

Feb. 14, 1933.

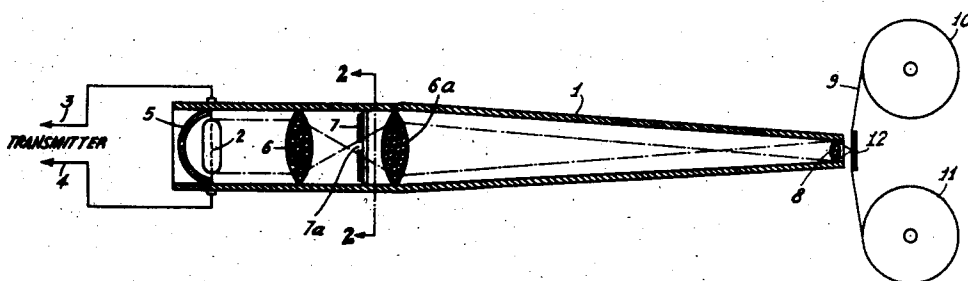
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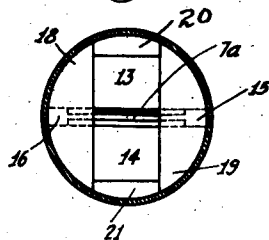
CONDENSED PHOTOPHONOGRAPHIC SOUND RECORD

Original Filed Jan. 9, 1928

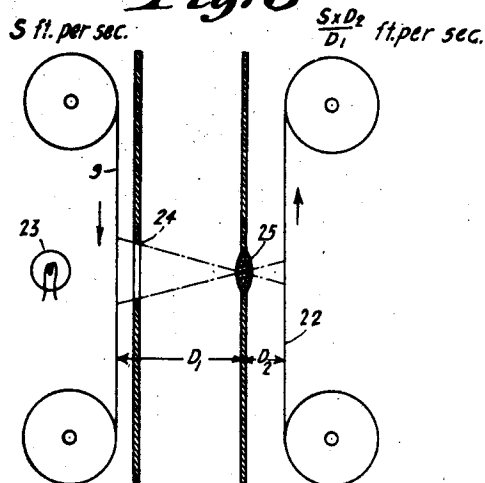
*Fig. 1*



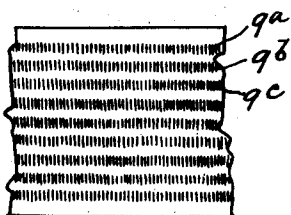
*Fig. 2*



*Fig. 3*



*Fig. 4*



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## UNITED STATES PATENT OFFICE

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## CONDENSED PHOTOPHONOGRAPHIC SOUND RECORD

Original application filed January 9, 1928, Serial No. 245,634. Divided and this application filed December 24, 1930. Serial No. 504,822.

My present invention relates to an improved photophonographic sound record. The object of this invention is to produce a record of a light sensitive material such as the usual photographic film or plate, this record being of such minute proportions that a single line of the recorded variations will take up but little space, and thus allow the printing of many lines thereof within a small space, thus producing in another way a very much more condensed "speaking book" described in my application Serial No. 716,296, filed May 28, 1924, Patent 1,734,248 of November 5, 1929.

A further object of this invention is to provide a sound record of microscopic proportions in accordance with the method set forth in application Serial No. 245,634, filed January 9, 1928, of which this present application is a division.

The ordinary record as produced by means including the usual slit of the prior art, is not as suitable for optical reduction to produce minute scale small records, such as are required for the practice of my present invention.

To carry out this invention, I produce a prime master record of any desired scale by the use of the method described in said prior application, Serial No. 716,296. This method removes mechanical limitations on slit size and permits utilization of sufficient light in recording so that it becomes possible to make use of comparatively fine grain slow speed emulsion film. For the same reason, this method allows of the production of a longer scale record by moving the primary recording film at a greater rate of speed at the time of recording. As will be evident, this permits recording of higher frequencies and therefore a greater percentage of the actual vibration of the original sound that is to be recorded.

Such primary record made with sufficient light optically projected upon the recording film can be made remarkably sharp, dense and of high contrast, whereby it is peculiarly adapted for photographic reduction to produce condensed records of the minute scale I require for the practice of this invention.

These records I produce by the added step of optical reduction as described in my co-pending application Serial No. 166,622. Optical reduction of such prime master records of the quality produced in accordance with my application Serial No. 180,378, Patent 1,655,811 of January 10, 1928, may be photographically reduced to greater advantage than recording direct at slow speed because the moving of the primary recording film at slow even speed is difficult mechanically.

My present invention thus includes a method of making a condensed photophonographic record of sound which includes first recording sound by means of light varied in accordance with sound wave variations, concentrating said light upon a suitable aperture of relatively large size whereby a selected portion of said light is allowed to pass and the remainder stopped out, and further reducing by camera means whereby an image of the aperture, reduced to desired size, is projected on a recording film; then moving said film at desired speed to produce a relatively large scale primary record of the sound variations, and then utilizing said record thus produced moving at a speed slower than the recording speed to project a minute image of said record on a film moving at an exactly proportional, still lower speed.

The above and other features of my invention may be more fully understood from the following description in connection with the accompanying drawing, in which;

Fig. 1 is a diagrammatic view of the recorder; and

Fig. 2 is a section on the line 2—2, Fig. 1, showing in detail a slot construction that may be employed; and

Fig. 3 is a schematic diagram showing the elements required for producing the secondary record; and

Fig. 4 is a detail view diagrammatically illustrating a photographic record of sound produced in accordance with my present invention.

Referring to Fig. 1, the recording projector includes reducing camera means and is diagrammatically indicated as including an en-

closing tube 1, containing a lamp 2, which may be any vacuum lamp of the type now well known in the art as capable of varying its radiation by and in accordance with sound variations. The sound variations and the keep alive current may be supplied from any suitable transmitting apparatus through the wires 3, 4. In the rear of the lamp 2 the casing 1 may be closed in by a reflector 5. The light, either direct or reflected, is centered by a lens 6, which in this case is shown as double convex. Beyond the focus where the converging rays cross and in a plane where a reduced image of the lamp will be formed, I arrange the slotted diaphragm 7 which cuts out as much of the image and light from lamp 2 as may be desired. The light which passes through the slot is further concentrated by the reducing lens 6a and a final reducing lens 8. The film 9, supplied from and moved by reels 10, 11, is guided in a predetermined plane by suitable support 12. The plane of the face of the film may be as near as desired to the focal or crossing point of the rays from lens 8, but preferably in a plane where a real image of the slot is formed.

It will be noted that I have not attempted to follow the divergence, convergence and crossing points of the light through the slot 7a of diaphragm 7, but have taken the extreme lines of the image of the lamp as indicating the cones and focuses characteristic of said image.

It will be evident that the nearer the receiving surface of film 9 is to the focus of lens 8, the more concentrated the light will be. Consequently, it may be desirable to utilize the well known expedient of screens for absorbing the heat rays in the beam and the light may of course be stopped down by diaphragms to any desired extent.

While my invention permits the use of a slot large enough to avoid mechanical difficulties in its production, one arrangement usable for this purpose is diagrammatically indicated in Fig. 2. Here the diaphragm comprises circular screens 13, 14, which are semi-circles except for the slot space 7a between them. Spacers 15, 16 of any desired thickness may be employed, against which the screens may be forced to insure proper spacing and parallelism of the slot edges. The slot may be stopped down if desired by segmental pieces 18, 19, which may be also positioned by spacers 20, 21.

Referring now to Fig. 3, I produce the sub-master, reduced sized records preferably by optical reduction means well known in the art by apparatus also well known and in use in the motion picture art. As shown, the apparatus comprises means for moving the prime master film record 9 in the direction shown at a speed of  $S$  feet per second. Means are also provided for moving the film 22 be-

ing reproduced in an opposite direction at a speed of

$$\frac{S \times D_2}{D_1}$$

feet per second. The light source 23 is provided, and the image of the film thus illuminated as viewed through the slot 24 is focussed by the lens 25 upon the moving film 22. This provides for the optical reduction of the light beams passed through the prime master film record moving at any desired speed in one direction upon the fresh film 22 moving in the opposite direction, but at a slower speed exactly proportional to the desired reduction in record scale as indicated.

I do not limit myself to the above means of duplication in reduced size as it will be obvious that the original or prime master record may be used as a control for varying the illumination of a slit, thus taking the place of a microphone as generally used in recording, providing means whereby the sub-master record may be made of any desired size on slow speed non-grain film, as the timing factor of exposure is under the control of the operator and does not limit the permitted slowness of film travel speed as when recording the original sounds.

As indicated in Fig. 4, the lines recorded on the film as at 9a, 9b, 9c, etc., may be very narrow and the records consist of transversely parallel gradation of shadings. There may be many parallel lines of record, the number and closeness of their spacing being limited by the practical considerations, an important one of which would seem to be the minimum width of space that is necessary to insure that one record will not encroach upon the other in recording, and to insure that in reproducing the images of all but one line of record will be cut out. As the films are liable to a certain amount of contraction, expansion, and distortion in the development, and by varying temperatures and moistures when in use, this may prove an important limitation.

With respect to the arrangement of the successive lines of recording upon the film 9, it is obvious that it may be convenient to record in strips alternately in opposite directions as when the film is reeled first in one direction and then in the other, but it will be evident that any suitable or well known form of record material may be utilized.

Having thus described my invention, attention is called to the fact that various modifications may be made coming within its scope, and that I am therefore not to be limited by the specific embodiment shown and described for the purpose of illustration but by the actual scope of my invention as indicated in the appended claims.

I claim:

1. A photophonographic record of sound

comprising a sound track of microscopic dimensions.

2. A photophonographic sound record comprising a band of transparent material  
5 having a photophonographic sound track of microscopic dimensions thereon.

3. A photographic record of sound comprising a sound track recognizable only by the aid of a microscope.

10 4. A photophonographic sound record comprising a band of transparent material having a multiplicity of adjacent sound tracks recognizable only by the aid of a microscope.

15 5. A sound record comprising a record carrier having a photophonographic sound track thereon so small that its characteristics are distinguishable only by the aid of a microscope.

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