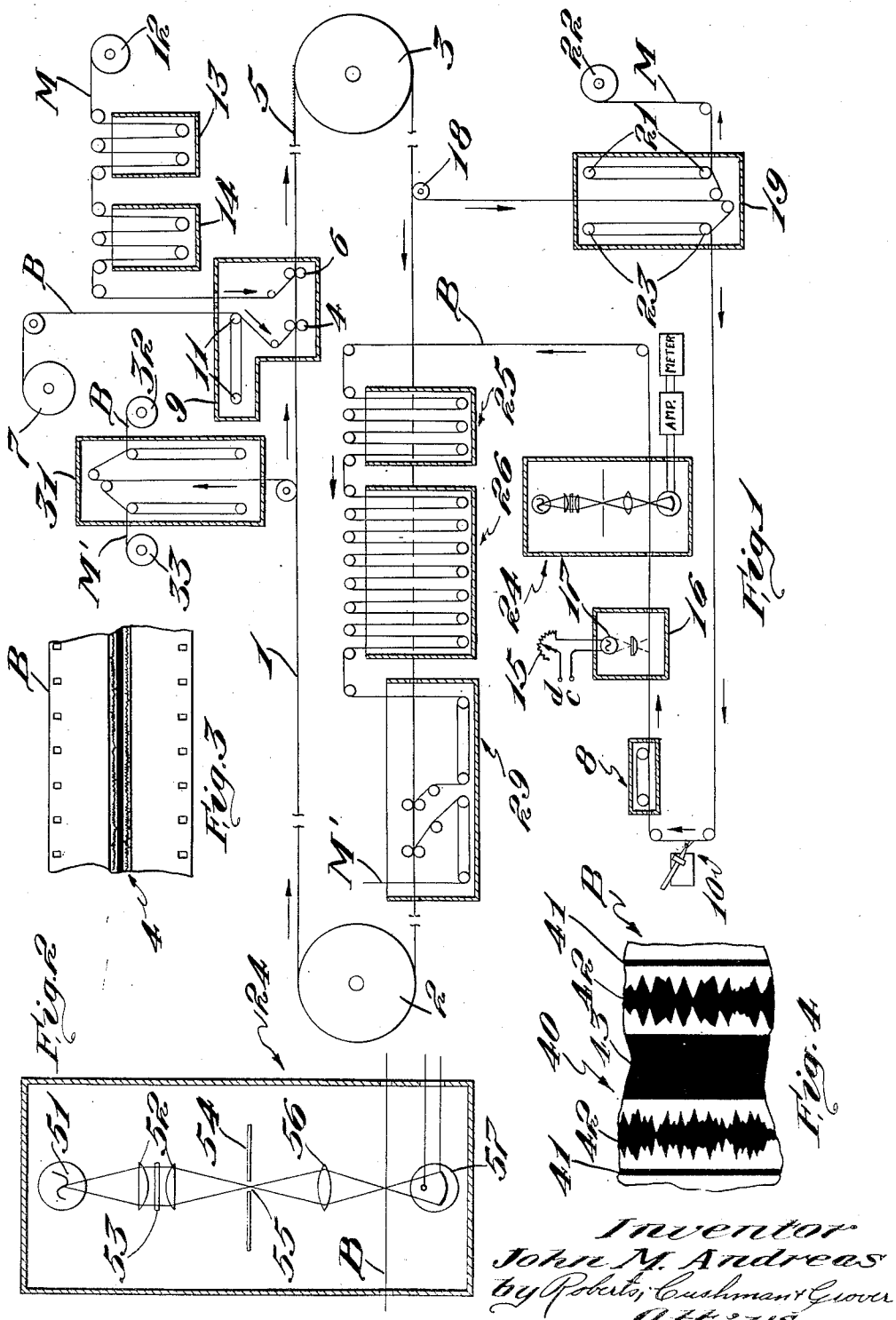
May 22, 1951 J. M. ANDREAS 2,553,841

CINEMATOGRAPHIC APPARATUS

Filed Nov. 20, 1948 2 Sheets-Sheet 1



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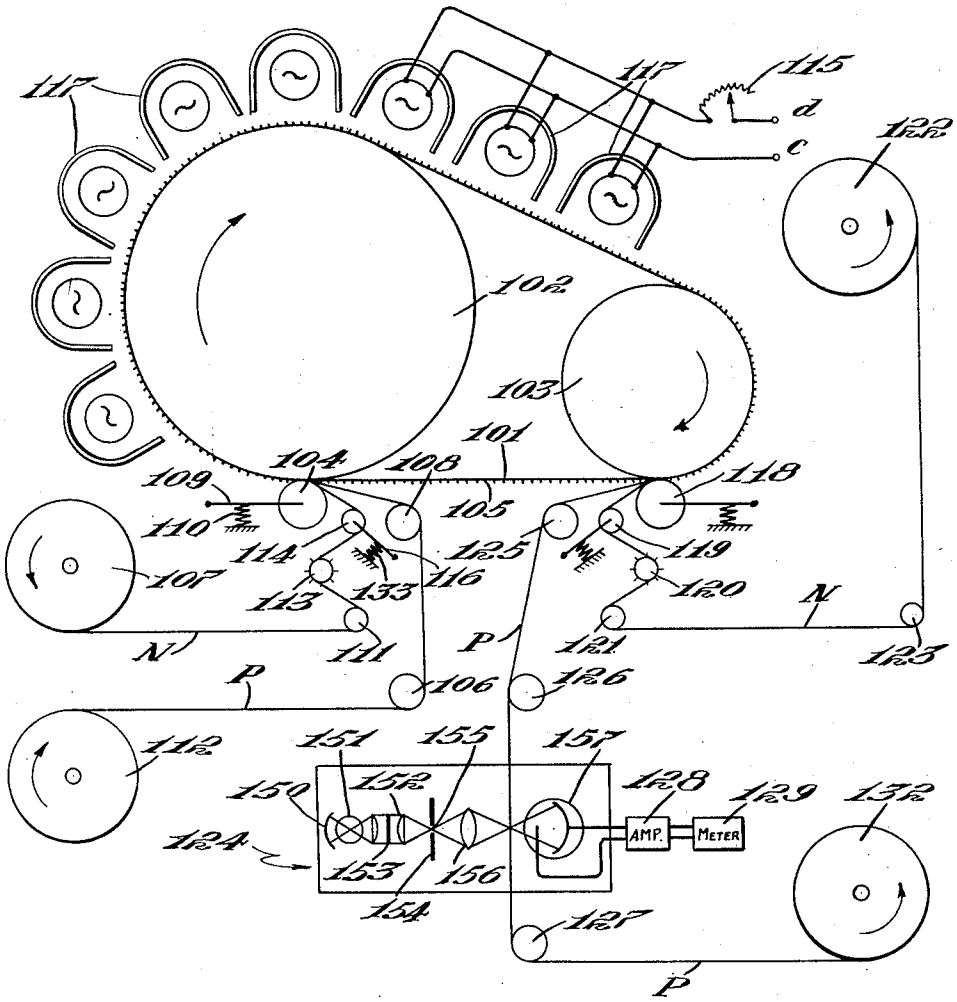

Fig. 5

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CINEMATOGRAPHIC APPARATUS

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5 Claims. (Cl. 95—75)

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This invention relates to the art of printing sound tracks on motion picture films. With the constant-density-variable area type of sound reproduction it is by definition necessary to keep the sound-track density equal to a constant reference density so that the light values received by the photo-cell of the sound head in the motion picture projector will not be modulated by variations in the density of the track. Likewise it is essential that the modulations in a variable-density sound track be related to a fixed reference density such that a given variation from that density will represent a certain variation in amplitude. It has formerly been thought necessary to develop the printed sound record before testing its density for the purpose of controlling the printing exposure in order to eliminate the above-mentioned undesirable variations. However, owing to the delay during the developing and finishing processes a great many feet of film may be printed incorrectly before the density test reveals the incorrect exposure. The larger the volume of film that is being printed and the greater the speed at which it is printed the more imperative it becomes for the density test to discover quickly and accurately the improper exposure.

Objects of the present invention are to provide a quick and accurate means of discovering undesirable variations in the density of a printed sound track, and to provide a density test which will permit a prompt correction of errors.

The present invention concerns a system of producing sound tracks employing a motion picture film strip which is coated in the sound-track area with a print-out emulsion and involves apparatus for producing a sound record having a portion of constant reference density comprising a device for printing the sound track by photographic exposure of the area so as to produce a print-out record, this device including an adjustable source of exposing light, means for controlling the effective intensity of this light, and a densitometer for testing the light absorptive qualities of the reference density portion of the exposed but undeveloped record including as a measuring illuminant a source of radiation to which the print-out emulsion is not sensitive, whereby variations in the reference density of the print-out record may be determined prior to further photographic treatment and the exposing light controlled to produce the desired reference density in the reference portion of the record. This said portion of constant reference density may be a strip parallel to or a marginal portion of the sound track such as the constant-width constant-density margin of a variable area sound track or a like margin or strip beside a variable density sound track.

In a further aspect the apparatus includes sound-track developing means, the densitometer

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being arranged ahead of the developing means so that variations in the density of the reference portion may be determined prior to development.

In another aspect the invention involves the method of producing a sound track which comprises printing a print-out sound record in the emulsion, testing the light-absorptive qualities of that record by means of radiation to which the emulsion is not sensitive and controlling the printing exposure in accordance with the test.

For the purpose of illustration typical embodiments of the invention are shown in the accompanying drawings in which

Fig. 1 is a schematic diagram of apparatus for printing picture and sound records;

Fig. 2 is a schematic diagram of the densitometer;

Fig. 3 is a view of a double width 16 mm. film strip carrying two variable width sound tracks;

Fig. 4 is an enlarged view of a portion of the sound tracks; and

Fig. 5 is a schematic diagram of another embodiment of the invention.

The particular embodiment of the invention shown in Figs. 1 and 2 involves an imbibition machine having an endless pin belt 1 traveling in an orbital path over drums 2 and 3, the belt having teeth 5 adapted to fit in the sprocket holes of films. The blank film B to be printed is fed from a supply roll 7 into a water tank 9 where the film loops back and forth over a series of rollers 11 to permit the gelatin coating to soak up a predetermined amount of moisture. A matrix M, carrying picture as well as sound records in the form of gelatin relief, is fed from the supply roll 12 through a dye tank 13 where it takes on dye in conformity with the relief, thence through a water tank 14 to rinse off superficial dye and thence through the water tank 9. The film B to be printed is fed to the belt between two pressure rollers 4 which seat the film on the belt, and the matrix M is fed to the belt between the pressure rolls 6 which seat the matrix on the film B.

After traveling together long enough for the dye in the picture and sound track areas to transfer from the matrix M to the blank B the two film are fed from the belt over a roller 18 into a drying box 19 where they are separated, the matrix M looping back and forth over rolls 21 while drying and then feeding to a take-up roll 22, and the blank B looping back and forth over a series of rolls 23 and then feeding past a device 10 for applying a sensitizing solution to the sound track zone of the film. Preferably the sensitizer is a solution of light-sensitive ferric iron salts in combination with a ferricyanide, although other emulsions of the print-out type such as bichromate salts, silver citrate, tartrate, oxalate or chloride, and kallitype emulsions may be used. The sensitized blank film B is then dried in tank 8 and passed through the exposure

box 16 containing a light source 17 for exposing the sound track zone of the film B through the dye sound track imbibed on the blank between rollers 6 and 18 as above described. The exposure is made from the face of the film B instead of the back because the dye image is confined largely to the surface of the coating on the film whereas the sensitizer has penetrated deeper in the film. The strip B is then fed through a densitometer 24, and thence through the developing and finishing tanks 25 and 26. When the pictures on the film B are printed with a single color, the blank may then be dried and fed to a take-up roll. However, in color printing one or more additional colors may be printed on blank B after it leaves the tank 26. In a two-color process involving red-orange and blue-green color aspect records the first color with which the sound track is printed, is preferably blue-green. In this case the tank 29 will be a water bath wherein a second matrix M' carrying the red-orange dye is rinsed and the two films B and M' seated upon the pin belt for imbibition of the red-orange picture record on the blank B. After the second dye is transferred the second matrix M' and the printed blank B are separated in the dry box 31 and taken up on rolls 33 and 32 respectively.

According to the present invention the visible record which is produced in the print-out emulsion by exposure alone is subjected to a density test immediately after exposure. Whereas in ordinary black and white silver processes the latent record is invisible and cannot be measured until after its development, the print-out record of a blue print emulsion or the like is clearly visible and may be measured immediately after printing. Although the density of the print-out record is not equal to that of the final developed record, it will give an accurate prediction of what the density of the final record will be.

Fig. 2 shows in detail the optical system used in the densitometer which includes a source of radiant energy 51, a pair of condensing lenses 52 between which is interposed a filter 53 to exclude radiation to which the undeveloped emulsion may be sensitive, a mask 54 having an aperture 55, an achromatic objective 56, and a photocell 57 sensitive to the radiation passed by the filter. Light from the lamp is gathered by the condenser, filtered, fills the aperture, passes through an achromatic objective which images the aperture on the film, passes through the film, and then reaches the photocell. The light energy values received by the photocell are amplified in an electronic circuit indicated in Fig. 1 by the box labelled AMP and used to vary the reading on an ammeter indicated by the box labelled "Meter." The ammeter may give a density reading, or may be set at a mid-scale null which corresponds to the desired reference density of the sound track, and used to indicate any variations from the desired density.

One type of sound record suitable for use with the present invention is illustrated in Figs. 3 and 4. This record comprises a double-width 16 mm. film strip carrying two sound records along the center of the strip. As shown in Fig. 4, the finished double sound record includes two marginal stripes 41 of constant width, two sound records 42 of variable width and a center stripe 43 of constant width. Subsequent to printing the sound and picture records the strip is divided longitudinally through the center stripe into two conventional 16 mm. strips. Preferably it is the

density of this center stripe which is measured prior to the division, however the constant width margin of the sound record on a double 16 mm. or a conventional 35 mm. film, or the variable width sound record itself may be measured in some cases.

In addition, a marginal stripe present with or incorporated in a variable density sound track may be tested. This stripe may be of any fixed density which transmits light values within the range of the sound head photocell. A variation in this reference density indicates that all the density values will be incorrect. Normally, the reference portion is a marginal area printed in the upper region of the density range. However, by suitable arrangement of the printing device a stripe or portion may be printed of any desired density value, for instance the mid-range density.

A rheostat or similar current regulating device is provided for the purpose of controlling the intensity of the printing lamp 17. Where a blueprint type emulsion is used it is customary to employ several strong mercury vapor lamps. In this case it may be the last of the lamps which is controlled. The operator of the printing machine observes the reading on the densitometer and adjusts the rheostat accordingly. Preferably the densitometer is located immediately after the last printing lamp in order to reduce the delay between exposure and testing to a minimum.

If desired the amplified photocell response may be applied to an automatic controlling device which adjusts the effective intensity of the printing lamp in accordance with the response of the photocell.

A preferred embodiment of the invention is illustrated in Fig. 5 which involves a cinematographic contact printing machine having an endless belt 101 traveling in an orbital path over drums 102 and 103, the belt having teeth or pins 105 adapted to fit in the sprocket holes of the films. The film strip P to the printed may be sensitized in the sound track area with a blue print type emulsion which may comprise potassium ferricyanide and ferric ammonium oxalate. The printing negative N carries a variable area soundtrack record, preferably a high quality black and white silver negative on a fine grain gray-base film. Both strips P and N are dry when their supply reels 112 and 107 respectively are mounted in the printing machine. The film P to be printed is fed from the supply reel 112 over guide rolls 106 and 108 to the seating roller 104. A pivoted arm 109 actuated by the compression spring 110 holds the seating roller 104 yieldingly against the drum 102. The film strip N is fed over the guide roll 111, the sprocket 113 and the floating pulley 114 and then is seated simultaneously with the strip P on the pin belt 101 by the seating roller 104. Owing to the fact that the negative N shrinks somewhat in development, the floating pulley 114 is supported on a pivoted arm 116 which is urged by the spring 133 to stretch the strip N between the sprocket 113 and the seating roller 104.

Both film strips are then carried on the belt 101 under a series of exposing lamps 117, one or more of which may be varied in intensity by means of a rheostat 115 which controls the power supplied at the terminals *d* and *c*. After passing under the lamps the two strips leave the pin belt at the floating roller 118 which is supported like the seating roller 104. The negative strip N then feeds over the tension pulley 119, the sprocket 120 and the guide rolls 121 and 123 to the take-

up reel 122. After leaving the roller 118 the positive strip P is fed over the guide rolls 125 and 126 through the densitometer 124, thence over the guide roll 127 to the take-up reel 132.

The densitometer 124 comprises a source of light 151, a reflector 150, condenser lenses 152, a red filter 153, a mask 154 having a slit 155, objective lens 156 and a photo-sensitive device 157. The filter 153 passes light to which the still undeveloped but visible print-out record on the film strip P is not sensitive. Such light passing through the slit 155 is imaged on the print-out sound track record of the film strip P through a reference portion of constant width as hereinbefore described and falls on the photosensitive tube 157. The response of the photo tube 157 is amplified in an electronic circuit 128 and applied to a meter 129. Undesirable variations in the density of the print-out record are indicated on the meter. The operator of the printing machine then adjusts the rheostat 115 according to his observation of the meter until a correct density indication is given by the meter 129.

It should be understood that the present disclosure is for the purpose of illustration only, and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. Apparatus for producing a sound record having a portion of constant reference density in a motion picture film strip sensitized in its sound record area with a print-out emulsion which comprises a device for printing a sound track by photographic exposure of said area of the emulsion so as to produce a print-out sound record, an adjustable source of exposure light, means for controlling the effective intensity of said source, sound track developing means, and a densitometer arranged ahead of said developing means for testing the light absorptive qualities of said portion of the exposed but undeveloped record, said densitometer including as a measuring illuminant a source of radiation to which the emulsion is not sensitive and optical means for directing a beam of said radiation only on said portion, whereby variations in density of the print-out sound record may be determined prior to further photographic treatment, and said exposure light source of the printer controlled according to the density of the record produced by said exposure to produce the desired reference density in said record.

2. Apparatus for producing a sound record having a portion of constant reference density in a motion picture film strip coated in its sound record area with a print-out emulsion, which comprises means for feeding the strip along a path, a device adjacent the path for printing a sound track by photographic exposure of said area of the emulsion so as to produce a print-out sound record, an adjustable source of exposure light, means for controlling the effective intensity of said source, sound track developing means on the path, and a densitometer closely adjacent said printer and ahead of the developing means on said path for testing the light absorptive qualities of said portion of the exposed but undeveloped record, said densitometer including as measuring illuminant a source of radiation to which the emulsion is not sensitive and optical means for directing a beam of said radiation only on said portion, whereby variations in density of the print-out sound record may be determined immediately after exposure and prior to development, and the printer controlled according to the density of the record produced by said exposure to produce the desired reference density in said record.

3. In the art of producing a sound record having a portion of constant reference density in a motion picture film strip sensitized in its sound track area with a print-out emulsion the method which comprises printing a sound track by photographic exposure of said emulsion so as to produce a print-out record, immediately testing the light absorptive qualities of said portion of the exposed but undeveloped record by means of radiation to which the emulsion is not sensitive and controlling the printing exposure according to said light absorptive qualities, whereby variations in density of the print-out sound record may be determined prior to further photographic treatment, and the printing exposure varied according to the density of the record produced by said exposure to produce the desired reference density in said record.

4. In the art of producing a constant density-variable area sound record in a motion picture film strip coated in the sound track area with a print-out emulsion the method which comprises printing a sound track by photographic exposure of said emulsion so as to produce a print-out record, immediately testing the light absorptive qualities of the exposed but undeveloped record by means of radiation to which the emulsion is not sensitive, and controlling the printing exposure according to said light absorptive qualities, whereby variations in density of the print-out sound record may be determined prior to further photographic treatment, and the printing exposure varied according to the density of the record produced by said exposure to produce the desired density in said record.

5. In the art of producing a sound record having a portion of constant reference density in a motion picture film strip sensitized in its sound track area with a print-out emulsion, the method which comprises printing a sound track by photographic exposure of said emulsion so as to produce a print-out record including the aforesaid reference portion, directing only on said portion a beam of radiation to which the emulsion is not sensitive, measuring the light-absorptive qualities of said portion of the exposed but undeveloped record by means of said beam and controlling the printing exposure according to the light-absorptive qualities of the record produced by said exposure, whereby variations in density of the print-out record may be determined prior to further photographic treatment, and the printing exposure varied to produce the desired reference density in said record.

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