Nov. 3, 1936. H. E. METCALF 2,059,472

SOUND RECORDING SYSTEM

Filed July 21, 1930

Fig. 1.

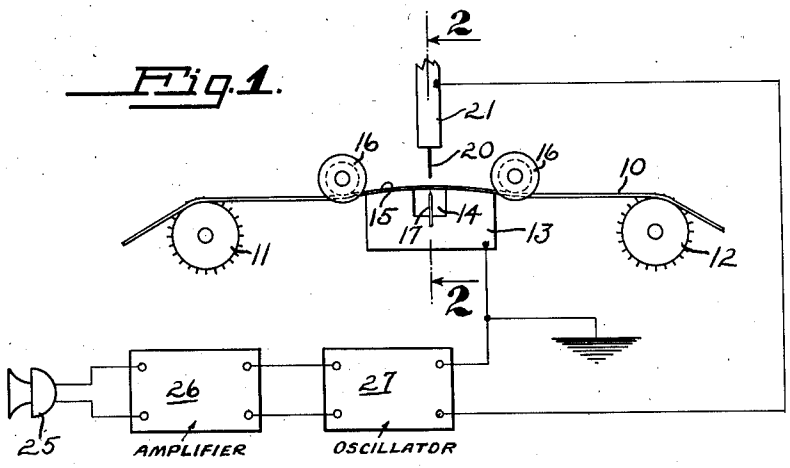
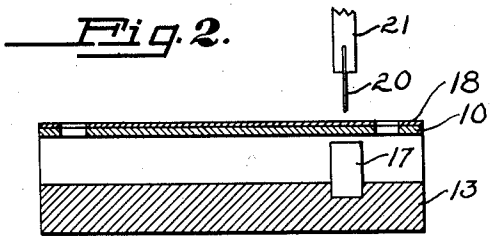


Fig. 2.



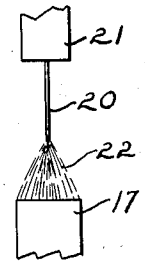


Fig. 3.

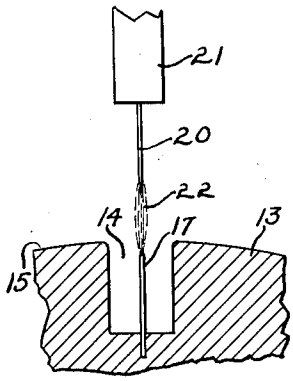
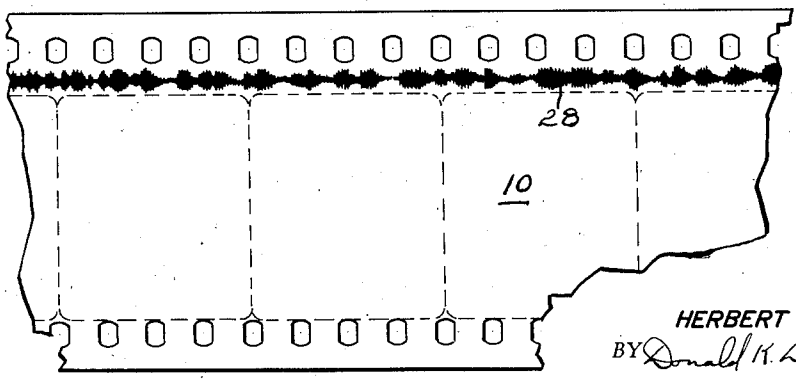


Fig. 4.

Fig. 5.



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2,059,472

SOUND RECORDING SYSTEM

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Application July 21, 1930, Serial No. 469,435

10 Claims. (Cl. 179—100.3)

My invention relates to systems for the recording of sound, or other vibrations or oscillations, upon chemically sensitive media such as photographic film; and particularly to talking moving pictures wherein the sound track is of the variable area type.

Among the objects of my invention are: first, to provide a variable area recording system having no moving parts in the recording head; second, to provide a sound recording system which is not subject to vibrational disturbances; third, to provide a variable area recording system which will produce a sound track, reproduction from which is not affected by slight lateral movements or "weaving" of the film; fourth, to provide a recording mechanism wherein the recording head is sufficiently compact and rugged to be mounted within cameras of standard construction; and fifth, to provide a recording system which is capable of recording a wide frequency band.

My invention possesses numerous other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention, as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawing:

Figure 1 is a schematic diagram of the recording apparatus.

Figure 2 is a cross sectional view, on an exaggerated scale, taken on the line 2—2 of Figure 1.

Figure 3 is a fragmentary view of the recording electrodes, as viewed longitudinally, illustrating the electrostatic field between them.

Figure 4 is a view similar to Figure 3, showing the field between the electrodes as viewed transversely of the film.

Figure 5 is an enlarged section of the film showing a portion of the sound track as produced by the system of my invention.

As is described in my co-pending application, Serial No. 425,811, filed February 4, 1930, I have found that when a chemically sensitive medium, such as a photographic film, is passed thru an electrostatic field, a trace is left upon the medium similar to that produced by light. The mechanism of this action is not fully understood. Traces may be produced in this manner by means of fields which are too weak to produce any visible corona, and when the field is increased to such an intensity that corona does occur, there is no evidence of fogging of the film or spreading of the trace such as might be expected, were the light produced the active agent in forming the trace.

Where a uniform field is used to mark the film, very fine gradations in density of the trace may be produced, and variable density sound recording of excellent quality may be made in this manner. If the field thru which the film is passed is non-uniform I have found that there appears to be a definite threshold value of field below which marking of the film does not occur, while above this threshold field-strength an exceedingly dense trace is produced upon the film. The fine gradations in density which are produced by a uniform field are almost if not entirely absent.

The effect might be explained upon the assumption that the marking is produced by ionic bombardment, and that where a field-strength is reached which will produce ionization complete blackening occurs, the threshold marking value being the ionizing potential. The evidence is as yet insufficient to support any complete theory, however, altho many satisfactory records have been produced.

In general terms, my invention comprises the use of this phenomenon to produce a variable area sound track or record upon the film. A pair of electrodes is provided between which a spatially non-uniform field is established, preferably triangular in form, and lying substantially entirely within a single plane normal to the movement of the film. A potential exceeding the threshold value required to mark the film is applied between the electrodes, and this potential is modulated by the sound to be recorded so as to move the point of threshold potential transversely of the film. Since the field is non-uniform, this movement of the threshold value point will occur merely by variation of the strength of the entire field, so that no mechanical movement is required in order to produce it.

A preferred form of the structure used in the production of sound records for talking motion pictures is shown schematically in Figure 1. This structure may be mounted within the motion picture camera, or may be within an entirely separate recording instrument, wherein the film 10 is moved uniformly by the constant speed sprockets 11 and 12. These sprockets pass the film over a block 13 which has a groove or recess 14 in the slightly convex face 15 over which the film is passed. A pair of guide rollers 16 is preferably used to keep the film stretched tightly over the block.

The block 13 may either be made of insulating

material, or, as is here shown, of metal. Set within the groove is an electrode comprising a narrow, knife-edge blade 17, whose width, transverse to the direction of motion of the film, is equal to the maximum width of the sound track. The height of the blade 17 is such that when the film is in place it barely escapes contact with the blade. The blade is placed under the film, i. e., so that the emulsion side of the film is farthest from the blade. An exaggerated sectional view of the arrangement is shown in Figure 2, wherein the emulsion 18 is shown on the film 10.

Positioned above the film is a needle-point electrode 20 set in a suitable holder 21. When a potential is impressed between the electrodes 17 and 20, an electrostatic field is produced having the general shape shown in Figures 3 and 4. There is, of course, some spreading of the lines of force, which are indicated by the dotted lines 22 in the two last-mentioned figures, but the field in general is planar and triangular in form. The field has its greatest intensity immediately beneath the point 20, tapering off toward the edges of the linear electrode 17.

In order to produce a record upon the film the simple circuit shown in Figure 1 may be utilized. In this drawing the microphone 25, which may be of any suitable type, feeds into the amplifier 26, the output of which is used to modulate an oscillator 27.

The oscillator may operate at substantially any frequency which is well above the audible frequency which it is desired to record. In practice, a frequency from 50,000 to 100,000 cycles per second has been found suitable, but there is no reason why higher or lower frequencies can not be used. The block 13, connecting with the electrode 17, is preferably grounded, but this expedient is optional, as the device will work without a ground.

The oscillator 27 is preferably so adjusted that without modulation, the threshold value of the field-strength required to mark the film extends substantially over the middle half of the lower electrode. In the presence of a modulating current the threshold value of field extends alternately farther across the lower electrode and back closer to the center, as the oscillating potential between the electrodes rises and falls. The result is that the film is marked with a trace 28 such as is shown somewhat crudely in the drawing of Figure 5, it being almost impossible to produce by other than photographic methods a trace of the symmetry which is actually exhibited by the film.

One of the principal advantages of the form of trace produced by this apparatus, is that it is symmetrical about the median line of the sound track. As a result of this fact, if the film weaves or oscillates slightly from side to side during either the recording or the projection of the sound, no corresponding distortion of the sound occurs. This is due to the fact that since the trace is slightly narrower than the sound track or the projection slit, a lateral motion of the film merely serves to cover a portion of the unexposed sound track on one side of the film, and uncover an equal of un-exposed track on the opposite side. The net amount of light admitted thru the projecting slit is not varied by these slight motions of the film, and hence no spurious or un-wanted sounds are projected.

Altho I prefer the symmetrical arrangement of the electrodes here shown, it will at once be evident that this is not an essential part of my invention. The point may be slightly displaced from the center of the electrode 17, or even be placed over one corner of this electrode, and still produce satisfactory recordings. In fact, any arrangement of electrodes which produces a spatially non-uniform field thru the film will make recordings of sound, altho it is obvious that some of these records will be better than others, and I have obtained the best results from the arrangement shown.

Altho I have used the term "sound" thruout this specification and in the claims, I do not wish this to be construed as a limitation. Any sound recorder which produces a visible trace is, essentially, an oscillograph, and may be used for recording any type of vibration which can be converted into electrical impulses or oscillations. The use of such a device as a sound recorder is of course its primary object, and the use of the word "sound" simplifies the terminology thruout, but this usage is not intended as a disclaimer of other applications to which the arrangement may be put.

I claim:

1. In a sound recording system, the combination of a photographic film, means for moving said film, means for creating an electrical discharge on one side of said film having a portion in contact with said film, means for varying the intensity of said discharge to vary the size of said film contacting portion, and an electrode on the other side of said film positioned to confine the size and shape of said film contacting portion to elemental dimensions.

2. In a sound recording system, the combination of a photographic film, means for moving said film, means for creating an electrical discharge on one side of said film having a portion in contact with said film, means for varying the intensity of said discharge to vary the size of said film contacting portion, and an electrode on the other side of said film having a linear edge adjacent said film positioned to shape said portion to have a contact area of elemental dimensions.

3. The method of recording impulses to form a variable area track upon a moving photographic film which comprises the steps of establishing an electrostatic field passing through said film with a major dimension transverse to the motion of said film, and having a portion in contact with said film of elementary dimension parallel to the motion of said film whose intensity is sufficient to leave a trace on said film, and altering the intensity of the entire field in accordance with the impulses to be recorded to cause the portion of threshold intensity to change its dimension transverse to the motion of said film without materially changing the said dimension parallel to the motion of said film.

4. The method of recording impulses on a moving sensitized film which comprises establishing an electrical discharge from a point in space to one side of said film, varying the intensity of said discharge to vary the area in contact with said film, and confining the shape of said contact area to elementary directions solely by an electrostatic field passing through said film.

5. The method of recording impulses on a moving sensitized film which comprises establishing an electrical discharge in contact with one side of said film, varying the intensity of said discharge to vary the area in contact with said film, and regulating the shape of said con-

tact area solely by a narrow transverse electrostatic field passing through said film.

6. In combination, a sensitized film, a recording electrode on one side of said film, means for creating an electrical discharge from said recording electrode to said film, means for changing the size of said discharge, and means on the other side of said film and opposing said recording electrode for regulating the direction of said size change.

7. In combination, a moving sensitized film, a pointed recording electrode on one side of said film, means for creating an electrical discharge from said recording electrode to said film, means for changing the size of said discharge, and a second opposed electrode on the other side of said film having a linear edge positioned transverse to the direction of motion of said surface to regulate the direction of said size change.

8. The method of recording sound on a moving sensitized surface which comprises ionizing air in contact with said surface over a defined area, changing the degree of ionization to change the size of said area, and directing the direction of size change solely by an electrostatic field passing through said film.

9. The method of recording sound on a moving sensitized surface which comprises ionizing air in contact with said surface over a defined area, changing the degree of ionization to change the size of said area, and directing the direction of size change solely by an electrostatic field, said field being variable substantially in one direction only in synchronism with said size changes.

10. The method of recording sound on a moving sensitized surface which comprises ionizing air in contact with said surface over a defined area, changing the degree of ionization to change the size of said area, and directing the direction of size change solely by an electrostatic field which is allowed to change substantially in one direction only in synchronism with said size changes.

HERBERT E. METCALF.