Aug. 17, 1926. 1,596,808

D. F. COMSTOCK

COLOR CINEMATOGRAPHY

Filed Jan. 5, 1922

FIG. 1

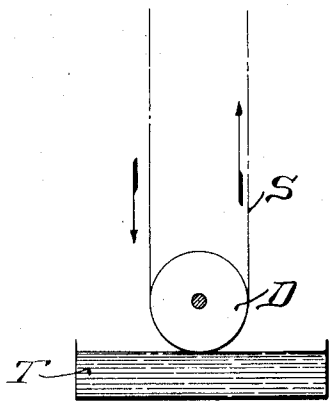


FIG. 2

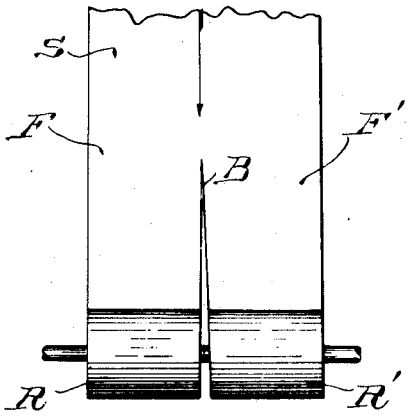


FIG. 4

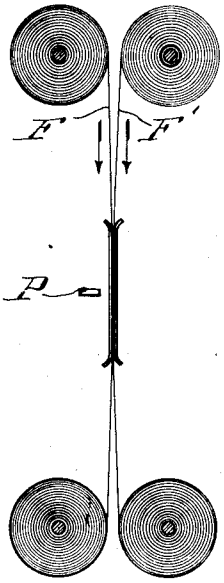


FIG. 5

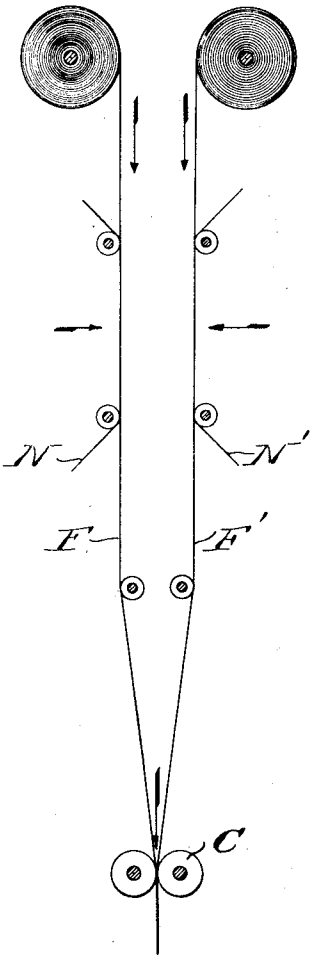
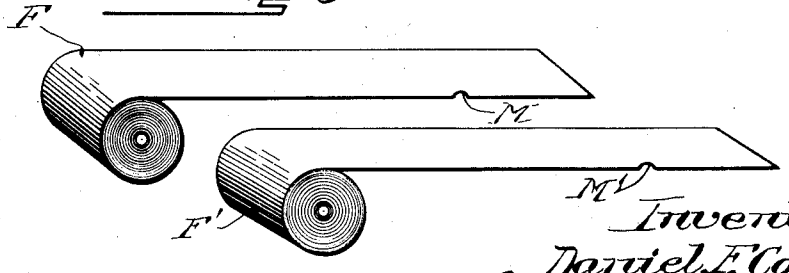


FIG. 3



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his attys.

Patented Aug. 17, 1926. 1,596,808

UNITED STATES PATENT OFFICE.

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COLOR CINEMATOGRAPHY.

Application filed January 5, 1922. Serial No. 527,069.

This invention relates to the art of color photography, more particularly to the so-called subtractive branch of the art in which the complemental images representative of the two or more color aspects of the object-field are supported in superposed registry in contradistinction to the additive branch where the complemental images are separately supported and separately projected upon a screen in registry, and still more particularly to films adapted to produce color pictures and to the method of making such films.

In the production of color films of the subtractive type there are various ways of making the colored positive. However, those methods which involve printing or otherwise forming the positives on separate strips and subsequently joining the various positives together to make a multi-ply positive or otherwise using the separate films to produce a single-width color film, possess advantages over other methods inasmuch as they avoid the difficulties incident to carrying multi-width or double-coated or recoated films through the necessary stages. The present invention has to do only with the first-mentioned class of processes, that is, processes involving the use of separate films for the respective complemental series of images, either when physically incorporated in the finished film or where used in the production of same. The following are examples of such processes.

One method comprises forming complemental series of negatives on separate films, printing separate positive films from the negatives respectively and subsequently uniting the positive films with the complemental positives in superposition. A second method differs from this method in that all the negatives are formed on a single film, the negatives of the respective series alternating longitudinally of the film. A third method comprises the formation of master positives in relief form, the respective complemental series being formed on separate films, and then printing the master positives in superposition upon a blank film by imbibition. Fourth and fifth methods are similar to said first and second methods but the positives are produced in relief form by printing from master positives and etching off the exposed emulsion leaving the unexposed emulsion in the form of indirect reliefs which constitute positives, the reliefs of the respective complemental series are stained different colors, and the complemental films are cemented or otherwise joined together. Sixth and seventh methods differ from the last aforesaid methods in that the positives are produced in the form of direct reliefs by exposing the positive films through the backs from negatives, and etching off the unexposed portion of the emulsion.

While the aforesaid methods involve only single-width and single-coated films which can be handled in ordinary types of machines, it has been difficult to secure proper color balance between the images of the complemental sets when separately printed on separate films. This is evidenced when the finished pictures are projected upon the screen by variations in the general color cast of the pictures. For example, the pictures may first have a reddish cast and as the film progresses this may change to a greenish cast and so on. While this variation is ordinarily not of the first order of magnitude it is frequently sufficiently pronounced to be decidedly objectionable. Moreover a marked variation in color may occur at any time and at frequent intervals, regardless of the care exercised in preparing the film.

The present invention is based on the discovery that the aforesaid variations in color balance are attributable to variations in the characteristics (such as sensitivity and sometimes thickness) of the emulsion of the respective films employed in making the finished positive, this variation necessarily occurring in the commercial manufacture of positive film stock. Variations in the sensitivity of the positive films (or the master positives) produce variation in the density or thickness of the developed images of each series of positives throughout the length of the film. In addition to this effect of variation in sensitivity, in the aforesaid indirect method of making reliefs, where the exposed emulsion is etched off, variation in the thickness of the emulsion also produces a variation in the average depth of the remaining emulsion constituting the indirect reliefs. Moreover, in the use of special films in

which the light absorptivity is an important element, variations in the absorptivity from point to point along the respective component films causes disturbing variations in the color values of the final film.

Inasmuch as these variations in density in each series (optical density or depth in the case of reliefs) are irregular, the net result is the aforesaid variation in general color cast of the projected pictures. In two-color films where the complemental series are colored red and green respectively, the pictures have a reddish cast where the green film runs under-dense or the red film runs over-dense and vice versa.

Not only do the separate films vary individually throughout their respective lengths but they frequently vary as a whole, that is on the average, relatively to each other; for example the average sensitivity of the respective films to be used in making the multi-ply film may be different irrespective of variations of the respective films throughout their lengths. While this difference in average between the films can be counteracted by varying the printing ratio of the films, this requires a preliminary testing of all the component films to determine their characteristics. Moreover, when the films are made up of a plurality of sections spliced together this difference in average necessitates a change in the printing ratio at the respective splices.

Recognizing the fact that the aforesaid variation in the character of film emulsion can not be avoided in the manufacture of cinematographic film on a commercial scale, the present invention aims to annul or minimize the effect of such variation.

In one aspect the invention consists in synchronizing the variation in the respective films so that corresponding portions of the separate light sensitive films have substantially identical characteristics, whereby when the films are superposed the variations match and the balance between the densities of the respective series of complemental images remains substantially constant throughout the length of the film. Consequently if one series runs more or less dense throughout certain lengths of the film, the other series runs correspondingly dense throughout the same lengths, so that the only effect is a change in total density which results merely in a change in the brightness of the picture without change in color cast.

I have found that the synchronization of the aforesaid variations may be effected by coating the several strips which are to be employed in making the multi-ply color film with the same emulsion at the same time, the strips being fed through the coating process in parallel juxtaposition so that corresponding portions of the respective films are coated under substantially identical conditions, the emulsion being applied to the film in any suitable way. At the coating stage of the process the respective strips may be in the form of separate ribbons of celluloid or other suitable material of the requisite length, width and thickness or they may be integrally joined in the form of a multi-width sheet. In the latter case the multi-width sheet is slit to separate the strips before they are exposed. After the strips are separated they are rolled and the rolls are matched, either by marking the ends or other portions of the respective films at points which were adjacent in the multi-width sheet or if the extreme ends of the films were adjacent in the multi-width sheet by merely rolling them with corresponding ends outermost, and the strips are subsequently used in this matched relationship.

In building up the component strips or films by splicing sections together, the respective films are spliced at corresponding points and the corresponding sections are matched as herein described, whereby the component films are matched throughout their entire lengths. Thus, it is unnecessary to change the printing ratio at the splices and in projecting the finished pictures the color balance remains undisturbed at the splices.

So far as I am aware a set of separate films matched as aforesaid for use in producing a color cinematographic film marks a distinct advance in the art and I therefore claim this product as a part of the present invention.

In practising the invention initially I have had the film matched by the manufacturer and shipped to the motion picture producer in matched form, but it is to be understood that the film may be shipped in sheet form to be slit and matched by the producer prior to exposure.

While the various applications of the present invention in the use of separate films to produce a color film will be evident from the foregoing nevertheless for the purpose of illustration I have shown diagrammatically one application in the accompanying drawings in which,—

Fig. 1 indicates the stage of coating the multi-width film;

Fig. 2 illustrates the step of slitting the multi-width sensitive film;

Fig. 3 represents a set of films matched according to the present invention;

Fig. 4 indicates the step of perforating the matched films; and

Fig. 5 shows one way of exposing and uniting the films.

Inasmuch as the steps of coating, slitting, perforating, exposing, etc., may be performed in various ways and by different machines and inasmuch as the method here claimed involves the order of procedure, I

have merely indicated the steps of the method without attempting to show any details of the various machines employed.

The particular method of coating the film shown in Fig. 1 is of the type employing a drum, indicated at D, rotating over a tank, indicated at T, which contains the sensitive emulsion in liquid form, the multi-width strip S being fed over the drum in contact with the liquid.

The method of slitting the multi-width film shown in Fig. 2 comprises feeding the coated strip S past a blade B, which divides the strip into a plurality of films F and F′ and thence winding the films into separate reels R and R′. While the multi-width strip is shown as having the width of only two films it may of course have a width such as to make any number of separate films.

In accordance with the cardinal feature of the invention involving the use of the films in matched relationship the films are preferably marked correspondingly. Thus in Fig. 3 the edges of the matched films F and F′ are notched at corresponding points M and M′. The films are matched not only longitudinally but also transversely inasmuch as they were laterally adjacent in the multi-width sheet.

The films thus matched are preferably perforated as shown in Fig. 4 where the films are fed together through a perforator, indicated at P, in the matched relationship in which they are to be subsequently joined together, thereby insuring accurate registration of the perforations in the respective films when joined together.

Fig. 5 illustrates one method of exposing the matched films which comprises feeding the films into parallel juxtaposition with negative films N and N′ having complemental series of negatives respectively, simultaneously exposing the positive films, and thence feeding the films together through a cementing machine C where the films are cemented together back-to-back. With the emulsions on the outside the multi-ply film may be carried through the developing and coloring process subsequently to the cementing, thereby avoiding unequal shrinkage of the component films in the wet treatments inasmuch as they are fast together. This process of cementing before developing is described and claimed in copending application Serial No. 512,398, filed November 2, 1921. A cementing machine suitable for use in the present process is described and claimed in copending application Serial No. 500,842, filed September 15, 1921.

From the foregoing it is evident that the essence of the invention consists in a set of light-sensitive cinematographic films separated from each other for separate exposure and other manipulation but relatively matched so that variations throughout the lengths thereof respectively are synchronized, and also in the production of a composite color film by thus matching the separate component films, then exposing the separate films with corresponding images on corresponding parts of the matched films, and subsequently superposing the exposed films in matched relationship. Thus the invention departs markedly from the prior art where the component films have been taken indiscriminately from the available stock of films and have been spliced indiscriminately, with no regard for the point to point similarity of the components throughout their lengths; indeed it has not been realized, so far as I am aware, that one of the causes of color-balance disturbance lies in the point-to-point variation of the emulsion of the respective component films.

It is also evident that after the matched films are joined together in matched relationship and before they are developed the composite film constitutes a double-coated film in which the variations of the respective coatings are synchronized or have corresponding positions along the length of the film.

The finished film is similarly unique in that the variations in the density of the images of the respective complemental series due to the aforesaid variations in the emulsions from which the images are formed have corresponding positions along the length of the film.

I claim:

1. In the art of cinematography, the method of making multi-ply films for color projection which comprises forming a multi-width sensitive strip, dividing the multi-width strip into separate strips, subsequently forming complemental series of images on the separate strips respectively with the images of each complemental set on portions of the separate strips which were adjacent in the multi-width strip, and joining the separate strips together with the images which are complemental to each other in superposition prior to the liquid treatment of the strips.

2. In the art of cinematography, the method of making multi-ply cinematographic films which comprises applying a sensitive coating to a multi-width strip, dividing the multi-width strip into separate strips, subsequently forming complemental series of images on the separate strips respectively with the images of each complemental set on portions of the separate strips which were adjacent in the multi-width strip, the separate strips being exposed through their backs to form latent images adapted to be converted into direct relief, and subsequently joining the separate strips

together with the images which are complemental to each other in superposition.

3. In the art of cinematography, the method of making multi-ply films for color projection which comprises forming a multi-width sensitive strip, dividing the multi-width strip into separate strips, disposing the strips in matched superposed relationship, cutting the sprocket openings simultaneously in both films while so disposed, forming complemental series of images on the separate strips respectively with the images of each complemental set on the matched portions of the separate strips, and joining the strips together in the said matched superposed relationship with the images which are complemental to each other in superposition.

4. In the art of cinematography, the method of making multi-ply films for color projection which comprises forming a multi-width sensitive strip, dividing the multi-width strip into separate strips, disposing the strips in matched superposed relationship, cutting the sprocket openings simultaneously in both films while so disposed, forming complemental series of images on the separate strips respectively with the images of each complemental set on the matched portions of the separate strips, and joining the strips together back to back with the images which are complemental to each other in superposition.

5. In the art of cinematography, the method of making color films which comprises applying a sensitive coating to a multi-width strip, dividing the multi-width strip into separate strips, forming complemental series of images on the separate strips respectively with the images of each complemental set on portions of the separate strips which were adjacent in the multi-width strip, the separate strips being exposed through their backs to form latent images adapted to be converted into direct reliefs, and employing the separate strips thus formed to produce a single-width film having complemental images in registry.

6. In the art of cinematography, a set of separate emulsion-coated films matched end for end, portions of the emulsions of the respective films which have corresponding positions longitudinally of the films being substantially identical and having thereon respectively mutually complemental images of complemental series.

7. In the art of cinematography, the method of making films for color projection which comprises forming a multi-width sensitive strip, dividing the multi-width strip into separate strips to provide separate light-sensitive films matched end for end, and forming complemental series of images on the separate strips respectively with the mutually complemental images of the complemental sets arranged in corresponding portions of the separate strips.

Signed by me at Boston, Massachusetts, this 31st day of December, 1921.

DANIEL F. COMSTOCK.