June 3, 1930. J. E. THORNTON 1,761,897

MULTICOLOR CINEMATOGRAPHIC AND OTHER FILM AND PROCESS OF MAKING SAME

Filed May 5, 1924

FIG. 1

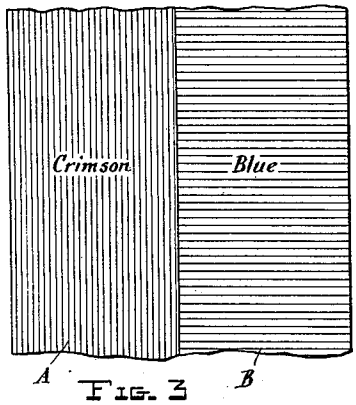


FIG. 2

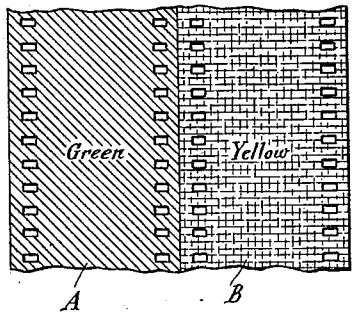


FIG. 3

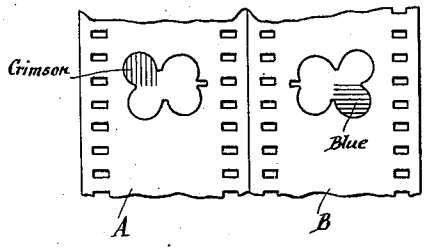


FIG. 4

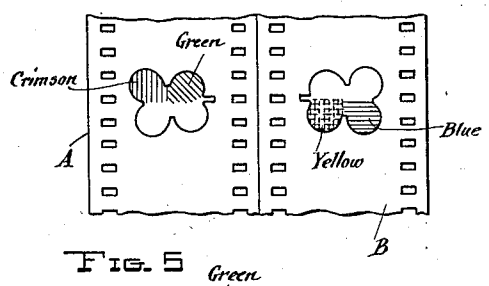


FIG. 5

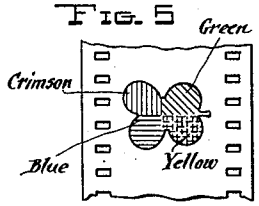


FIG. 7

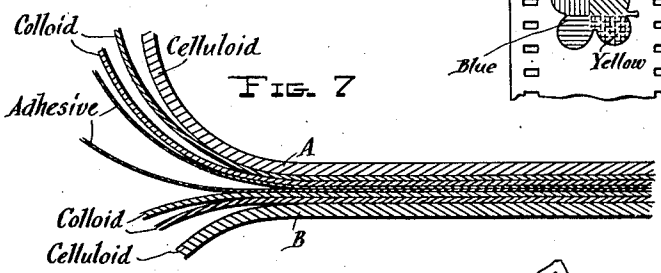
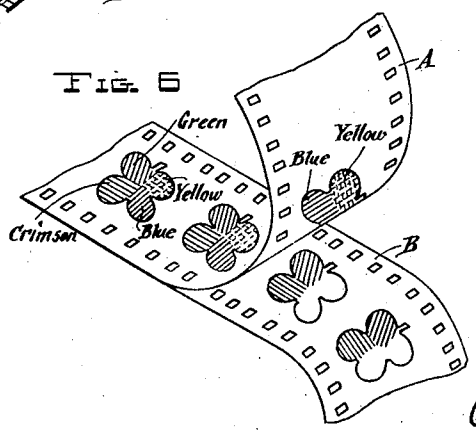


FIG. 6



INVENTOR

John E. Thornton,

by

ATTORNEY

Patented June 3, 1930

1,761,897

UNITED STATES PATENT OFFICE

JOHN EDWARD THORNTON, OF LONDON, ENGLAND, ASSIGNOR TO JOHN OWDEN O'BRIEN, OF MANCHESTER, ENGLAND

MULTICOLOR CINEMATOGRAPHIC AND OTHER FILM AND PROCESS OF MAKING SAME

No Drawing. Application filed May 5, 1924, Serial No. 711,251, and in Great Britain May 18, 1923.

This invention relates to the production of multi-color cinematograph or other films of transparent film-positives, by means of four section-images or color components, two of said section-images or color-components being formed or printed upon one thin support and the other two upon another thin support. The two thin supports may initially form one half width or section of a single film of double standard width and half standard thickness, the two half widths or sections after printing being separated and finally cemented together, so that four component images are superimposed or assembled within the space of one picture-area, to produce a single picture or series of pictures, each consisting of four component images and built up in such manner that they form pictures of four colors or varying tones of color.

The type of positive-transparency thus produced is that technically known as "subtractive", each picture, with its entire range of colors, being complete in itself, the transparent support being of no greater area when complete than necessary for monochrome pictures. A cinematograph film of this type therefore fits all standard projectors.

Previous color film systems

Cinematograph two-color film-positives comprising only two component images have been produced in the following ways:

(*a*) By photographically printing one color-component image upon the front of a single piece of film and the other single color-component on the back of said single piece of film.

(*b*) By printing both color-component images superimposed one upon the other upon the same side of a single piece of film.

(*c*) By printing each color-component image upon a separate film, and then cementing the two films together to bring the two images into one compound two-ply piece of film.

There are great practical difficulties in printing more than two component images by photographic processes upon one support, and for that reason it has been found necessary, in the present state of the art, to limit the manufacture of cinematograph multi-color films to two colors only, although it is universally recognized that an extension beyond this number of colors is desirable.

By the present invention the many technical difficulties which have hitherto prevented the successful manufacture of four-color pictures are avoided by adopting the simple method of using two separate films with two images upon each (each image being in one color only) and superimposing and cementing them together. The transparent supports are each of half thickness, and the four component images formed upon the two supports are, when superimposed and cemented, assembled in one picture-area and therefore produce a complete multi-color picture upon one film or plate of multi-layer construction. The picture is therefore produced in the form of two half-pictures (one upon each support) and the finished picture is a four-image picture on a two-ply support.

The positive transparencies may be produced upon continuous film in cinematograph or stationary picture series, or they may be in single form as stationary pictures for use as projection transparencies, window-transparencies, or the like, and upon other supports such as thin rollable films, extremely tenuous transfer films, thick stiff film plates, or rigid glass plates.

Each of the four images is produced in a different color.

The invention will be described with reference to the accompanying drawings and as applied to cinematograph films.

Figure 1 is a plan view of a piece of double width film material, one half width of which is coated with sensitized colloid containing dye of one color and the other half width of which is coated with sensitized colloid of another color.

Figure 2 is a plan view of the same piece of double width film material, each half width of which has been re-coated with a differently colored sensitized colloid, said piece of double width film material having been provided with traction perforations.

Figure 3 is a plan view of a piece of double width film material having a single color

component image printed on each half-width thereof, the image being shown in heraldic convention.

Figure 4 is a view similar to Figure 3 but having a second color component image imprinted on each of the component images shown in Figure 3.

Figure 5 is a plan view of a portion of film positive or transparency wherein the two half widths of film shown in Figure 4 have been superimposed face-to-face in one picture area.

Figure 6 is a perspective view of the positive film or transparency, the layers at one end being shown as separated.

Figure 7 is a diagrammatic section, on an enlarged scale, of the positive film shown in Figure 6.

The film is formed from a support of double width, each half-width or strip A or B of which bears two section-images or components in two different complementary colors; and each half-width or strip A or B comprises a different pair of differently colored but complementary components, the four component images comprised in the two half-widths or strips all being complementary to one another. The set or pair of half-widths or strips A and B which bear the four component images therefore constitute one complete color-picture series when the two half-widths or strips are correctly assembled and indissolubly united to form one complete single-strip multi-layer film as indicated in Figures 5 and 6.

As shown in Figure 2, each thin half-width or strip A or B, in its separate state, consists of a strip of transparent celluloid or other waterproof material having secured to one of its faces a layer of non-waterproof sensitized colloid upon which are printed two differently-colored section-images.

In its complete state the finished film consists of two such strips A and B of thin film, each of which has been printed in two colors, as shown in Figure 4, and then cemented together so that they finally form one single film of compound-layer but otherwise standard form and thickness.

Color combinations

In the preferred embodiment of the invention for a four-color picture one two-color film-print is made comprising section pictures consisting, for example, of crimson and blue and another two-color film-print is made comprising section pictures consisting, for example, of yellow and green. If the prints are carefully made in the correct shades of color, the picture resulting from the combination of the two section-prints will, when viewed as a transparency, apparently contain the following colors:—crimson, yellow, blue and green by direct colors, and orange, blue-green, purple, brown, black, and other shades indirectly by combination or overlap of two or more colors, so that, in effect, there will be a larger number of colors or shades than the original four, thus lengthening the color scale.

I have indicated a combination of colors, such as crimson and blue (which are not complementary) in Figures 1 and 2, and similarly green and yellow in Figures 2 and 4, so that the colors complementary to those used in the first printing will be found only in the second printing.

But in order to avoid certain difficulties in exposure and printing it may be more advantageous to make each printing contain its own complementary colors, in which case the first printing would contain red and green and the second printing would contain yellow and blue (or violet). The invention therefore is not restricted to any particular combination, but may have its colors arranged in the most convenient combination for printing.

The above is a broad outline of the invention, and I will now give a more detailed description of the various steps of the complete process.

The primary (or camera) negatives

It will be obvious that the original (or camera) section-negatives must have their color values correctly balanced by the use of correct color filters when photographing to produce the negatives.

One set of the original (camera) images may, if desired, be reversed in relation to another in known manner by the use of prisms when photographing. These original (camera) section-negatives may be obtained by any of the various known arrangements of camera and optical systems, but the several section-images of the same picture should be made from exactly the same standpoint, through one lens, the primary image being split by prisms or other devices, each light-beam being then filtered through separate color filters before reaching the panchromatic sensitive negative film, all as well known and understood.

The negatives may be made on screen-film, which simultaneously records all colors at one exposure in the area of one picture upon a single width strip of film or they may be made on screen-film which records the four colors in two groups upon two films or one double width film.

Positive film material

For the film base any suitable transparent support may be used, but material such as celluloid, cellulose-acetate, or the like is preferred because it is waterproof and relatively almost inexpansible.

For the sensitized colloid layer intended to be printed upon any suitable non-waterproof colloid may be used, such as gelatine, albu-

men, gum, fish-glue, agar-agar, or the like, according to the particular printing process to be adopted, but wherever practicable gelatine is the colloid preferred.

The waterproof base or support is preferably made about .002 inch thick and the colloid coating is preferably made about .001 inch thick, making a section-film having a total thickness of about .003 inch thick; and the two layers of different physical characteristics (the cellulose and the colloid) must be indissolubly united or amalgamated by the usual means known to those versed in the art of film manufacture.

After the two printed thin section-films have been indissolubly united they form one compound-layer film having a thickness of about .006 inch.

The printing process

There are various well known processes which can be utilized, either alone or by combination of two or more, for carrying out the invention, and of these the following are of chief interest and value:—

(A) Gelatino-silver emulsion, printed, developed, bleached, and its images dyed afterwards.

(B) Gelatino-silver emulsion having colored pigment or dyes incorporated with the emulsion, the portion of coloring matter not required in the image being removed after development.

(C) Bichromated gelatine or other suitable colloid, printed, hardened, developed, bleached, washed, and dyed afterwards.

(D) Bichromated gelatine or other suitable colloid having colored pigment or dyes incorporated with the colloid, the portion of coloring matter not required in the image being removed after development.

Other printing processes which may be more or less usefully used, especially in combination, are the iron processes, such as cyanotype and others; processes using uranium, copper, platinum, or other metallic salts; and dye processes, among which may be mentioned primuline, diazotype, or the like. All these are more or less well known to photographic experimenters, each having its own advantages or disadvantages, and each requiring exposure to light for printing the image.

The two differently-colored prints may be made by the same process or by two different processes used in combination.

The respective colored images may be of the style known as "full-tone", without any dots, or they may be in the form of a mosaic composed of innumerable fine lines, geometrical patterns, or irregularly distributed dots; or the two types of images may be used in combination in building up the final complete color picture.

Where the line, dot, or pattern method is used alone, the two differently-colored section images are preferably located in the same plane or stratum on one side of each section film in alternating adjacent areas, although they may, if desired, be printed one over the other by superimposition, as in the "full-tone" method.

Where the "full-tone" method is used alone, the two prints are superimposed upon the same side of the film, by re-sensitizing the film after the first print in order to produce the second.

For example, the first print may be made by gelatino-silver emulsion and, after developing, coloring and finishing the first print, the film may be sensitized again with bichromate or one of the sensitive dye processes already referred to, so that the second print is made in the same layer of stratum of gelatine as the first, the one gelatine layer serving for both images.

In another form the second print may be made on top of the first silver or bichromate print by means of a printing process of the photo-mechanical imbibition type which needs no sensitive surface or light action, such, for instance, as those known as dye-printing or hydrotype or pinatype, by which the second colored image can be printed over the first by transfer from a dyed impression plate, either directly or onto the colloid containing the first image, or preferably on to another layer of plain colloid or varnish coated on top of the first layer.

Registration

Accurate registration and superposition of the several color sections is secured by means of accurate perforations in the corresponding films—both negative and positive—and by perfectly-fitting registration pins.

If two separate single width strips are used, it is preferred to punch the perforations in both the two section-films simultaneously, whilst the two strips are laid and clamped face-to-face or back-to-back, in order that both shall be exactly alike; and where double width strips are used, all the perforations for a picture are made simultaneously by one punch.

Shrinkage

Where two single width strips are used, uniform shrinkage is secured by simultaneous printing, developing, washing, drying and other operations for both films, and the same temperatures of all solutions, drying rooms, or other sources of expansion and contraction. Where a double width film strip is used, these requirements are automatically met.

Assembling and completing

Having completed each of the two-color thin section-positives (either as separate

strips or as a double width strip which has been longitudinally severed to form two strips) it only remains to assemble and unite them. This is done by coating each strip with an exceedingly thin layer of adhesive material, which is allowed to partially penetrate the printed layer and is then slowly dried and again re-moistened; and after correctly assembling and registering the two strips by their registering perforations, applying pressure picture-by-picture and step-by-step until the two films are indissolubly united and become as one and having perforations for feeding the completed film through any standard projector.

What I claim as my invention and desire to protect by Letters Patent is:—

1. A method of producing multi-colored cinematograph film positives upon double width transparent material of half standard thickness consisting in simultaneously coating one half width of the double width material with a sensitized colloid containing dye of one color and the other half width with a sensitized colloid containing dye of a different color, photographically printing on each half width a partial image, washing off the surplus colored colloid, recoating each half width of the support with a differently colored sensitized colloid, which also differs in color from the colors in the first coating, printing on each half width a second partial image in the same picture space as the first partial image, washing off the surplus colloid, dividing the strips longitudinally, superimposing the two divided strips with their partial images in register and cementing them together to produce a complete picture in four colors in a single picture area.

2. A transparency film comprising a pair of superimposed strips and bearing four component images within a single picture area, one of said strips carrying two of said component images, each in a different color, and the other strip carrying the other two component images, each in a different color; two component images carried by each strip being in colors differing from the colors of the component images carried by the other strip.

In testimony whereof I have hereunto set my hand.

JOHN EDWARD THORNTON.