

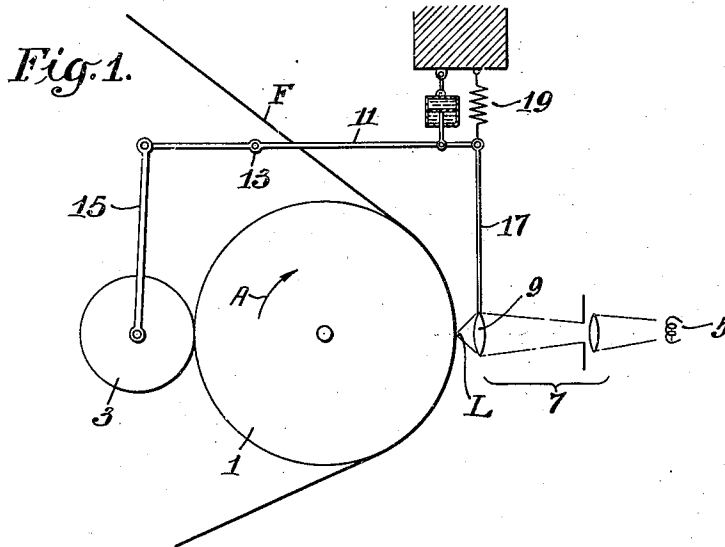
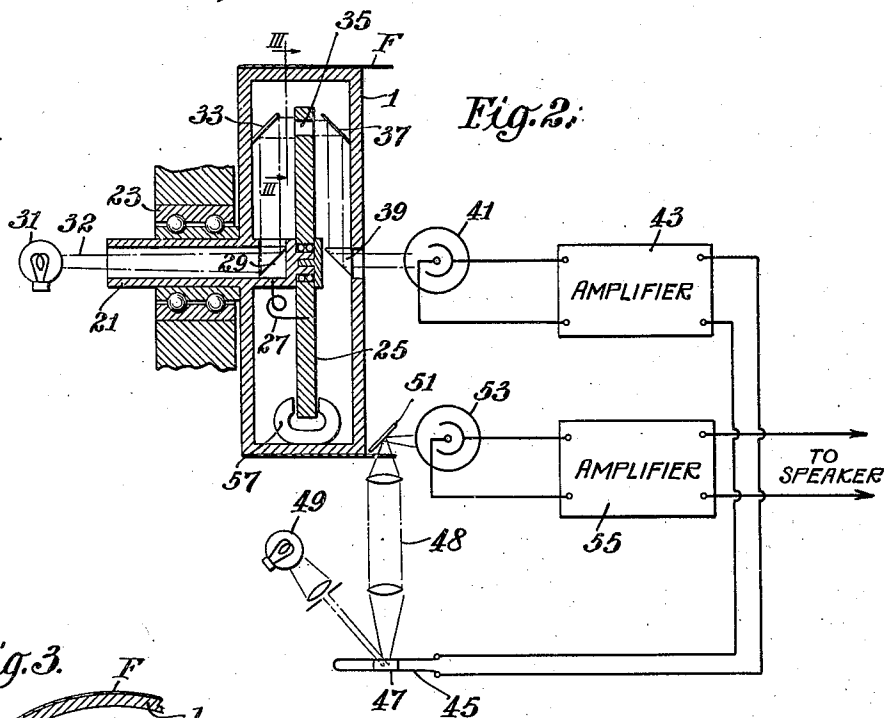
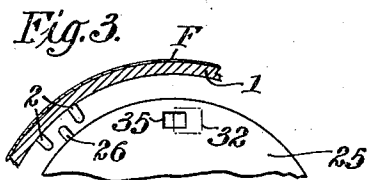
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SOUND RECORDING AND REPRODUCING APPARATUS

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SOUND RECORDING AND REPRODUCING
APPARATUS

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This invention relates to sound recording and reproducing apparatus of the type employing a photographic record, and more particularly to the method of and apparatus for neutralizing the effect upon the finally reproduced sound of variations in the speed of the photographic carrier on which the sound is recorded.

It is well known that in order to record sound upon or reproduce sound from a photographic carrier, it is essential, among other things, that there shall be no variations in the speed of the movable carrier relative to the light beam by which the sound is recorded or reproduced, as the case may be. Thus, if a light beam is directed in a fixed path, it is necessary that the carrier shall move at uniform speed; otherwise, obnoxious variations in the pitch of the finally reproduced sound will result.

It is also well known that the mechanical parts of apparatuses which are employed to record or reproduce sound photographically are not sufficiently perfect mechanically to insure the continued uniform travel of the carrier, even if initially set up to do so. As a matter of fact, much difficulty has been encountered in this respect because of slight mechanical imperfections in sprocket teeth, gear teeth, intermittent drive mechanisms, bearing friction, etc., all of which have contributed in no small way to drive the carrier with slight variations in speed, and these slight variations result in what is popularly known as "gurgles" or "wows" in the sound as it is finally reproduced.

Various suggestions have been made in the prior art for overcoming the foregoing difficulties. For example, it has been suggested to apply a heavy mass to the moving parts and to operate in association with them various mechanical filtering devices. While these have met with some varied success, they do not entirely solve the problem.

The primary object of my invention is to provide a method of and apparatus for operating photophonographic apparatus of the type above referred to in such a manner that the above-noted difficulties existent in prior art devices will be entirely eliminated.

More specifically, it is an object of my invention to provide an improved method of and apparatus for operating photophonograph apparatus whereby relatively slight variations in the speed of the record carrier will be neutralized or compensated for in a manner to result in true and exact reproduction of the original sound.

Another object of my invention is to provide an

improved method of operating photophonographic apparatus of the above-noted type whereby, although the sound carrier is permitted to partake of slight variations in its movement, the sound will be reproduced accurately regardless of such variations.

Still another object of my invention is to provide an improved method, in apparatus of the type aforesaid, whereby variations in the relative movement between the carrier and the light beam is prevented.

A further object of my invention is to provide improved photophonographic apparatus for carrying out the improved method of my invention.

It is also an object of my invention to provide improved apparatus as aforesaid which will be highly efficient in operation as well as simple of manipulation.

In accordance with my invention, I permit the photographic sound carrier to be moved through the apparatus with the slight variations necessitated by the imperfections in the apparatus, but cause the light beam or scanning element to synchronously follow the speed variations in such a manner that the relative speed between the carrier and the light beam is always constant.

The novel features of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of several embodiments thereof, when read in connection with the accompanying drawing in which

Figure 1 is a diagrammatic view, in elevation, illustrating one way of carrying out my invention,

Figure 2 is a similar view, partly in section, illustrating another way of carrying out my invention, and

Figure 3 is a detail view of a portion of the apparatus shown in Figure 2 as seen from the line III—III therein and looking in the direction of the appended arrows.

Referring more specifically to the drawing, there is shown, in Figure 1, a rotatable drum 1 over which a film or carrier F passes and a rotatable roller 3 in frictional engagement therewith. Light is directed onto the film F from a suitable source 5 by an optical system 7 including an objective 9 which is coupled to the roller 3 by a lever 11 pivoted at 13 and the connecting arms 15 and 17.

In operation, as long as the film F moves uni-

formly past the light beam L, the roller 3 merely rotates on its own axis. As soon, however, as there is a variation in the motion or speed of the film F at the sound translating station represented by the drum 1 and the optical system 7, as, for example, a momentary acceleration, the drum 1, if rotating in the direction of the arrow A, will cause the roller 3 to momentarily move upwardly slightly and this upward movement is transmitted to the objective 9 through the arms 15 and 17 and the lever 11 to cause the objective 9 to correspondingly move downwardly. Conversely, if the film F slows down slightly, the objective 9 will be caused to move upwardly correspondingly. In this manner, the relative movement between the film F and the objective 9 is always maintained constant.

In the system just described, if the moment of inertia of the roller 3, the mass of the lens 9, the lever 11 and the arms 15 and 17, and the ratio of leverage in the lever 11 have proper values, any changes in the motion of the drum 1 or film F will be exactly followed by the light beam L in synchronism therewith. A weak spring 19 may be provided, if desired, to cause the lens 9 to vary about a fixed position, while an oil filled dashpot, for example, may be used for damping the movable system.

In the modification shown in Figure 2, the drum 1 is hollow and has a concentric hollow shaft 21 by means of which it is mounted for rotation in a ball bearing 23. Mounted within the drum 1 for rotation on the inner end of the shaft 21 is a disc 25, preferably of copper, which is coupled to the shaft 21 by a weak spring 27. A prism 29 within the shaft 21 directs light from a source 31 onto a reflector 33 which in turn directs the light beam through an opening 35 in the disc 25, the disc 25 being so arranged that the light beam 32 from the source 31 only partly overlaps the opening 35, as clearly shown in Figure 3. The light which passes through the opening 35 is reflected by a reflector 37 onto a second prism 39 which directs it out of the drum 1 onto a photoelectric cell or any other suitable electro-optical device 41 in circuit with an amplifier 43 and a galvanometer 45.

The galvanometer 45 is equipped with a mirror 47 which directs a second beam of light 48 (either a recording or a reproducing beam, as the case may be) from a source 49 onto the film F through a suitable optical system. In the case of a reproducer, the latter beam, after traversing the record on the film F, may be reflected by a reflector 51 onto a second photoelectric cell 53 connected to an amplifier 55, the output of which may be employed to actuate a suitable loud-speaker (not shown). If desired, a permanent magnet 57 may be fixed to the inside of the drum 1 for damping the disc 25.

In operation, it will be seen that, as the drum 1 rotates, the disc 25, which may be termed a reference disc for the sake of convenience, will rotate with it through the spring 27. Since the disc 25 is unloaded, it can be driven at a constant speed equal to the average speed of the drum. Now, if the drum 1 suddenly speeds up slightly or slows down slightly in response, for example, to mechanical imperfections of the driving parts, the degree of overlap between the light beam 32 and the opening 35 will be changed, permitting less or more light, respectively, to reach the photoelectric cell 41. The amplified output of the photoelectric cell 41 will then move the galvanometer mirror 47 correspondingly, whereby

the beam 48 will either move forward or backward slightly, depending upon whether the film F is slightly sped up or slowed down. Thus, it is always possible to maintain constant relative movement between the film F and the scanning beam 48. In practice, the disc 25 may be provided with an extension 26 at any suitable point on its periphery for cooperating with a pair of stops 2, 2 on the drum 1 to limit relative rotation between the drum and the disc upon starting and stopping of the apparatus.

In either system hereinbefore described, it is, of course, necessary that the light beam move in phase with the film. For this reason, it is necessary that the amplifier 43 of the last described system have a negligible phase shift, if any, in the working frequency range and that the galvanometer 45 be stiffness controlled. The disc 25 could be made to have its natural period at about one or two cycles per second, for example, and could be near critically damped. Similarly, the resonant frequency, of the lever systems 15, 11, 17 of the modification shown in Figure 1 could be made of the same order. If the film is driven from a motor by means of gear driven sprockets, the principal frequencies of speed modulation would be well above these frequencies.

While I have shown two specific devices in accordance with my invention by means of which my improved method may be carried into practice, it will be apparent to those skilled in the art that many modifications of my invention are possible. For example, the displacement between the disc 25 and the drum 1 could be utilized directly to move a mirror or lens by having the disc connected to a screw working in a nut which is fastened to the drum 1 on its axis. Relative displacement between the disc and drum would then cause a displacement of the screw along the drum axis. Also, if desired, the displacement of the disc and drum could be made to vary the resistance in a rheostat connected through a battery to the galvanometer. If desired, the displacement between the disc and drum could be made to control the field flux of a high frequency (say 1,000 to 10,000 cycles) generator built into the drum, the output of which could be rectified, filtered, and used to operate the galvanometer. Many other modifications will, no doubt, readily suggest themselves to those skilled in the art. Also, it will be readily apparent to those skilled in the art that my invention is not limited to apparatus employing photographic record carriers, as it is equally applicable to apparatus employing magnetic wire or tape record carriers and wherein the scanning element comprises a magnet which can be made to move in correspondence with variations in movement of the carrier. The invention is, obviously, also applicable to apparatus employing disc record carriers wherein either mechanical or electromechanical means, such as an electromechanical pick-up, for example, constitutes the scanning device. Furthermore, the invention is applicable to both recording and reproducing apparatus, as heretofore already pointed out, and in the latter apparatus, any or all parts of the scanning mechanism, including the photoelectric device employed, may be made movable in accordance with variations in movement of the carrier. I desire, therefore, that my invention shall not be limited except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In photophonographic apparatus having a sound translating station including a drum and means for moving a sound record past said station with slight variations in movement, means including a lens system for directing a beam of light onto said film at said station, and means including a member having frictional engagement with and driven by said drum for moving at least a portion of said lens system in correspondence with said variations whereby to move said light beam correspondingly and thereby to maintain the relative movement between said film and said light beam constant.

2. In photophonographic apparatus, the combination of a movable drum, a film movable over said drum in engagement therewith, a movable roller in frictional engagement with said drum, means for directing a light beam to said film, and means interconnecting said roller and said light beam directing means whereby movement induced in said roller by a change in rotation of said drum is transferred to said light beam directing means.

3. The invention set forth in claim 2 characterized by the addition of means for providing stiffness and damping for said interconnecting means.

4. In photophonographic apparatus, the combination of a pair of relatively rotatable members, means flexibly coupling said members whereby they are adapted to be normally rotated in

unison, a film movable over one of said members with slight variations in movement, means for directing a beam of light through the other of said members, an electro-optical device adapted to be energized by said light beam in accordance with the amount of light transmitted by said other member, and a movable light reflecting member in circuit with said electro-optical device and arranged to direct a second beam of light onto said film, the variations in movement of said film causing relative movement between said members whereby to control the amount of light transmitted to said electro-optical device to thereby control the instantaneous position of said light reflecting member and produce variable movement of said second light beam in accordance with the variations in movement of said film.

5. The invention set forth in claim 4 characterized in that said first named member is constituted by a hollow drum and said second named member is constituted by an opaque disc mounted within and concentric to said drum, said disc being provided with an aperture therein through which said first named light beam is directed to pass.

6. The invention set forth in claim 4 characterized in that said second named member is made of metal and characterized further by the addition of means for magnetically damping said metal member.

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