H. C. BULLIS.

METHOD OF PRODUCING MAGNETIC SOUND RECORDS FOR TALKING MOTION PICTURE FILMS.

APPLICATION FILED DEC. 15, 1915.

1,213,150.

Patented Jan. 23, 1917.

2 SHEETS—SHEET 1.

Fig. 1.

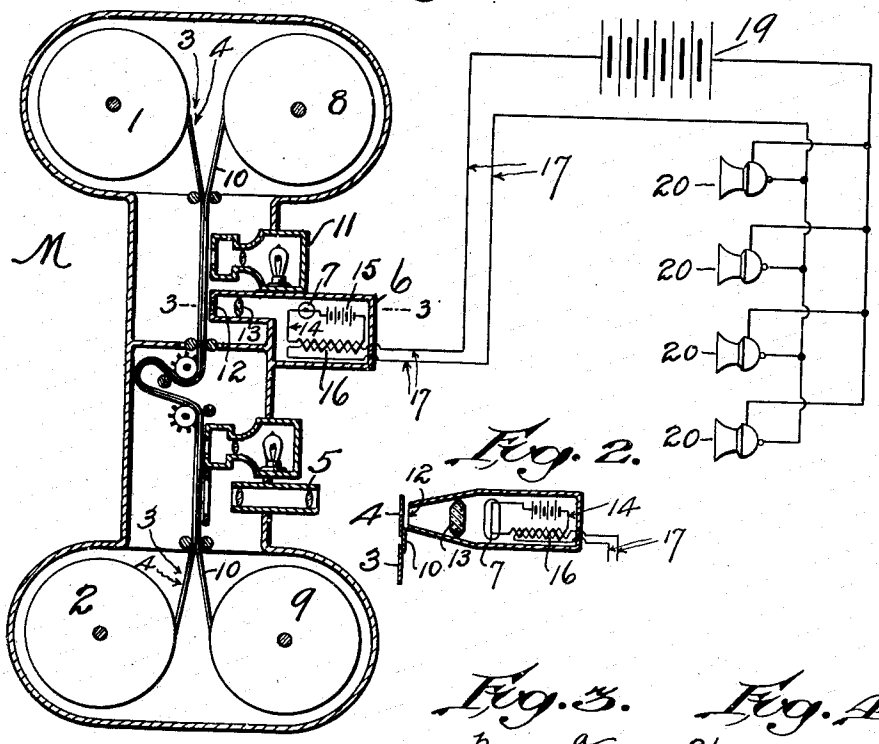


Fig. 2.

Fig. 3.

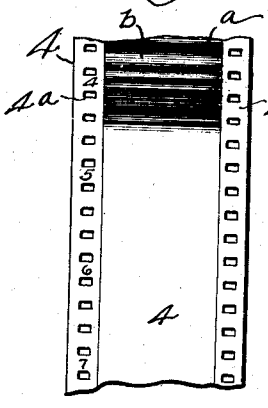


Fig. 4.

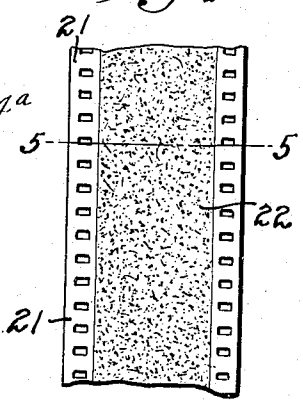


Fig. 5.

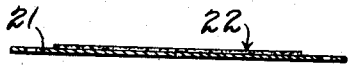
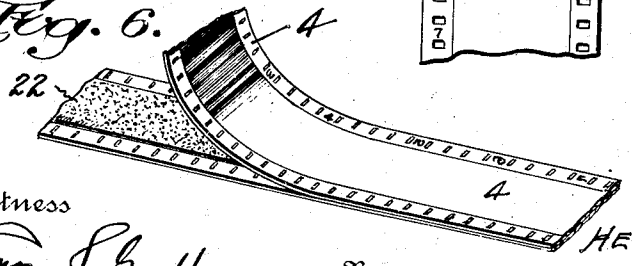


Fig. 6.



Witness

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2 SHEETS—SHEET 2.

Fig. 7.

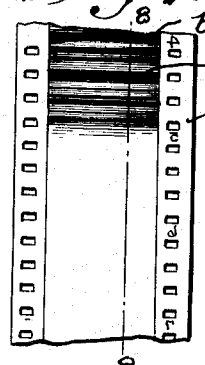


Fig. 8

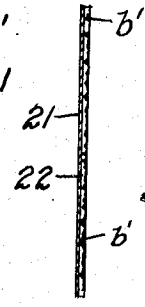


Fig. 9.

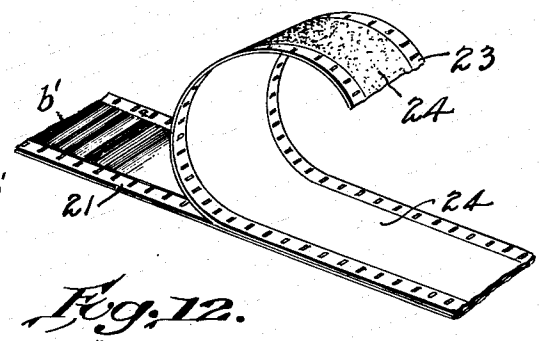


Fig. 10.

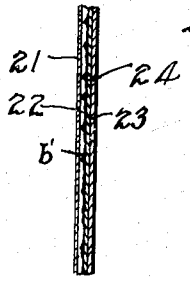


Fig. 11.

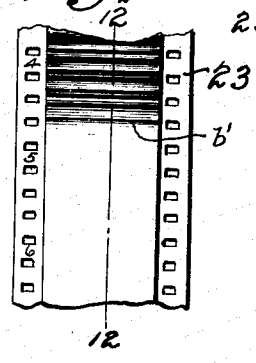


Fig. 12.

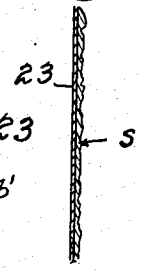
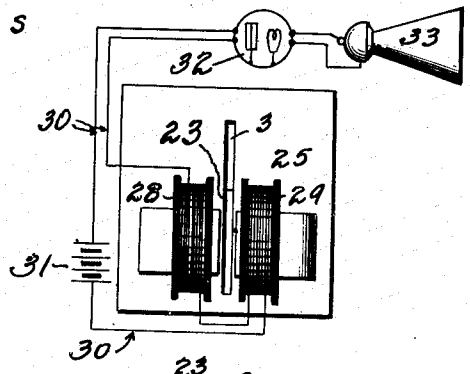


Fig. 15.



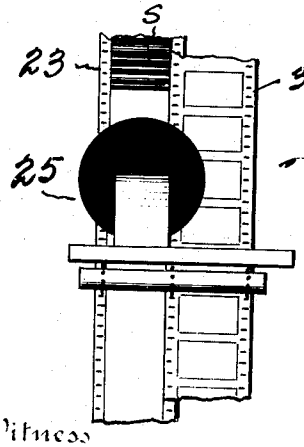


Fig. 14.

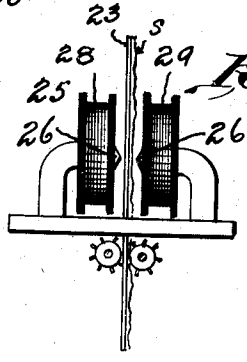


Fig. 13.

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METHOD OF PRODUCING MAGNETIC SOUND-RECORDS FOR TALKING-MOTION-PICTURE FILMS.

1,213,150. Specification of Letters Patent. Patented Jan. 23, 1917.

Application filed December 15, 1915. Serial No. 67,088.

To all whom it may concern:

Be it known that I, HENRY C. BULLIS, a citizen of the United States, residing at Redwood Falls, in the county of Redwood and State of Minnesota, have invented certain new and useful Improvements in Methods of Producing Magnetic Sound-Records for Talking-Motion-Picture Films, of which the following is a specification.

This invention relates to the general subject of acoustics and has special reference to a process for producing a sound record that is particularly adapted to be utilized in connection with motion picture films.

As is well known, various efforts have been made to produce the so-called talking motion pictures, the most common and widely known method being the combination of the motion picture and mechanical talking machine. However, great difficulty has been experienced in properly synchronizing these two separate instrumentalities to obtain a perfect synchronism and syntonism between the pictures and speech sounds belonging thereto, and therefore an entirely electrical method has been sought whereby the sound record could be recorded simultaneously with the taking of the pictures, and also translated simultaneously with projecting thereof. Accordingly, after much experimenting, a method of this general character was evolved and in attaining the desired end, the variations in the intensity of light produced by a "talking arc" were photographed on a continuously moving film by means of suitable lenses. After being developed, the resulting photogram was passed between a source of light and a selenium cell included in a reproducing circuit, whereby light rays of varying intensity were caused to fall on the cell and thereby vary its electrical resistance. Thus, with the aid of suitable electrical and sound magnifying devices included in the cell circuit, the record on the film strip was translated into audible speech sounds. Although this method of producing the so-called talking pictures eliminated many of the objections incident to the combination of the separate mechanical instruments above mentioned, it has not, for various practical reasons, come into commercial use. One of the most pronounced objections to this latter method as heretofore practised, is due to the fact that it is difficult to provide suitable mechanical devices whereby the sound and pictures may be accurately recorded on the same film, since the pictures must be recorded on an intermittently moving portion of the film, while the sound record is made on a continuously moving portion. Therefore, I have found that it is more practical as set forth in my copending application Serial No. 67,087 filed Dec. 15, 1915, to record the sound and picture on separate films which move in synchronism and have suitable registering means recorded thereon, whereby they may be readily matched to attain the result of producing the pictures and their corresponding speech sounds simultaneously. This two-film method not only renders the attainment of the ultimate object in a commercially practical manner, with the use of a selenium cell to translate the sound record, but at the same time makes possible the use of an entirely new and different method of reproducing the sounds. That is to say, by having the films separate, but capable of being readily matched in proper relation, it is possible to utilize the sound record made on a film by the apparatus shown in my copending application aforesaid to form another sound record that may be magnetically translated instead of by the use of an electrical cell such as heretofore. In other words, I propose to use the film containing a sound record produced by the result of photographing varying intensities of light as a master negative for making sound films having metallic sound images thereon corresponding in magnetic permeability to the varying light striations on the master film. Accordingly, it will be apparent that the present novel method has in view the utilization of a master photographic negative film for producing a positive metallic sound record film, which may be readily translated by being passed between the poles of an electromagnetic inductive device which is included in an electric circuit with suitable means for amplifying and transmitting the speech sounds.

A further and more specific object of the present method is to utilize a source of sound controlled light which will produce a negative that may be used for printing without making a reversed image. In other words, it is proposed to make a negative which may be used direct to print its sound image on a film having thereon a sensitized gelatinous

coating carrying a finely divided metallic substance in suspension, and which becomes fixed in a series of images corresponding to the light striations on the original negative or master film to provide a plurality of transverse lines of metallic material of varying magnetic permeability.

Although the present method may be carried out in various ways, and by any convenient means, one form of apparatus is illustrated in the accompanying drawings wherein—

Figure 1 is more or less diagrammatic view of the means employed for making the photographic light record of master negative of the sound waves. Fig. 2 is a detail sectional view taken on the line 3—3 of Fig. 1 showing diagrammatically the device used for producing varying flashes of light corresponding to the varying volume or intensity of the sound waves. Fig. 3 is a detail view of a portion of the film strip having thereon the photogram resulting from the first step performed in the apparatus of Fig. 1. Fig. 4 is a detail view of a portion of a film strip having thereon a sensitized gelatinous coating containing a finely divided metallic material in suspension, and which is used as a base on which to print the negative master record. Fig. 5 is an enlarged cross sectional view on the line 5—5 of Fig. 4. Fig. 6 is a view illustrating the second step of the present method, wherein the photogram strip shown in Fig. 3 is placed upon the surface of the sensitized coating on the strip shown in Fig. 4 for printing. Fig. 7 is a detail plan view of a portion of the magnetic strip having the sound image printed thereon. Fig. 8 is a detail sectional view on the line 8—8 of Fig. 7. Fig. 9 is a view illustrating the third step of the method which involves the attaching of a permanent film strip to the sound images hardened by the action of light on the sensitized coating. Fig. 10 is a longitudinal sectional view of the parts shown in Fig. 9. Fig. 11 is a detail plan view of the final metallic sound record. Fig. 12 is a longitudinal sectional view on the line 12—12 of Fig. 11. Fig. 13 is a detail view of a type of magnetic inductive device for translating the sound recorded on the strip in Figs. 12 and 13. Fig. 14 is a front elevation of the apparatus shown in Fig. 13, and also illustrating how the picture strip made concurrently with the photogram strip may be reproduced along with the magnetic sound record strip. Fig. 15 is a top plan view of the construction shown in Fig. 13 with the talking circuit diagrammatically indicated.

Similar reference characters designate corresponding parts throughout the several figures of the drawings.

A novel feature of the present method involves the making of a master negative in the form of a photogram record film, which is a photographic record of different intensities of light, caused by the inductive effect of a microphone circuit reacting upon a normally fixed light circuit. In other words, it is proposed to produce a sound record film by means of a flash lamp inductively coupled with a microphone circuit, so that the light flashes from the lamp will be inversely related to the sound waves. The sound record thus produced on the negative assumes the form of a plurality of transverse lines extending entirely across the strip, the same being of different intensity and varying in width, and hereinafter referred to as striations. After the master negative is made, it is developed and utilized for the making of a metallic sound record, which latter is preferably carried on a film strip of the type usually employed in motion picture machines. Thus, it will be apparent that the present sound record is especially adapted to be combined with the usual picture strip to produce the so-called talking motion pictures.

Although the several steps of the present method involving the novel features set forth may be attained through the use of various suitable instrumentalities, I have illustrated one form of apparatus in the accompanying drawings, and to this end, I preferably utilize a recording apparatus similar to that shown in my co-pending application, Serial No. 67,087, filed Dec. 15, 1915. As illustrated in Figs. 1 and 2 of the present case, the said recording apparatus is designated in its entirety by the reference character M, and includes suitable reeling devices 1 and 2 for passing both a picture strip 3 and photogram strip 4 respectively before a picture recording lens device 5 and a sound recording device 6 which includes a varying source of light 7. The reeling devices 8 and 9 carry a film strip 10 for recording on both the picture strip 3 and photogram strip 4 suitable marks of identification as described in my application aforesaid, whereby the two strips may be readily matched.

Referring more particularly to the photogram strip 4 which is transferred from the upper reel 1 to the lower reel 2 along with the picture strip 3, it will be seen that the same may be passed before a source of light 11 for printing thereon suitable identification marks, and is then passed before the relatively narrow horizontally disposed slot 12 of the sound recording device 6 to receive the light flashes focused through the slit by means of a concentrating lens 13. In this sound recording device 6, the source of recording light is preferably a relatively long electric lamp which is disposed longitudinally of the interior of the casing of the device, so that the single tungsten filament

thereof may be parallel with the slot 12. This lamp is a part of a lamp circuit designated as 14 and including a source of electrical energy 15, and under normal conditions, the flow of current in the circuit is such that the filament of the lamp gives a steady, bright glow. The circuit 14 in which the sound controlled flash lamp 7 is arranged, has a portion thereof forming one winding of an induction coil 16, another winding of which is formed by a portion of the microphone circuit 17. This latter circuit includes a source of electrical energy 19 and a plurality of microphones 20, and as will be apparent, is inductively coupled with the light circuit 14.

Now, in the present device, where it is desired to make a negative sound record in which the most transparent striations represent the variations in sound and the darkest represent silent or relatively silent intervals, it is necessary that the result of the inductive effect of the current in the microphone circuit upon the current in the lamp circuit shall be of such a nature as to oppose the flow of current in the lamp circuit. In other words, the current in the coil of the microphone circuit must work in opposition to the current in the coil of the lamp circuit to produce an inductive resistance to the flow of the current in the lamp circuit. This effect is just the opposite to that required where it is necessary to increase the amount of light given off by the filament of the lamp in the lamp circuit, as is necessary in the case where the negative is made for production by means of a selenium cell, as set forth in my copending application hereinbefore mentioned. These microphones 20 above referred to may, of course, be arranged in any desirable location, and when receiving sounds that are to be recorded vary the resistance in the microphone circuit, which by induction produces a reactive effect upon the current normally flowing through the circuit 14 so that the filament of the lamp varies in its brightness in accordance with the inductive resistance imposed by the microphone circuit upon the lamp circuit. That is to say, the induction coil coupling between the light circuit and the microphone circuit causes the lamp to flash dimly for loud sound waves, and vice versa with a corresponding graduated relation between the light flashes and the sound waves for tones between these two extremes. This has the effect of photographing a light or transparent striation on the negative film for loud tones and vice versa, with the result that when the positive film is finally developed, the sound striations will correspond in amplitude or character to the original sound waves. In other words, the normal bright light of the lamp representing a silent interval will produce the darkest striations on the negative master film, while the weaker flashes representing the sounds will produce a more transparent striation. Thus, by the use of this type of light which is inductively coupled with the microphone circuit, it is possible to produce what may be termed a "positive" negative light record. That is to say, the light record made by this means may be used to directly print the permanent metallic sound record without the intermediate step of making a reversed image film. Heretofore, it has been necessary to first make a negative light record, then make a reversed image negative, whereby the proper sound striations might be reproduced in printing duplicates, but this is entirely eliminated with the present type of flash lamp. Accordingly, from the foregoing, it will be clear that the first step of the present process consists in making a "positive" master negative light record film, by means of a flash lamp arranged in a light circuit which is inductively coupled with a microphone circuit, and then developing the strip to define the sound image. The film will then appear substantially as shown in Fig. 3 of the drawings, wherein it will be observed that the sound is recorded in a plurality of striations of varying width and intensity extending transversely across the full width of the body of the film, the marginal edges 4^a being provided with the usual traction openings, and also as indicated in this figure, the darkest or most intense striations *a* represent the relatively silent intervals between the rapidly recurring lighter striations *b* which represent the different qualities of recorded sounds.

In Figs. 4 and 5 of the drawings, there is shown what may be termed a temporary film strip designated as 21, and having its body portion provided with a sensitized gelatinous coating 22 containing finely divided metallic material in suspension. Although various kinds of coating composition may be successfully adapted for this purpose, a simple and practical coating composition is an emulsion of gum bichromate containing finely divided iron particles or other suitable para magnetic material, held in suspension therein.

The next step in this novel method is shown in Fig. 6 of the drawings, wherein this temporary strip 21 having thereon the sensitized gelatinous coating has laid upon it the photogram film 4. The light record of the film 4 is then printed on the sensitized coating 22 whereby the light record is converted into a sound record on the temporary film by hardening the gelatin in all places where the light penetrates as indicated in Fig. 7. That is to say, when the images of the strip 4 are printed on the coating 22 the light will penetrate more or less all of the transparent and nearly transparent stria-

tions *b* on the film 4 which represent sounds of varying quality and pitch. Thus, there is printed on the coating 22 of the temporary strip 21 a metallic sound record *b'* corresponding in magnetic permeability to the amplitude or character of the original sound waves as indicated by the light striations. As will appear more clearly by a sectional view taken on the line 8—8 of Fig. 7 where the sound striations were the lightest on the negative, the gelatinous coating containing the magnetic material becomes hardened to the greatest depth, while in places where the sound striations are relatively small, the light striations on the negative were the darkest, thus representing weaker sounds. Thus, the entire surface of the gelatinous coating becomes hardened to a more or less greater depth according to the degree or intensity of the light admitted by the photogram film during the printing process. The heavy portions *b'* of Fig. 8 represent the portions of the magnetic coating hardened by the light, thus leaving the coating beneath the heavy portions, and next to the temporary film strip 21 in a relatively soft condition. Thus, should this magnetic strip be subjected to a bath for removing the soft or unhardened gelatin, it will be apparent that the hardened or set gelatinous portions would be practically without any support. Therefore, in order to preserve the entire sound record made by printing the light photogram on the sensitized gelatinous coating, it is necessary to provide the metallic record with a permanent backing, and this must be acomplished prior to subjecting the sensitized temporary film strip to the bath above referred to. Accordingly, to provide a permanent support or backing for the hardened sound record material, the surface thereof has applied thereto a permanent carrier strip 23. This third step is illustrated in Fig. 9 of the drawings wherein it will be observed that the strip 21 having the magnetic coating 22 has impressed on the face of the hardened metallic record material, the permanent record strip 23 which carries on one side thereof an adhesive substance 24 that securely grips and adheres to all of the hardened metallic striations, as shown in Fig. 10. The composite structure shown in the latter figure is then subjected to a suitable bath whereby soft portions of the gelatin are removed, and the temporary film is removed or stripped, thus leaving an irregular surface *s* of magnetic material permanently secured to the film strip 23, as shown in Figs. 11 and 12. After the permanent magnetic record film strip is thus produced, it may be then translated by being passed between the poles of a suitable electromagnetic device 25, such for instance as shown in Figs. 13, 14, and 15 of the drawings. In these figures, the references 26—26 designate the opposite pole pieces of a magnet device which may be of the electromagnetic type or permanent type as shown and having the coils 28 and 29 which are included in an electric circuit 30. (Fig. 15). This circuit also includes a source of electrical energy 31, and suitable sound amplifying devices designated generally as 32, and a loud speaking telephone device 33. Accordingly, it will be apparent that the metallic sound record produced in accordance with the steps of the foregoing method may be utilized together with the motion picture film, as shown in Fig. 14 to produce the so-called talking pictures, the speech sounds corresponding to each picture being translated according to the well known telegraphophone principle.

Even though the translation of these speech sounds is accomplished by the telegraphophone principle, the sound record produced by the present method possesses many points of superiority and many advantages over the usual steel wire strip common to the telegraphophone method. One of these advantages is that it is possible to place the sound record on a film strip which is of the same character as the picture strip, whereby the sound record strip may be moved through a standard type of motion picture machine along with the usual picture film. Another advantage is that the magnetic sound record produced by this method is much more enduring than a record made upon a steel wire or strip, since it is difficult for the latter to hold its magnetism for any length of time, while according to the present method each sound striation contains exactly the same amount of metallic material at all times that is originally given to it by the light passing through the photogram negative.

From the foregoing, it is believed to be apparent that the present novel method essentially consists in making a light photogram of sounds of varying quality and pitch by means of a flash lamp arranged in a circuit which is inductively coupled with the microphone circuit. The resulting light photogram is then developed and used as a "positive" master negative for printing upon a temporary film strip having thereon a sensitized gelatinous coating containing finely divided magnetic material. The printing of the photogram on this sensitized gelatinous coating thus produces a series of hardened gelatinous metallic striations corresponding in magnetic permeability to the intensity of the light striations of the photogram. Prior to subjecting the temporary film strip having thereon the metallic sound record to a suitable photographic bath, the same has secured to its face on which the striations occur, a permanent film strip whereby all parts of the gelati-

nous coating not hardened by the action of light will be washed away from the permanent sound record strip while the metallic sound striations will be secured thereto. After the sound record is thus produced on the permanent film strip, it may be translated by suitable electro-magnetic devices along with the projection of an accompanying picture strip to produce the so-called talking motion pictures.

I claim:

1. A method of photographing sound records on a sensitized record medium which consists in flashing thereon light beams, and causing said light beams at the source to be inversely varied in intensity by the sound waves to be recorded.

2. A method of photographing sound records on a sensitized record medium which consists in flashing light beams thereon in a series of transverse striations, and causing said light beams at the source to be inversely varied in intensity by the sound waves to be recorded.

3. A method of producing sound records which consists in photographically producing a positive negative master record of sound controlled light flashes which are inversely related to the sounds, then printing the said master negative on a sensitized surface containing finely divided metallic material in suspension, and subsequently removing all of said sensitized coating not hardened by printing the master negative on said sensitized surface.

4. A method of producing sound records which consists in producing a photogram record of sound controlled light flashes which are inversely related to the sound waves, then printing said photogram record on the sensitized coating of a temporary film strip, then providing the printed sensitized surface with a permanent backing strip, and subsequently removing all of the sensitized coating not hardened in the printing step and also stripping the temporary film strip from the permanent backing.

5. A method of producing sound records which consists in producing a photogram record of sound controlled light flashes which are inversely related to the sound waves, then printing said photogram record directly on a sensitized metallic coating carried by a temporary film strip, then attaching a permanent backing strip to the hardened surface of the sensitized metallic coating, and subsequently removing all of the sensitized coating not hardened in the printing step, and also stripping the temporary film strip from the permanent backing.

6. A method of producing sound records which consists in producing a photogram record of sound controlled light flashes which are inversely related to the sound waves, then printing said photogram record directly on a sensitized metallic coating carried by a temporary film strip to produce a series of transverse hardened metallic striations corresponding in magnetic permeability to the sounds as reflected in light images on the photogram strip, then adhesively attaching a permanent film strip to the hardened metallic striations, and subsequently removing the sensitized metallic coating not hardened by the printing step, and also removing the temporary film strip.

In testimony whereof I hereunto affix my signature in the presence of a witness.

HENRY C. BULLIS.

Witness:
EMORY L. GROFF.