

April 11, 1944.

G. T. LORANCE

2,346,496

FILM SOUND RECORDING SYSTEM

Filed June 5, 1941

2 Sheets-Sheet 1

FIG. 1

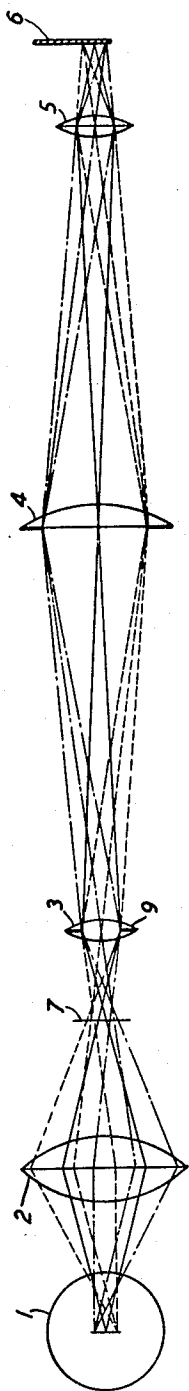
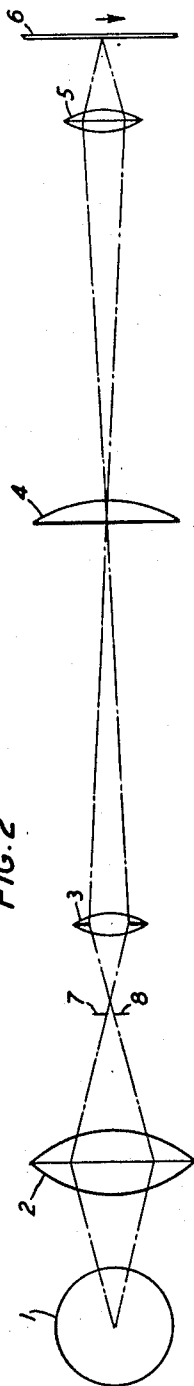


FIG. 2



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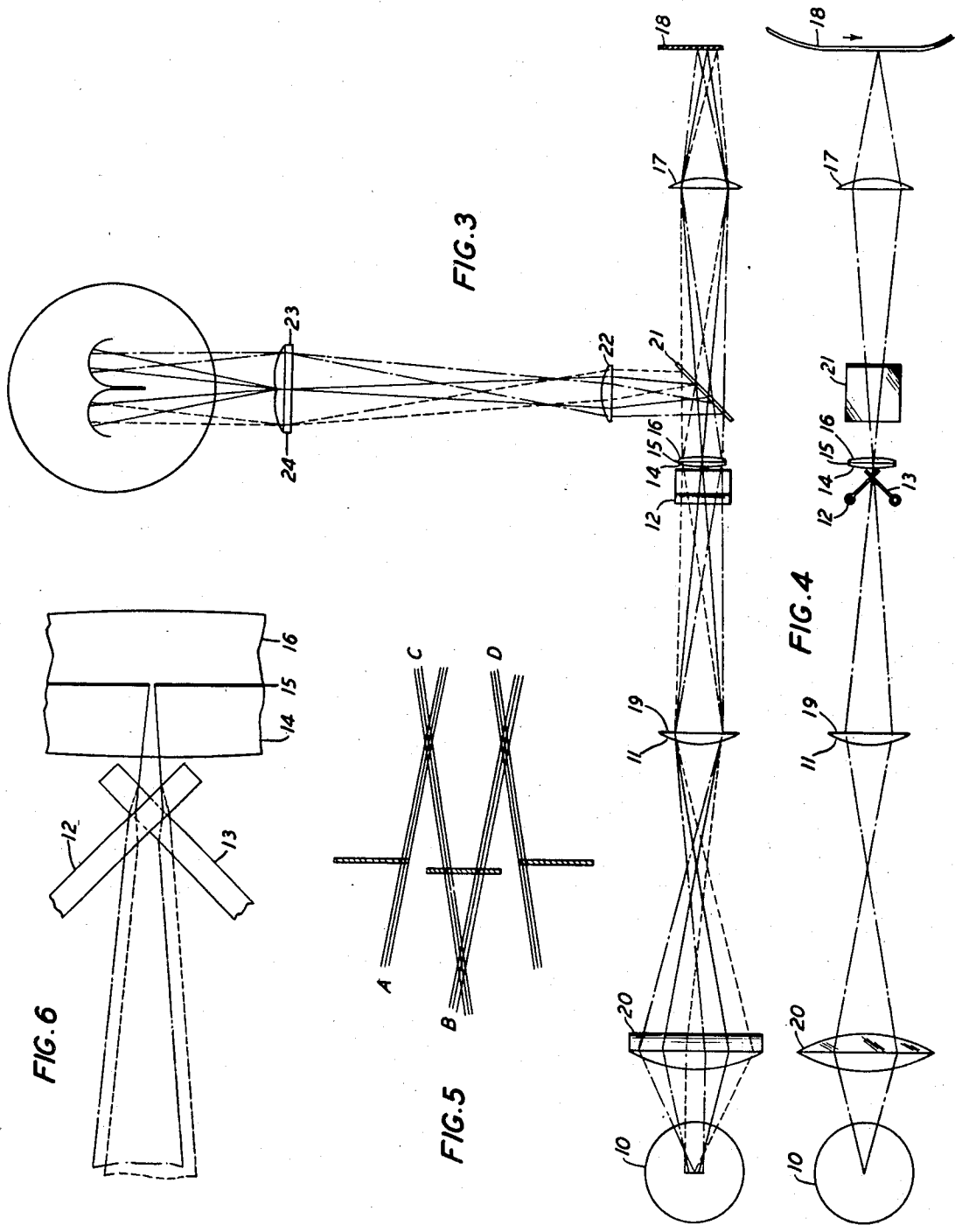
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FILM SOUND RECORDING SYSTEM

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Application June 5, 1941, Serial No. 396,651

3 Claims. (Cl. 88—61)

This invention relates to film sound recording systems, and particularly to a system for recording signal currents by a beam of light of variable intensity.

The object of the invention is a system for recording signal currents, such as sound varied electrical currents, by a beam of light of constant area, varied in intensity in accordance with the variations in the signal currents.

A feature of the invention is a simultaneous variation in the intensity of the light in accordance with the general envelope of the amplitude variations of the signal currents, in addition to a variation in the intensity of the light due to the instantaneous variations in the signal currents.

Another feature of the invention is a single three-ribbon light valve for simultaneously and oppositely varying the intensity of two beams of light in accordance with the variations in the signal currents, and similarly varying both beams in accordance with the envelope of the signal currents.

A further feature of the invention is means for monitoring each of the light beams.

Other features and advantages of the invention will be apparent from the following description, read in connection with the drawings, in which:

Fig. 1 shows, in plan view, a simplified form of a single optical channel;

Fig. 2 is an elevation of the system shown in Fig. 1;

Fig. 3 shows, in plan view, a complete system embodying the invention;

Fig. 4 is an elevation of the system shown in Fig. 3;

Fig. 5 shows in enlarged scale the light beams passing through the three-ribbon light valve; and

Fig. 6 shows in enlarged scale the refractor plates used in the system of Figs. 3 and 4.

Light from the source 1 is collected by the condenser lens 2 and illumines the relay lens 3, which focusses the beam of light upon a long narrow slit in an opaque mask affixed to, or closely associated with, the collector lens 4. An image of the illuminated slit is focussed by the objective lens 5 on the surface of the film 6, shown in section in Fig. 1. The film 6 is moved at constant speed by known means, and may be considered as moving downward in Fig. 2. The length of the slit associated with the lens 4 is placed laterally to the film 6. The lens 2 focusses the light from the source 1 between the lens 2 and the lens 3. The ribbons 7, 8 of the known type of two-ribbon light valve are aligned with the beam at a point near the focus, but not at the

focus, such that the ribbons will be completely illuminated when separated by a current of maximum amplitude, and will operate as an optical stop to vary the intensity of the light falling on the lens 3, and the intensity of illumination of the slit associated with the lens 4. Thus, a beam of light of uniform size, but varying intensity, will be impressed on the film 6. Since the light valve ribbons operate by cutting into the useful light pencils in the beam from the top and bottom, the beam must have straight vertical sides. To secure this result, a square or rectangular stop 9 is placed in the lens 3, or in an opaque plate closely associated with one surface of the lens 3.

The ribbons 7, 8 are moved by the signal currents in the usual manner, and may also be varied in spacing in accordance with the envelope of the signal currents by the usual noise reduction control circuit.

In Fig. 3, light from the source 10, is collected and focussed by the condenser lens 20 on a relay lens 11. The pencils of rays from the center, the ends and the quarter points of the filament of the source 10 have been indicated. As shown in Fig. 5, a three-ribbon light valve may be used, the center ribbon being oscillated by the signal currents, and the outer ribbons being connected in serial relationship to the usual noise reduction circuit, so that the outer ribbons will both move outward as the amplitude of oscillation of the center ribbon increases and will both move inward as the amplitude of oscillation of the center ribbon decreases. The light valve is placed in the beam near, but not at the focal point of the lens

20. Two openings in the pole-pieces of the light valve permit light to pass between the upper ribbon and the center ribbon to expose one-half of the sound track, and to pass between the center ribbon and the lower ribbon to expose the other half of the sound track. Only the center ribbon is used to record the signal, thus, as it vibrates vertically, as shown in Fig. 5, the exposure to one-half of the track is increased while the exposure to the other half of the track is decreased thereby recording a push-pull track. As the openings in the pole-pieces are offset, there are really two optical axes at the relay lens but as they are only .006 inch apart, they do not show in Fig. 3. However, as shown in Fig. 6, the two optical axes are brought into lateral alignment by the refractor plates 12, 13, which may be simple optical glass flats of suitable thickness, set at an angle of about 45 degrees to the optical axis. The light from the refractor plates 12, 13 is directed on a slit formed in an opaque plate 15, which may con-

veniently be placed between the two lens elements 14, 16, which form the collector lens. The opaque plate 15 may be a separate thin plate, or may be an opaque deposit, such as a metal deposited by cathodic sputtering, or some paint, varnish lacquer, etc., on the surface of one of the lens elements, and having a narrow slit scraped or otherwise formed through the plate. A similar construction may be used for the slit associated with the lens 4.

In the design of optical systems of this character though the light actually is transmitted from the source to the film, it is often easier to start with the desired image and trace back to the source, taking care that all apertures are as required and the light source is large enough to supply all needed rays. Thus, in Fig. 5, the rays shown are the images of the slit formed in the plate 15 as seen through the refractor plates 12, 13 and the lens 11, the rays AB defining the edges of the slit as seen through one plate, and the rays CD defining the edges of the slit as seen through the other refractor plate. The ribbons of the light valve are so located as to just clear these images.

The slit in the opaque plate 15 is imaged by the objective lens 17 on the surface of the film 18, which is shown in section in Fig. 3 and as moving downward at uniform speed in Fig. 4.

As the light valve ribbons are not imaged, in either the plane of the slit in the opaque plate 15, or at the film 18, their movement varies the aperture of the relay and objective lenses. This variation is similar in both lenses as the aperture of the relay lens 11 is imaged in the aperture of the objective lens 17 by the collector lenses 14, 16. To avoid non-linearity, the apertures must have straight parallel and vertical sides. This result is achieved by placing a mask 19, having such an aperture, very close to the lens 11 to form the aperture of this relay lens 11.

If the light source 10 has a coiled filament, the coil structure should not be imaged on the film. Such an image is avoided in the present system by forming a cylindrical surface on the lens 20. The diameter of the filament coil is imaged in the plane of the light valve ribbons, and the length of the coil is imaged in space between the light valve ribbons and the relay lens 11. Thus, a sufficient length of the filament is made to contribute to the brightness of each point in the image of the slit that no striations are produced in the illumination of the image on the film.

In order to monitor on the recording light beams, a transparent plate 21 is placed in the recording light beams at such an angle as to

transmit the larger part of the light to the film, and to reflect sufficient light to the collector lens 22. The collector lens 22 directs the two recording beams from the two openings of the recording device individually to the two cylindrical lens elements 23, 24. The lens elements 23, 24 direct the two beams of light to individual light sensitive elements, which may be, as shown, the two cathodes of a double-cathode photoelectric cell.

What is claimed is:

1. In a recording system, an elongated source of light, a condenser lens forming an image of said source in space, a recording device including a plurality of opaque shutters in the light from said source near, but not at, said image, a relay lens, an optical stop having an aperture with straight parallel sides closely associated with said relay lens and illuminated by the light passing said recording device, a collector lens, an aperture plate having a long narrow slit associated with said collector lens at the focus of said relay lens, a light sensitive surface moved at constant speed, and an objective lens forming an image of said slit on said surface.

2. In a recording system, an elongated source of light, a condenser lens forming an image of said source in space, a recording device including three parallel spaced opaque shutters aligned with the longer axis of said source in the light from said source near, but not at, said image, a relay lens, an optical stop having an aperture with straight parallel sides closely associated with said relay lens and illuminated by the beams of light passing said shutters, a collector lens, an aperture plate having a long narrow slit associated with said collector lens at the focus of said relay lens, optical means for aligning the beams of light passing said shutters upon said slit, a light sensitive surface, and an objective lens forming an image of said slit on said surface.

3. In a recording system, a coil filament lamp, a recording device including three parallel spaced opaque shutters, a condenser lens having a spherical and a cylindrical surface forming an image of the diameter of said coil on said shutters, and an image of the length of said coil in space beyond said shutters, a relay lens, an optical stop having an aperture with straight parallel sides associated with said relay lens and illuminated by the beams of light passing said shutters, a collector lens, an aperture plate having a long narrow slit associated with said collector lens, optical means for aligning said beams on said slit, a light sensitive surface, and an objective lens imaging said slit on said surface.

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