

Nov. 10, 1931.

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1,831,771

METHOD OF PRODUCING TWO-COLOR CINEMATOGRAPH POSITIVE FILMS

Original Filed Dec. 13, 1923 2 Sheets-Sheet 1

SENSITIVE FILM.

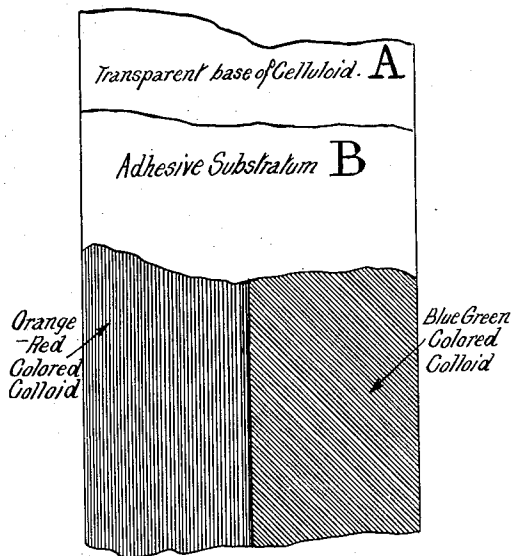


Fig. 1.

PERFORATED for PRINTING.

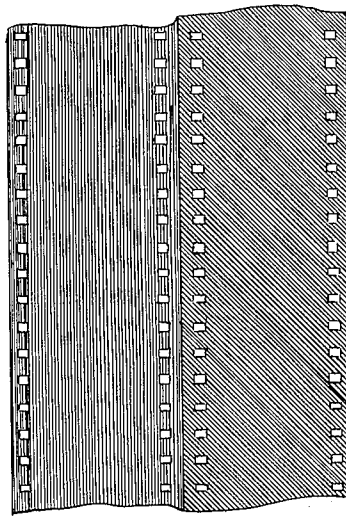


Fig. 2.

PRINTED FILM

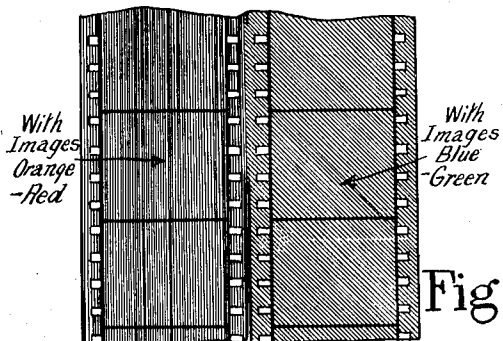


Fig. 3.

SUPERIMPOSED AND CEMENTED.

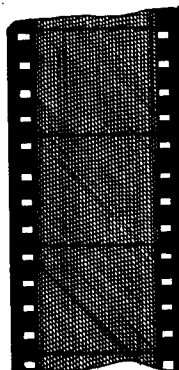


Fig. 4.

Shows where Film is split in Dividing into Two Films for Superimposing.

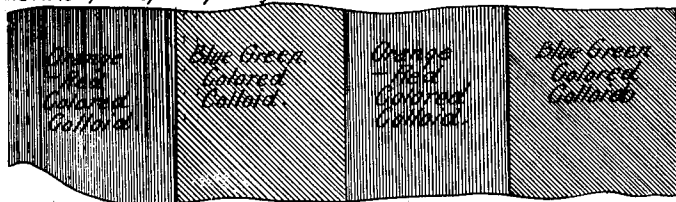


Fig. 5.

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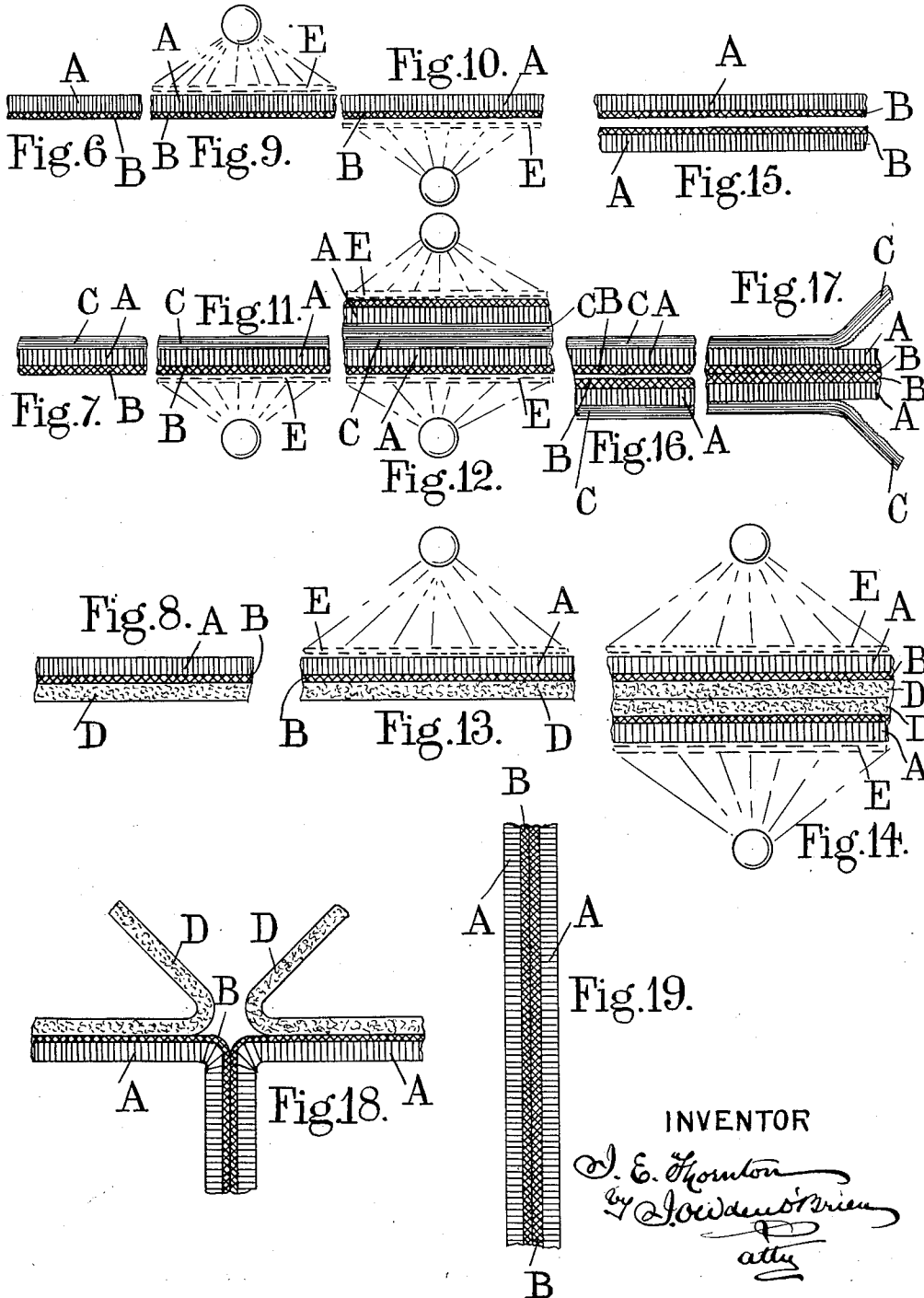
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METHOD OF PRODUCING TWO-COLOR CINEMATOGRAPH POSITIVE FILMS

Original Filed Dec. 13, 1923 2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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A METHOD OF PRODUCING TWO COLOR CINEMATOGRAPH POSITIVE FILMS

Original application filed December 13, 1923, Serial No. 680,511, and in Great Britain December 27, 1922.
Divided and this application filed June 8, 1925. Serial No. 35,762.

This invention relates to scratchless-image two-piece two-color film positives and process of producing same by photographic means on sensitized ready-colored film 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 scratchless two-color photographic images by using two thin supports of celluloid or other transparent material, each support being of only half the standard thickness, and each of which is sensitized with a differently colored colloid (one being orange-red and the other blue-green to produce a suitable complementary combination) upon which two colored section-prints are made, one of the images being reversed; and after printing, developing, and finishing the two differently colored section images upon the two supports, the two thin films are then indissolubly united image-face to image-face, with the two thin supports outwards to form permanent outer covers of the completed film, and the delicate colored images enclosed or sandwiched between them; the necessary flexibility being secured by using supports of only half the standard thickness; and accuracy of registration being secured by printing and developing the two sets of images simultaneously in the form of a double-width film to ensure equal expansion and contraction of the two halves; the double-width film being longitudinally severed after printing to form the two single-width films which are then superimposed and cemented face-to-face to form a single-width compound layer two-color positive of standard single width and thickness, the application being a division of my prior application Serial No. 680,511 filed December 13, 1923.

As will be seen from the state of the art, as described in my earlier patents some of the films have been produced by dyeing two section images in two different colors after printing, the sensitive films by exposure to light, followed by development.

The improvement sought by this invention is to provide a system whereby the coloring matter is incorporated in the sensitized ma-

terial by its maker at the factory, in an accurately defined and measured quantity and of exactly the correct shade of color or colors, instead of by the printer, and the color positive cinematograph film is constructed from two such films cemented together image-face to image-face. The printer therefore has removed entirely from his operations the troublesome staining or dyeing of the printed film. All he has to do is to correctly expose the ready-made colored film during printing, and correctly develop it afterwards by automatic timed development at correct temperatures. Thus the loss often experienced in dyeing printed film is avoided.

In my earlier processes where the two differently colored images were formed upon the outside faces of the film—whether such be composed of one central piece of celluloid or of two pieces—it has been found that when such films are subjected to careless usage by the operator of the projector during exhibition; or if particles of grit gain access to the gate of the projector, or between the coils of the spooled film; or if the film during its movement comes into rubbing contact with portions of the machine; one or both of the sectional color images quickly become badly scratched. Removal of one color by a scratched line would produce upon the screen a vertical line across the picture corresponding to the other color, so that in such places the screen image would represent part only of a picture in one color, whilst the unscratched portions would represent a two-color picture.

In a two-color film constructed according to this invention the two delicate colored images are placed in the centre, and the transparent cellulose base or carrier of each image is located on the two outside faces when the film is assembled this result being obtained by cementing the two colloid faces together with suitable cement, instead of the two backs. Thus the complete colored picture is perfectly protected by being sandwiched between 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. It is also desirable to preserve the celluloid faces against scratches by a still further outer layer of removable soluble colloid varnish.

5 This construction and mode of manufacture has many advantages. One is that it permits the use of printing processes of the relief-image type, such as those known as carbon, carbograph and others, which require
10 that the image shall be printed from the back through the transparent celluloid support but developed from the front or colloid face; it also allows images of the non-relief type to be made, which require printing and develop-
15 ing from the front (sensitive) side.

But, in a two-piece film according to this invention, with the coloring matter incorporated in the separate pieces by the maker during manufacture of the film material at
20 the factory in an accurately defined and measured quantity of exactly the right shade and color, the printer has eliminated entirely from his part of the work all the troublesome staining or dyeing of the film after printing, and
25 the great difficulty of correct matching and balancing of the colors throughout the entire length of film, which may amount to many miles per day.

Throughout the specification and claim the
30 term "face" refers to the sensitized colored 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 water-
35 proof material which carries the face or layer of colloid, and which eventually becomes the outside layer of the completed film.

Referring to the accompanying drawings:—

40 Fig. 1 is a face view of a sensitized ready-colored double-width film before printing, one half colored orange-red and the other half colored blue-green.

Fig. 2 is a similar view showing the film
45 perforated before printing.

Fig. 3 is a similar view of the film after printing with two section images of different colors before slitting into two.

Fig. 4 is a view of the completed film with
50 the two parts superposed and cemented together either face-to-face or back-to-back.

Fig. 5 is a similar view of wide web with alternating stripes of color.

Fig. 6 section of single sensitive film before
55 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. 7 section of single sensitive film before
60 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. 8 section of single sensitive film before
65 being printed upon with a transparent cellu-

loid 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. 9 indicates the printing of the sensi- 70
tive film Fig. 6 through the celluloid back A, the negative E being placed against the back of the film to produce a relief image when developed.

Fig. 10 indicates the printing of the sensi- 75
tive film Fig. 6 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. 11 indicates the printing of the sensi- 80
tive reinforced film Fig. 7 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. 12 indicates the printing of two of the 85
sensitive reinforced films Fig. 7 simultaneously, the films being placed or clamped together back to back and printed through the sensitized faces B, the negatives E being
90 placed against the faces of the film to produce a non-relief image when developed.

Fig. 13 indicates the printing of the sensi-
95 tive reinforced film Fig. 8 through the celluloid back A, the negative being placed against the back of the film to produce a relief image when developed.

Fig. 14 indicates the printing of two of
the sensitive reinforced films Fig. 8 simultane- 100
ously, the films being placed or clamped together with the reinforcing layer D on the face B of one against the reinforcing layer D
105 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
110 developed.

Fig. 15 indicates the position of two of the
115 printed and developed films Fig. 6 one colored orange-red and the other colored blue-green, face B to face B before uniting.

Fig. 16 indicates the position of two of
the printed and developed reinforced films
120 Fig. 7 one colored orange-red and the other colored blue-green, face B to face B before uniting, and before removal of the water-
125 proof reinforcing layer C.

Fig. 17 indicates the position of two of the
printed and developed reinforced films Fig.
130 7 after being united face B to face B, showing the waterproof reinforcing layer C being removed.

Fig. 18 indicates the position of two of
the printed and developed reinforced films
135 Fig. 7, 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. 19 section of finished film united face
140 B to face B the two printed, developed, colored layers B, 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 carrier 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 the celluloid faces may be still further protected against scratches by an outer layer of removable soluble colloid varnish.

Film material and printing processes

The colored images may be printed by various known and suitable process using sensitized material such as gelatino-silver-bromide; gelatino-silver-chloride; bichromated gelatino; various processes using metallic salts such as iron, uranium; the carbon pigment process; dyed gelatine processes, via silver, bichromate, or iron; but for purposes of this specification I have only utilized and illustrated the sensitized methods commonly preferred, viz:—those sensitized with silver salts and those sensitized with bichromate salts.

Manufacture of the film material itself is described in U. S. Patent No. 1,610,827. The material comprises a very thin transparent base A of celluloid, cellulose-acetate, or similar waterproof material, with a thickness of about .0015 inch, having upon one side an adhesive substratum of the kind known to those versed in the art of film manufacture, and a further coating B 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.

If the film contains silver-bromide it will be of the rapid printing variety, requiring a short exposure to light, subsequent developing and fixing, followed by treatment in a hardening and bleaching or oxidizing bath. (Alternatively silver-chloride, iodide, or other silver salts may be used in its manufacture.)

If the film does not contain silver salts the colloid will require sensitizing in a bath of a suitable bichromate salt, followed after printing, by removal of the unchanged or unhardened colored colloid.

Various types of prints

It is possible to make a number of variations in the print, according to the structure and composition of the film, and the resulting image may be of either the relief or non-relief type.

If the image is to be of the relief type the unprinted or soft gelatine is washed away by dissolving it with hot water, (but an alternative method is to use a saturated cold solution of a bichromate accompanied by more or less brush friction). Such reliefs can be made if the film has been sensitized either with bichromate or silver salts, as in either of the two methods described.

If, however, the image is to be of the non-relief type, and the unprinted or soft gelatine allowed to remain in the finished print, the gelatine must be made transparent by the discharge or removal of the coloring matter from the unprinted parts. This can be done if such color is composed of dye that is soluble in water or suitable reagents or is capable of being bleached by reagents.

In the present stage of knowledge of the art, and having regard to the required technical skill and cost involved in printing, the cheapest and simplest of these several variations is undoubtedly to manufacture the prints upon the "carbon" type of film—that is one made up with colloid containing pigment or dye, and sensitized with bichromate, to be printed by long exposure and developed with hot water.

But where long exposure is objected to the next best alternative is to manufacture the prints upon film of the type containing a combination of silver-bromide or chloride emulsion and pigment, or dye, or pigment and dye, to be printed by short exposure, followed by development, fixing, bleaching and hardening, and finally by hot water. As already stated this film will print quicker but cost more and will also need far more care in the various operations.

Printing the film sections

The film is manufactured of double width, one half of the transparent base A being coated with colloid B containing pigment or

dye of orange-red and the other half coated with colloid B containing blue-green. Such a double-width film is, by the preferred method, 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 exposure and density; development 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.

In the processes of printing, developing and finishing the ready-colored film a number of variations are permissible within the scope of this invention, of which the following are given as examples:—

The print may be made from two separate strips of negatives E (one being formed with its images reversed in relation to the other), and each negative E may be printed upon a separate colored sensitive strip at a separate operation as indicated in Figs. 4, 5, 6 and 8. Or the colored strips may be placed back to back with their celluloid bases B adjacent, and the negatives E placed outside each with its face adjacent to the face B of the colored strip to which it corresponds, as indicated in Fig. 7. The whole four strips are then passed through a suitable printing machine in which they are clamped together during the period of exposure to lights which shine through the back of the two negatives E. The two positive strips are then developed and finished either together or separately.

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

Or alternatively again, a double width negative may be used to print two separate colored positive strips.

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.

In all the above 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. It is preferred to perforate both color-section materials simultaneously whilst laid face to face or back to back, as a safeguard against any differences that might arise from relative differences of shrinkage or from variations of temperature.

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 ensure 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 reinforcement D of paper.

This temporary reinforcement D 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.

This reinforcement may be of porous paper D applied to the front or sensitive colored colloid side B of the film; or it may be either of porous paper or of waterproof paper C applied to the back or celluloid side A of the film. I prefer however, to use waterproof paper C when applied to the celluloid side as in Fig. 7 and porous paper when applied to the colored colloid side as in Fig. 8 in order to secure the different types of relief or non-relief images as hereinafter more particularly described.

The only disadvantage of this reinforced film if made with a paper backing applied to the celluloid base side of the film is that it cannot be used for the carbon relief process, because it cannot be printed through the celluloid owing to the paper backing.

Such celluloid film with paper backing must therefore be always printed from the front or colloid side, thus producing a flat or non-relief image. For that reason the ready-colored colloid must contain a dye of the type that can be washed away from the unprinted portions by some process of washing or of bleaching.

But if the reinforced film is made with a reinforcing of porous paper D applied to the front of the colloid layer B, so that the sensitive colloid layer is sandwiched between the celluloid back A and the reinforcing paper layers as indicated in Fig. 8, the film can be printed through the back of the waterproof celluloid, as indicated in Figs. 13 and 14 and developed from the front through the porous paper; and when the final stage of development by hot water is completed, the soluble colloid being dissolved allows the porous paper layers D to be removed as the two printed and developed sides are brought face B to face B and cemented together, as indicated in Fig. 18.

To remove the paper backing when the print has been completed, 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-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 in Fig. 19. The completed film is now 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.

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

The method of producing a cinematograph two color film which consists in applying an adhesive layer on to a web of celluloid of half standard film thickness, coating stripes of blue-green colored colloid and orange-red colored colloid alternately on the adhesive, each stripe being the width of a standard film, cutting the web into double standard width strips, perforating the strips, printing and finishing a single section image on each half width, severing the double width strip longitudinally and superimposing the two half widths image face to image face to enclose the picture bearing colloid between the two celluloid supports.

In testimony whereof I have hereunto set my hand.

JOHN EDWARD THORNTON.