacity in any manner. For example we will suppose that the record is originally made in the form of a varying density record as this is the type of

record that the greatest volume of fluctuation has been recorded upon by the original sound waves and produces louder reproduction without amplification than any other type. By referring to Fig. 2 it will be seen that the shutter 46 moves longitudinally of the film and therefore shuts off the light rays to a certain degree the full width of the aperture. This increases or decreases the amount of light rays acting upon aperture 22 and consequently produces an exposure the full width of the exposing aperture, the density of which will vary when developed in proportion to the amount of light acting upon the film. It will be noted in this as well as the other positions of the shutter that the particles of silver in the developed film record 32 are not magnified and the magnified image photographed upon the sensitized film in the usual manner, consequently no coarseness or distortion due to the grain in the emulsion, when enlarged, is produced. This result is accomplished in the shutter position shown by the illumination acting from a wide angle light source and allowing the penumbra formed by said combination to be recorded upon the sensitized film.

Fig. 5 shows the shutter 46 working diagonally across exposing aperture 22. With the shutter working in this position it will be seen that a great amount of closure may be produced with a small shutter movement. This shutter position in combination with a narrow angle source of illumination will produce images of varying width upon sensitized film 42 an example of which is shown in Fig. 8 which shows the record after development. This record consists of black and white portions which are fully exposed and unexposed respectively. Fig. 6 shows a record, after development, which is made by the same shutter position but with a wide angle illuminating source. This record consists of an unexposed portion, a partly exposed portion and a fully exposed portion. The unexposed portion represents the umbra, the partly exposed portion represents the penumbra and the fully exposed portion represents outside the penumbra.

Referring to Fig. 7 the base 57 has been moved upon the top of the box 20 to such a position that the movement of the shutter arm 46 is at right angles to the longitudinal dimensions of the sensitized film 42. The wire 66 has been removed so as to not interfere with the light rays when the shutter is used in this position. With this position of the shutter member it will be seen that the width of the aperture acted upon by light rays is varied. Fig. 8 shows a type of record, after development, made with this shutter position.

Referring to Fig. 9 the swinging cover 61 pivoted upon shutter 46 at the pivot point 65 is shown covering the regular blade of shutter 46 and forming another blade designed to cut off light rays from aperture 22 at two different points at the same time. A specimen of a type of record made with this combination co-acting with a narrow angle source of illumination is shown in Fig. 10. Fig. 11 shows the same shutter combination co-acting with a wide angle light source.

Referring to Fig. 13 the base 57 is set upon box 20 so that the shutter movement is at right angles to the longitudinal dimensions of sensitized film 42. The swinging cover 61 is swung to expose aperture 63 contained in shutter 46. The aperture 63 lying at right angles to aperture 22 allows a small point of exposure upon the sensitized film from light source 47. A narrow angle light source is used in this combination for fully exposing the exposed portions. A specimen of a type of record made with this combination is shown in Fig. 14.

Referring to Fig. 15 the base 57 is located so as to place wire 66 supported by shutter 46 at right angles to the exposing aperture 22. It will be seen that the wire 66 is carried by extensions of shutter 46 so as to expose all of aperture 22 on each side of wire 66. Thus the wire 66 shields from exposure a very small portion of film 42 through aperture 22. Fig. 16 shows a specimen of record made with this combination.

Fig. 12 is a specimen of the type of record made from the combination as shown in Fig. 2 co-acting with a wide angle source of illumination.

A very important advantage gained by the use of transformed records which are transformed into a variable width line record is that they lend themselves to perfect printing upon a positive film where no gradation is required, a thing that cannot be done with the variable density line successfully. A further advantage is that no regulating of the exposure is required as is necessary with the variable density record.

It is obvious that various means of accomplishing the desired results might be carried out and the machine be made of different materials and in different designs and it is the principle involved which I desire to protect rather than the mechanical skill by which it may be carried out.

What I claim, is:

1. The method of photographically recording sound waves which consists in transferring photographically recorded sound waves from a developed sound record film to a sensitized film and utilizing said developed sound record film for controlling the movements of a shutter member or members acting to control light rays impinging upon said sensitized film and producing extremely slow travel of both said films.

2. The method of photographically recording sound waves which consists in transferring photographically recorded sound waves from a developed sound record film to a sensitized film and controlling the movements of a shutter member in accordance with the variations in opacity of said developed sound record film and acting to vary the light rays impinging upon said sensitized film and apertures for limiting the exposed area of both said films to certain limits longitudinally and transversely and using the full width of the said sound record for controlling the movements of said shutter member.

3. The method of photographically recording sound waves which consists in transforming a sound record varying in density into a sound record varying in width of the exposed or unexposed portions by using a shutter member controlled by the variations in a sound record film and controlling the area of exposure transversely of a sensitized film in accordance with the fluctuations in said sound record film and fixing the amount of exposure longitudinally of said film so that only a small portion will be exposed longitudinally without variation of the said longitudinal area.

4. The method of recording sound waves which consists in using a developed film sound record for controlling the movements of an electrically operated shutter member and using the full width of said sound record for controlling said shutter and restricting the longitudinal area of exposure to a very narrow slit and exposing through a narrow slit transversely of a sensitized film a very small portion of said shutter member and producing an undulating line of exposure longitudinally of said sensitized film varying in its transverse position upon said sensitized film in accordance with the variations in the said sound record film.

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