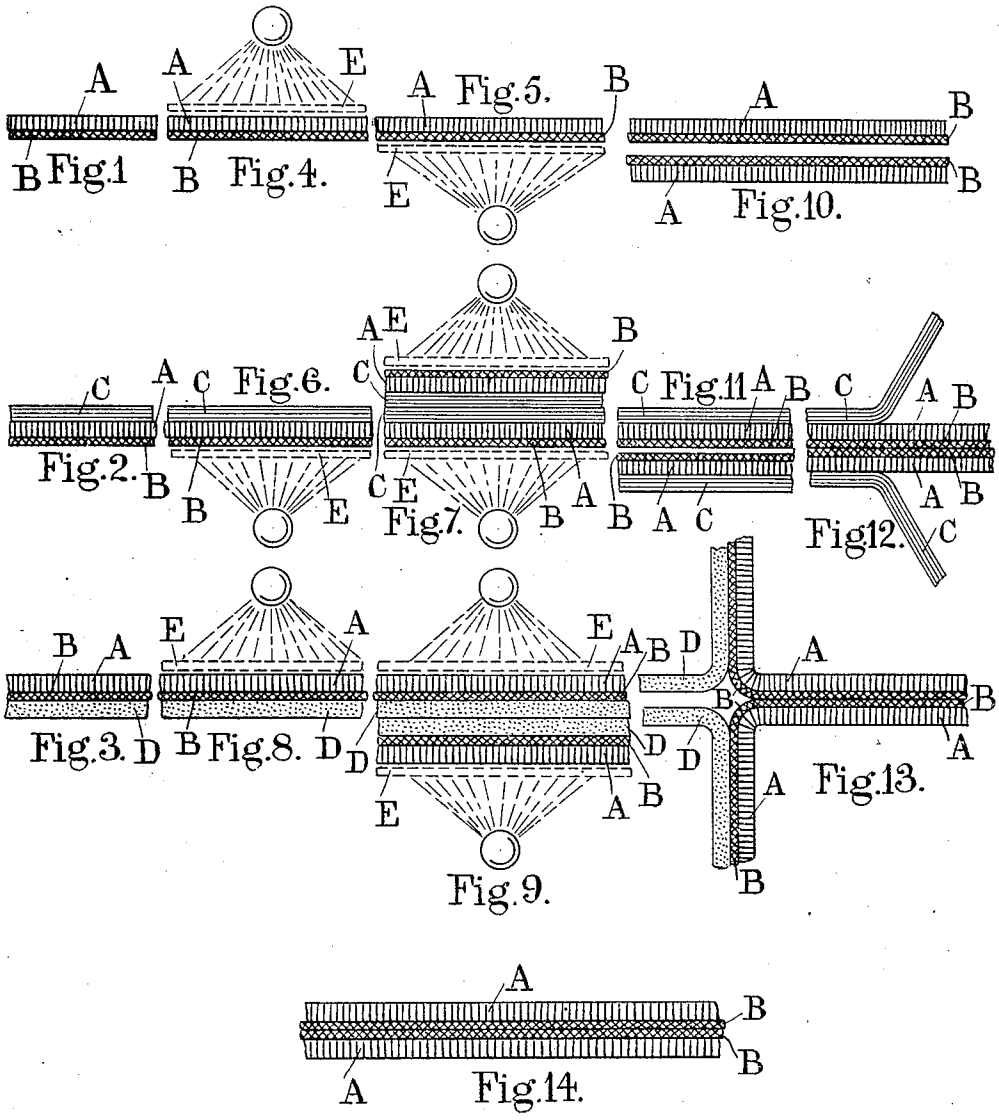
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CINEMATOGRAPH COLOR FILM AND METHOD OF MANUFACTURE

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UNITED STATES PATENT OFFICE.

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CINEMATOGRAPH COLOR FILM AND METHOD OF MANUFACTURE.

Application filed December 13, 1923, Serial No. 680,511, and in Great Britain December 27, 1922.

This invention relates to the construction of two-piece two-color film positives in continuous strips of unlimited length as used for cinematography or for stationary or other pictures where continuous lengths of colored transparencies are required; and its object is to produce such films with scratchless images enclosed or sandwiched between two base-supports of celluloid or other transparent waterproof material.

The supports each carry according to the invention one color of a two-color picture series one of the images being reversed, and each support is of only half the standard thickness; and after having the section-images printed upon them the two thin films are indissolubly united image-face to image-face, the two thin supports forming a permanent part of the completed film; the necessary flexibility being secured by using supports of only half the usual thickness; and accuracy of registration being secured by printing the two sets of images simultaneously upon a film of double-width in order to ensure equal expansion and contraction for both halves; the double-width strip after printing and finishing being longitudinally severed to form two single-width films, which are superimposed and cemented face-to-face to form a single-width strip of standard thickness.

Throughout the specification and claims the term "face" refers to the sensitized colloid layer in which the images are formed, but which eventually becomes the interior of the film; and the term "back" refers to the base or support of celluloid or other waterproof material which carries the face or layer of colloid, and which eventually becomes the outside layer of the completed film.

The invention will be fully described with reference to the accompanying drawings, in which diagrammatically and to an enlarged scale the films are illustrated.

Fig. 1 is a section of single sensitive film before being printed upon showing transparent celluloid back or base A, .002 of an inch thick and a sensitized face B, .001 of an inch thick.

Fig. 2 is a section of single sensitive film before being printed upon with transparent celluloid back or base A, .002 of an inch thick, a sensitized face B, .001 of an inch thick, and a waterproof reinforcing layer C, .002 of an inch thick on the back of the base A.

Fig. 3 is a section of single sensitive film before being printed upon with a transparent celluloid back or base A, .002 of an inch thick, a sensitized face B, .001 of an inch thick, and a reinforcing layer D of porous paper .002 of an inch thick on the sensitized face.

Fig. 4 indicates the printing of the sensitive film Fig. 1, through the celluloid back A, the negative E being placed against the back of the film to produce a relief image when developed.

Fig. 5 indicates the printing of the sensitive film Fig. 1 through the sensitized face B, the negative E being placed against the face of the film to produce a non-relief image when developed.

Fig. 6 indicates the printing of the sensitive reinforced film Fig. 2 through the sensitized face B, the negative E being placed against the face of the film to produce a non-relief image when developed.

Fig. 7 indicates the printing of two of the sensitive reinforced films Fig. 2 simultaneously, the films being placed or clamped together back to back and printed through the sensitized faces B, the negatives E being placed against the faces of the film to produce a non-relief image when developed.

Fig. 8 indicates the printing of the sensitive reinforced film Fig. 3 through the celluloid back A, the negative being placed against the back of the film to produce a relief image when developed.

Fig. 9 indicates the printing of two of the sensitive reinforced films Fig. 3 simultaneously, the films being placed or clamped together with the reinforcing layer D on the face B of one against the reinforcing layer D on the face B of the other, and printed through the celluloid backs A, the negatives E being placed against the celluloid backs of the films to produce a relief image when developed.

Fig. 10 indicates the position of two of the printed and developed films Fig. 1, one colored orange-red and the other colored

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blue-green, face B to face B before uniting.

Fig. 11 indicates the position of two of the printed and developed reinforced films Fig. 2, one colored orange-red and the other colored blue-green, face B to face B before uniting, and before removal of the waterproof reinforcing layer C.

Fig. 12 indicates the position of two of the printed and developed reinforced films Fig. 2 after being united face B to face B, showing the waterproof reinforcing layer C being removed.

Fig. 13 indicates the position of two of the printed and developed reinforced films Fig. 3, one colored orange-red and the other colored blue-green, and the method of uniting the face B to face B and removing the reinforcing layer D of porous paper.

Fig. 14 is a section of finished film united face B to face B the two printed, developed, colored layers B being enclosed between the backs or bases A of celluloid or other transparent waterproof material.

In carrying out the invention, the two separate films of which the complete two-color film is to be built are made in known manner as hereinafter more fully described; are printed by known processes such as hereinbefore described; and when printed, developed and colored are cemented face to face.

By this construction the two delicate colored images on the faces B of the separate films are placed in the centre of the completed film and the transparent cellulose base or carriers A of each image is located on the two outsides, this result being obtained by cementing the two gelatine faces B together with suitable cement, instead of cementing the two backs together as has hitherto been done. Thus the complete colored picture is perfectly protected by being sandwiched between the two strong and transparent celluloid, cellulose acetate, or other durable outer layers. Any scratches which these outer layers may receive will thus not damage the inner colored picture layers, and the dirt which usually collects in these scratches during constant use of the films can be easily cleaned off without damaging the delicate picture image. But if desired the celluloid backs may be still further protected against scratches by an outer layer of removable soluble colloid varnish.

The colored images may be printed by any known and suitable process using sensitized material; for instance gelatino-silver-bromide; gelatino-silver-chloride; bichromated gelatine; various processes using metallic salts such as iron, uranium; the carbon pigment process; dyed gelatine processes, via silver, bichromate, or iron; or by processes that do not require sensitized material, such as photomechanical dye-impression printing and other imbibition processes; but for purposes of this specification I have only utilized and illustrated the sensitized methods commonly preferred.

Manufacturing the film material.

In manufacturing the film itself I start by forming a very thin transparent base A of celluloid, cellulose-acetate or similar waterproof material. A suitable thickness is .002 inch. This is coated upon one side with an adhesive substratum of the kind known to those versed in the art of film manufacture. When dry a further coating B is applied of a thickness of about .001 inch, consisting of a suitable colloid such as gelatine, gum, albumen, fish glue, or the like, according to the type of printing process adopted, with which is incorporated either opaque pigment as used in the carbon process, or dye; or pigment and dye; or silver-bromide and pigment; or silver bromide, dye, and a mordant; or silver-bromide, pigment, dye and a mordant or for photo-mechanical or dye-impression printing or imbibition processes the colloid is plain without such additions.

The positive film material is preferably manufactured of double width. Such a double-width film can be printed, either by contact or by projection, from a negative of similar double width. This system has the great advantage that the two negative images are likely to be of identical exposure and density, the two positive images are of identical density, and all operations are identical for both sets of side-by-side images; and finally there is no danger of the images being wrongly printed or wrongly assembled after printing.

The double-width print can be made from two separate negative strips E placed side by side during printing; or it may be folded back to back and clamped between the two negative strips during printing.

In any arrangements of negative and positive strips the rule must be followed that when a relief image is required the negatives must be placed so that the sensitive strips are exposed and printed from their backs through their celluloid supports with negative face side against celluloid back of sensitized strip, but where non-relief images are required printing may be from back or front, but preferably from the front with negative face against sensitive face.

It will be obvious that not only must the negatives be thus arranged to suit the particular printing process adopted, but also that one set of negative images must be reversed in relation to the other and in relation to its supporting transparent base. Such reversal can be effected by using a camera of known construction for taking the original negatives provided with a reversing prism or reflector. Or if one of the

originals is not reversed at time of photographing, a reproduced (or second) negative can be made from it in which the necessary reversal is effected during the process of reproduction by the copying camera.

The term negative is hereinbefore used in the sense that it is intended to apply to the strip or strips used for printing from, although in some of the processes described a negative-image printing-cliché is required, whilst for other processes a positive-image printing-cliché is necessary.

In every case accurate register of the negative and positive images is obtained in known manner by means of accurately made perforations in the respective films, and by registering pins on the printing machine which exactly fit the holes in the films and accurately position the relative images.

When separate single strips are used for either negatives or positives or both, it is a convenience to have identification numbers or marks printed on the blank edges of negative sections and print sections, to insure correct printing and correct assembling afterwards. The same rule is useful in a lesser degree even if the double-width negative and positive strips are used.

Stronger reinforced color-section material.

The ordinary film used for monochrome pictures is about .006 inch thick and is therefore strong enough to stand rough handling by the operators in the film printery. But as the thin color-section films hereinbefore described are only about .003 inch thick they require very delicate handling and are liable to greater wastage and loss from tearing and breaking.

This objection can be overcome by strengthening each of the color-section films with a temporary reinforcing backing of paper.

This temporary reinforcing backing is about .003 inch thick and therefore brings each color-section film up to about .006 inch thick. It is applied during manufacture of the film material and remains attached from the time it leaves the factory until the two-color picture film has been printed and completed in the printery by uniting the two differently colored sections, as indicated in Figs. 11 and 12.

Before uniting, the two section films when placed face to face make a total thickness of about .012 inch, and when the temporary backings are removed after uniting the two sections the completed two-color film will be about .006 finished.

Adoption of the reinforcing backing to the thin film is not only of great advantage to the film printer in avoiding wastage and loss, but it is also of great advantage to the maker of the film material in that the manufacture is greatly simplified for the following reasons.

Sensitive film formed by a colloid layer applied to a celluloid layer requires that the celluloid strip shall be formed by means of complex base-casting, drying, and shrinking machinery, after which the colloid layer is applied as a separate process by emulsion coating and drying machinery. With film of .006 inch thickness the risk of damage is small, but with film of .003 inch thickness the risk of damage in handling long continuous strips is very great.

But by adopting the reinforcing backing system the entire film, including the transparent waterproof celluloid base and the sensitive non-waterproof colored colloid layer, is manufactured by applying solutions of the respective materials, by means of successive coatings and dryings, to a continuous web of paper which serves the double purpose of a casting and coating surface and of a temporary reinforcing backing.

Another advantage to the film printer is that loss from tearing of the very thin celluloid base itself during manufacture, coating, drying, reeling, and slitting is reduced to a negligible quantity. Against this has to be set the cost of the paper backing, but as an inferior or inexpensive quality is good enough (instead of using the expensive rag paper necessary for photographic sensitive papers) the cost of the paper is more than counterbalanced by the saving of film wastage—both to the film manufacturer and to the film printer.

Still another advantage to the film printer by using the reinforced film is that accurate registration of the two section-images is easier obtained with the reinforced film than with the non-reinforced, owing to the greater thickness of the former and the greater stiffness around each hole of the perforations.

This reinforcing paper backing may be of porous paper applied to the front or sensitive colloid side of the film; or it may be either of porous paper or of waterproof paper applied to the back or celluloid side of the film. I prefer however, to use waterproof paper when applied to the celluloid side as in Fig. 2, and porous paper when applied to the colloid side as in Fig. 3, in order to secure the different types of relief or non-relief images as hereinafter more particularly described.

To remove the paper backing when required each paper strip is attached to a separate reel, and the film to another. When all are rotated in unison each reel winds its own particular strip, which easily comes away as indicated.

Assembling and completing the two-color pictures.

Having obtained the two positives—one with blue-green and the other with orange-

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red images, and either upon the reinforced paper-backed material or upon the thinner transparent material—it now only remains to assemble and unite the positives, first by coating each colloid face with an adhesive uniting stratum then drying same, and then moistening same and applying pressure, the sections being assembled and united picture-by-picture and step-by-step, face B to face B in accurate register to produce a complete single-strip, two-color film as indicated as in Fig. 14, ready for exhibition as a transparent cinematograph film in colors and having its colored pictures enclosed between two protective layers of transparent waterproof material such as celluloid, cellulose acetate, or the like which also form the supports of the colloid images, and provided with a series of perforations for feeding it through any standard projection apparatus built for the standard monochrome film; and which will project upon the screen a multi-color picture.

Additions or modifications.

When the two-color film is completed it may be further reinforced by varnishing on both outside faces with a preparation designed to protect the celluloid from being scratched. Various substances are applicable, but colloids such as albumen, gelatine, or agar-agar are suitable as they can be readily washed off and replaced whenever required. If preferred they may be hardened with alum, formalin, or bichromate.

If the film is printed through the celluloid parallel light rays are desirable, to avoid spreading of the image and loss of sharpness, owing to thickness of the celluloid intervening between the face of the negative and the sensitive layer when printed by contact. But if printed by projection through a lens this condition of parallel rays will be already sufficiently met.

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

1. A two-color film comprising two thin transparent base supports of substantially half standard thickness, printed with differently colored section images and united together face to face one of the color-images being reversed both color-images being enclosed within and protected by the base supports by which the pictures are carried.

2. A two-color film comprising two celluloid supports of substantially half standard thickness, a colloid layer on each support printed with differently colored section images and united together printed-colloid-face to printed-colloid-face one of the colored images being reversed and both enclosed within and protected by the celluloid supports by which they are carried.

3. A perforated cinematograph two color positive film comprising two colloid picture bearing layers cemented together and enclosed between two base supports of transparent waterproof material of substantially half standard-film thickness by which the picture bearing layers are protected.

4. A perforated cinematograph two color-positive film comprising two gelatine picture bearing layers cemented together the pictures on one being reversed in relation to those on the other and enclosed between two celluloid supports of substantially half standard-film thickness by which the picture bearing gelatine layers are protected.

5. A perforated cinematograph two-color-positive film comprising two separate films of substantially half standard thickness, one printed with a series of section-pictures in one color and the other printed with a series of complementary reversed section-pictures in a different complementary color the two films combined and indissolubly united printed-face to printed-face to form one film of approximately standard thickness having one series of complete color pictures embedded and enclosed within its interior and protected from scratches.

6. A perforated cinematograph two-color positive film comprising two separate celluloid films of substantially half standard thickness one film printed with a series of section-pictures in orange-red and the other film printed with a series of reversed section-pictures in blue-green the two printed films combined and united printed-face to printed-face to form one film of approximately standard thickness.

7. An improved cinematograph two-color positive film of standard thickness, comprising:—(*a*) a layer of celluloid of substantially half the standard thickness, (*b*) a layer of uniting substratum coated on to the inner face of the celluloid; (*c*) a layer of non-waterproof colloid printed orange-red indissolubly united to the celluloid layer; (*d*) a layer of adhesive uniting stratum coated on to the face of the printed colloid, (*e*) a second layer of celluloid similar to layer *a*; (*f*) a layer of uniting substratum thereon similar to layer *b*; (*g*) a layer of non-waterproof colloid similar to layer *c*, printed blue-green; (*h*) a layer of adhesive uniting stratum coated on the face of printed colloid layer *e'*.

8. The process of building up a cinematograph two-color film which consists in preparing two films of substantially half standard thickness with single section picture on each complementary to one another and joining the two section films image-face to image-face whereby the picture bearing colloid is enclosed between the two backs or layers of waterproof material.

In testimony whereof I have hereunto set my hand.

JOHN EDWARD THORNTON.