[Second Edition.]

PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in or relating to Color Cinematographic Films and Method of Making Same.

We, TECHNICOLOR MOTION PICTURE CORPORATION (a corporation organised under the laws of the State of Maine, United States of America), of 110, Brookline Avenue, Boston, Massachusetts, United States of America, Assignees of DANIEL FROST COMSTOCK, a citizen of the United States of America, of Cambridge, Middlesex, in the United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

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 (either on the same side or on opposite sides of the film) 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 the production of color pictures by relief images, *i.e.*, images formed in relief on a film of gelatin or other suitable material.

The production of color cinematographic films adapted for subtractive projection presents peculiar difficulties not experienced in the production of still pictures. One such difficulty is to maintain a uniform balance between the color values of the complemental images throughout the length of the film. While the colors of a single pair of complemental images, differently colored to produce the desired selective absorption, can be balanced without great difficulty to produce the various hues with accuracy, it is extremely difficult to produce a series of such pairs in rapid succession and in diminutive size, with films which may vary somewhat throughout their lengths, and under operating conditions involving both variation in the light and also variation in the illumination of moving objects due to changes in their positions relatively to the light.

Theoretically an advantageous way of producing such a cinematographic film would be to employ a double coated film, printing a series of images representing one color aspect of the object field on one side of the film and on the other side printing a complemental series in registry with the first series, then etching off the exposed emulsion of each coating leaving the unexposed emulsions in the form of indirect reliefs of clear gelatin, and finally staining the reliefs on opposite sides of the film different colors respectively.

We have discovered, however, that while an indirect relief formed by the unexposed portion of the gelatin is in theory a reversed counterpart of the direct-relief image which would be formed if the unexposed portions of the gelatin were etched away, this is not true in the production of cinematographic films inasmuch as the emulsion inevitably varies more or less in thickness throughout the length of the film. Consequently, even though the exposed images extend to a uniform average depth in the emulsion, the indirect reliefs vary in average depth since they represent the difference between the uniform average depth of the exposed images and the variable depth of the emulsion.

[*Price* 1/-]

Moreover, cinematographic films vary in sensitivity throughout their lengths and while this is not serious in making ordinary picture film it is very objectionable in making color positives in the form of indirect reliefs, as will be evident from the following consideration. Since the positive reliefs comprise the residue after the removal of the exposed portions of the emulsion, the reliefs will be thin where the exposed gelatin is thick and *vice versa*. Consequently, in printing a positive film slight variations in sensitivity throughout the length of the film produce large changes in the high-lights of the images, just where such variations are most noticeable. In the case of the internal printing method hereinafter disclosed, this disadvantage is conspicuously absent.

Objects of the present invention are to overcome the aforesaid difficulty pertaining to the production of color cinematographic films and to produce a single width film which can be employed in the ordinary projector, and which has colored complemental images accurately and uniformly balanced as to relative color values throughout the length of the film.

A more specific object of the present invention is to utilize relief images in the production of color cinematographic pictures and at the same time to avoid the aforesaid variation in average depth or thickness throughout the length of the film.

The invention comprises a cinematographic film of the type having a support of celluloid or the like and having thereon a series of color-absorption pictures each consisting of a set of differently colored relief images, the support comprising components which are superposed after the coating has been exposed through the back, characterised in that the components are superposed before the latent images are developed and are cemented together back-to-back, that is, celluloid-to-celluloid in contradistinction to coating-to-coating or coating-to-back.

While separate single-width strips may be employed according to the present invention a double-width strip has a number of unique advantages among which may be mentioned the following.

Owing to the width or strips being integrally joined together along their edges, longitudinal shrinkage or expansion thereof must be substantially identical. Consequently the film may be carried through the developing or other wet processes before the strips are cemented together without loss of registration due to unequal shrinkage; and the strips may therefore be folded face-to-face if desired. Moreover owing to the juxtaposed portions of the respective widths being manufactured at the same time and under the same conditions they are substantially identical in thickness, composition, *etc.*, so that they tend to shrink and expand equally. If both widths of the film are coated at the same time, as they preferably are, the emulsion on juxtaposed portions of the respective widths is substantially identical in sensitivity thereby eliminating the variations in color balance between the complemental images on the respective widths which ordinarily results from variations in sensitivity of film stock. Thus while the sensitivity of the emulsion of the double-width film may vary throughout the length of the film, the sensitivity of both widths will vary together, the result being merely a variation in the total density of the superposed images without any relative variation which would unbalance the color ratio.

As above intimated, the latent images are converted into reliefs after the component films have been secured together. The respective series may be differently colored by first staining one side with one dye and subsequently staining the other side with another dye. A substantial and permanent union can be effected by joining the films back-to-back with a celluloid solvent which practically welds the celluloid backs together in the form of a single integral film.

A suitable method of converting the latent images into reliefs consists in developing the images with a developer such as pyro which hardens the gelatin in the immediate neighbourhood of the developed silver grains leaving the unexposed emulsion soft, bleaching the silver back to the form of silver salt with potassium ferrocyanide, and fixing out the silver salts with ordinary hypo, and etching off the soft gelatin with hot water.

In order to illustrate the application of the invention we have shown, more or less diagrammatically, one concrete embodiment thereof in the accompanying drawings, in which,—

Fig. 1 is a perspective view of a length of film showing one order of procedure;

Fig. 2 is a cross-section of the film, partly open; before the reliefs are formed;

Fig. 3 is a cross-section of the film after being closed and after the reliefs have been formed: and

Fig. 4 is a similar view of a slightly different form of the finished film.

The particular embodiment of the invention chosen for illustration comprises a double-width strip of celluloid S—S¹ coated with a sensitive emulsion E—E¹ and folded along its longitudinal center with the emulsion on the outside. The film is perforated as indicated at A before being printed (or otherwise exposed) and the perforations are preferably made while the two parts of the film are closed together. After being perforated the film is opened as represented at B and printed from the inside as indicated at C, the complemental images being symmetrically positioned relatively to the folding line so that when the film is again closed the images register. By perforating the film before it is opened the perforations are symmetrically positioned relative to the folding line and therefore register when the film is again closed. Consequently the complemental images may be symmetrically positioned and accurately registered by locating the series of images on one width relative to the perforations in that width and locating the series of images on the other width with reference to he perforations therein.

The complemental images may be formed on the respective strips S and S¹ in various ways but they are preferably formed by a process of printing from a single negative having series of complemental negatives, the complemental negatives of the respective series being exposed simultaneously from the same point of view (as described for example in our prior Patent No. 194,971, filed May 2, 1922) so that the complemental images will be exactly geometrically similar and therefore accurately registerable when the strips are joined together. Any suitable mechanism for accurately positioning and registering the images may be employed in forming either the negatives or the positives or both.

The several series of images may be printed concomitantly in a single operation or successively in separate operations. If the negative film from which the positives are printed is in the form of a double-width film having the complemental images reversed transversely of the film as disclosed in said Application No. 194,971, or in the form of two separate strips having one series on one strip and the complemental series on the second strip in reverse position transversely of the film, both series are preferably printed simultaneously. In printing from a single-width negative having the images of the two series alternating, one series may be printed on one width of the positive in one operation and the other series printed upon the other width in a succeeding operation.

After the strips have been printed from the inside they are again folded together as indicated at D and preferably cemented.

The ingredient or composition employed to unite the component strips back-to-back should meet several requirements. It should unite the strips so that they will not separate in use or under unfavourable atmospheric conditions and so that the resultant film is substantially transparent. It should be adapted to effect a quick joinder of the strips and to permit a speedy dyeing of the resultant film.

Methyl alcohol meets all of these conditions, although other ingredients or compositions may be employed. Methyl alcohol does not merely glue or cement the strips together but inasmuch as it is a solvent of celluloid the strips may be homogeneously united or fused together by wetting their backs with the alcohol sufficiently to soften the surfaces and then pressing the strips together back-to-back. Owing to the fact that methyl alcohol is miscible with water, the alcohol trapped between the strips when they are pressed together may escape through the strips and thence through the gelatine coatings even when the latter are wet.

To make the film lie flat after being folded and to make it more flexible at the folded edge, and to make it refold along the same line, the folded edge may be moistened with a celluloid solvent such as methyl alcohol, thereby to permit the film to fold more sharply; or it may be rubbed with a pad saturated with a solvent not only to moisten the fold but also to reduce the thickness at the fold. This is preferably done after the film has been folded and before it is perforated or at least before it is printed or otherwise exposed.

Instead of the treatment mentioned in the preceding paragraph or in addition to this treatment the folded edge of the film may be trimmed off after the widths have been secured together. If desired the film may be made sufficiently wider to permit the aforesaid trimming and at the same time to leave the distance between the sprocket holes and the edges of the film the same on both sides. When so trimmed the finished film appears as shown in Fig. 4.

The images are developed after the strips are folded together. The images

are then fixed. After being developed and fixed the images are etched to convert them into reliefs and subsequently stained. The relative positions of the complemental images on the opposite sides of the film are indicated in the lower part of Fig. 1.

If the strips are integrally connected at their edges and folded together the finished film appears in section as shown in Fig. 3, where R and R^1 represent the complemental relief images; if the component strips are separate and joined only by cement, both sides of the film appear like the left-hand side of Fig. 3, *i.e.*, as shown in Fig. 4.

From the foregoing it will be evident that the new positive film strip has the following characteristics. Each picture on it consists of a pair of homogeneous colloid reliefs, and respectively uniformly and complementarily colored by transparent staining or dyeing, to constitute a screen capable of absorbing light not of its own color proportionally to its thickness.

Where these reliefs mutually are negligibly thin, white light incident upon them is transmitted unchanged. Where the one is thick and the other thin, the pure color of the thicker is transmitted. Where both are of effective thickness, the light is obstructed according to the successive absorption by each member of the pair of its complemental fractions; but in practice, totally black objects being infrequent rarities, even the shadows have color in them, varying according to the variations in thickness of the relief from a neutral or balanced mixture tone to the tone of one or the other complementary color of the respective member of the pair of complementary reliefs.

An important advantage of the present invention is due to the fact that the holding of the coloring dyes is in the nature of a mechanical process. Where chemical mordants are used for dyes the chemical properties of the dyes come into consideration and form a limiting condition to the number of dyes and combination of dyes which can be successfully used. In the case of those processes depending upon the fact that hard gelatin and soft gelatin have different action on certain dyes this limiting condition is even more pronounced, since extremely few known dyes of the right colors can be found which thus distinguish between hard and soft gelatin. In the present process any dyes may be used which will be absorbed by gelatin, inasmuch as all that is necessary is that the geometrical volume of the relief be filled with dye. A very wide range of dyes is therefore possible of use and by combining various dyes and various properties the most delicate changes in color may be produced.

In forming the relief images the marginal portions of the gelatin or other colloid material are completely removed in the hot-water etching bath, the marginal portions being unexposed. Thus the gelatin or other colloidal material in which the images are formed terminates short of the marginal edges of the film and indeed is confined to the space between the series of marginal registering openings (Figs. 3 and 4). This is important in coloring the relief images inasmuch as pigment solution can be applied to one side with little or no tendency to creep around the edges of the film to the opposite side by virtue of the bare celluloid margins. Even if the solution does creep over the edges, the shoulders formed by the edges of the relief images serve as dams against spread over the images.

While we have described the invention with reference to a two-colour process for the sake of simplicity, it will be evident that it may be utilized in three (or more) color work, as for example by using a triple, quadruple, *etc.*, width film, by superposing three or more separate films, *etc.*

The term "complemental images" is herein used to designate images representative of different color aspects of an object field which, when combined by projection or otherwise, will yield a more or less accurate color reproduction of the object field, the colors which the images represent not necessarily being exactly complementary.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A cinematograph film of the type having a support of celluloid or the like and having thereon a series of color-absorption pictures each consisting of a set of differently colored relief images, the support comprising components which are superposed after the coating on each has been exposed through the back, characterized in that the components are superposed before the latent images are developed and are cemented together back to back.

2. A cinematograph film according to Claim 1, characterized in that the two components are integrally connected at the edges in the form of a multi-width

strip adapted to be folded with the complemental images in registry.

3. In the manufacture of a cinematographic film according to Claim 2 folding and perforating the multi-width strip and then unfolding it before exposure.

4. A cinematographic film according to any of the preceding claims further characterized in that the margins of the supporting strip are bared after development and before the images are colored.

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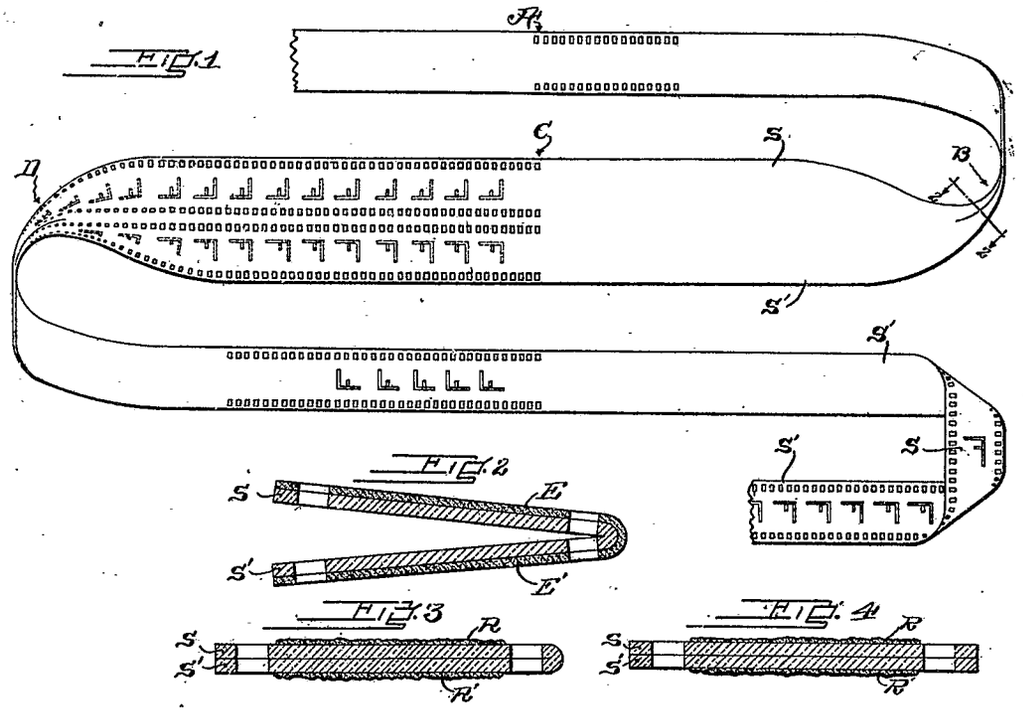

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