

Dec. 25, 1923.

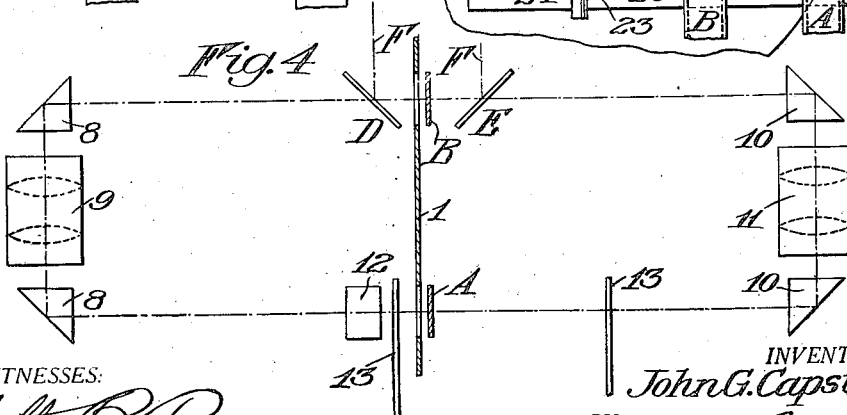
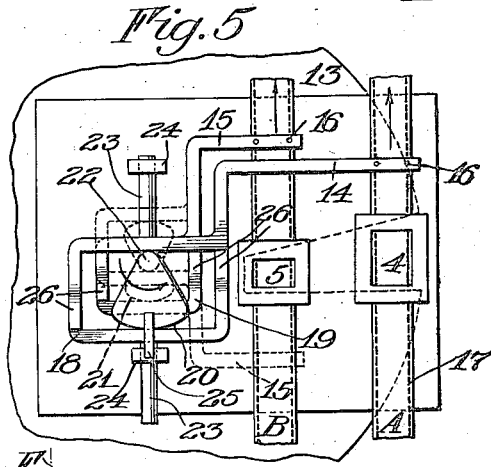
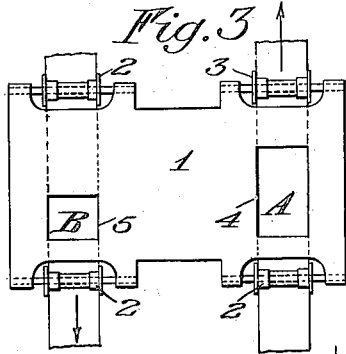
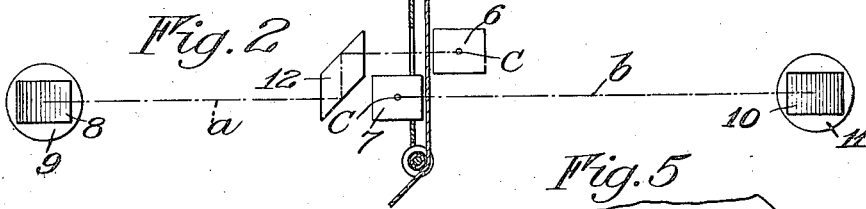
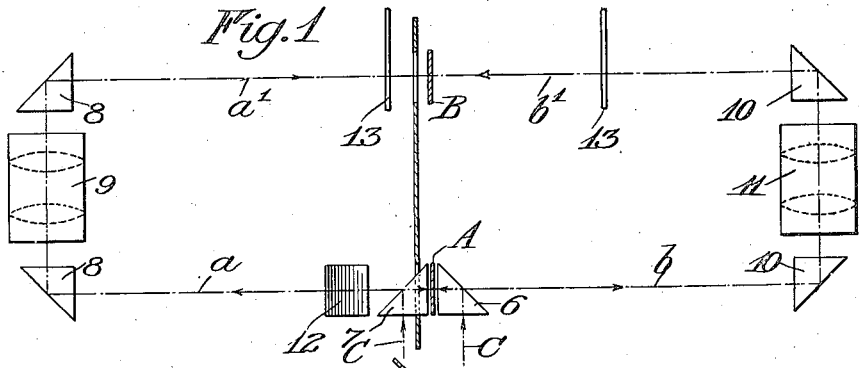
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J. G. CAPSTAFF

PHOTOGRAPHIC REPRODUCTION AND METHOD OF AND APPARATUS FOR MAKING THE SAME

Filed Sept. 21, 1914

2 Sheets-Sheet 1



WITNESSES:

*Mattie B. Payne*  
*Russell H. Haffner*

INVENTOR.

*John G. Capstaff*

BY

*Charles F. Rich*  
 HIS ATTORNEYS.

Dec. 25, 1923.

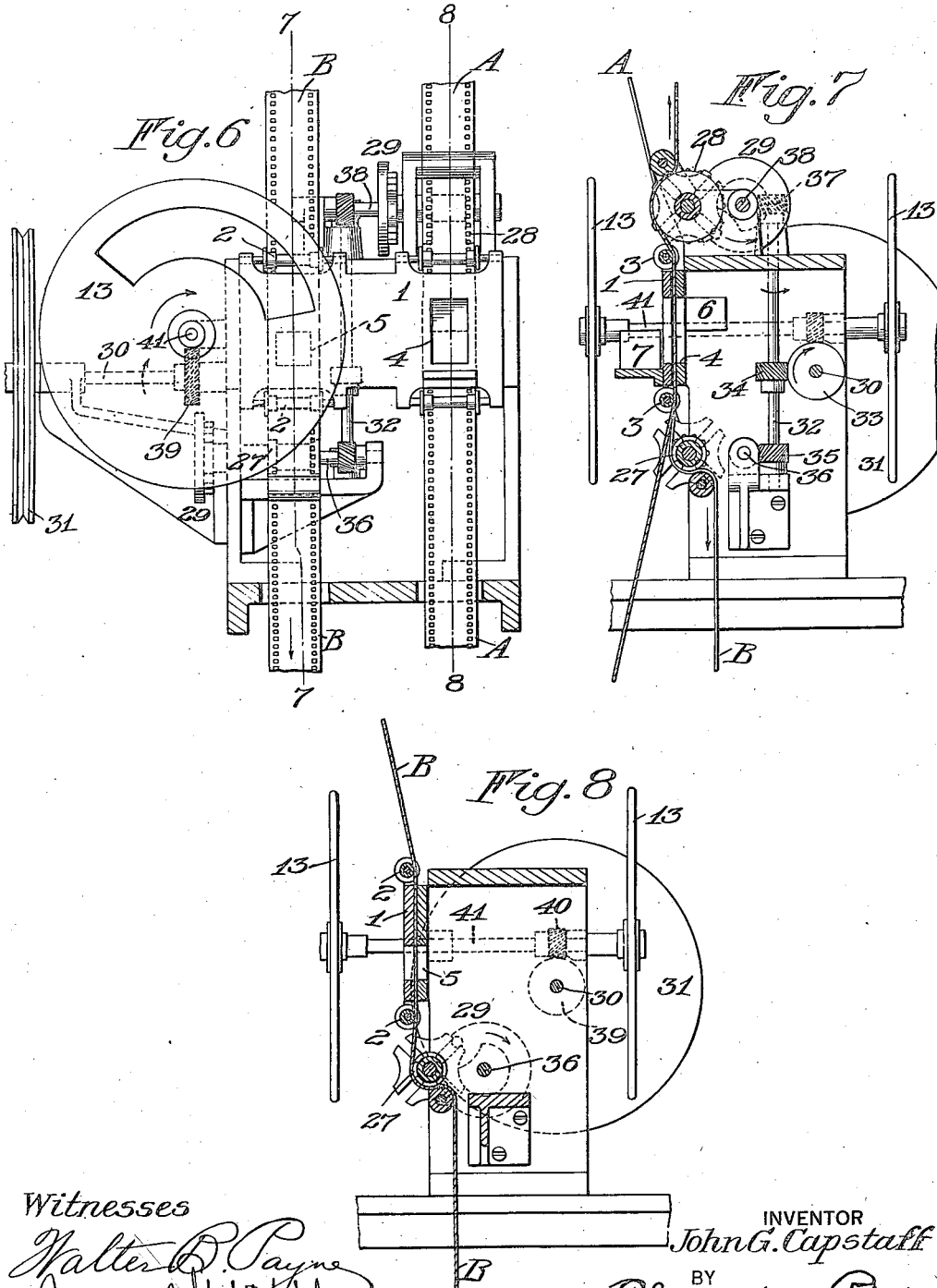
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J. G. CAPSTAFF

PHOTOGRAPHIC REPRODUCTION AND METHOD OF AND APPARATUS FOR MAKING THE SAME

Filed Sept. 21, 1914

2 Sheets-Sheet 2



Witnesses  
*Walter B. Payne*  
*Annun M. Hiffell*

INVENTOR  
*John G. Capstaff*  
 BY  
*Chas. C. Cook*  
 his ATTORNEYS

Patented Dec. 25, 1923.

1,478,599

# UNITED STATES PATENT OFFICE.

JOHN G. CAPSTAFF, OF ROCHESTER, NEW YORK, ASSIGNOR TO EASTMAN KODAK COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

PHOTOGRAPHIC REPRODUCTION AND METHOD OF AND APPARATUS FOR MAKING THE SAME.

Application filed September 21, 1914. Serial No. 862,716.

*To all whom it may concern:*

Be it known that I, JOHN G. CAPSTAFF, of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Photographic Reproductions and Method of and Apparatus for Making the Same; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the reference numerals marked thereon.

My present invention relates to photography and it has for its object to provide a simple and convenient method of making compound photographic reproductions. The improvements are further directed to the production or reproduction of photographs in colors and the invention has for its object also to improve the manufacture of motion picture strips in which the pictures appear in their natural colors. Features of novelty reside in the photographs themselves which articles of manufacture are a part of the present invention. To these and other ends the invention consists in certain improvements and combinations of parts all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Figure 1 is a top plan, partially diagrammatic view, partly in section, of a projection apparatus for printing cinematograph film in accordance with my invention;

Figure 2 is a side elevation of the same apparatus;

Figure 3 is an elevation of the gate of the machine;

Figure 4 shows a plan of a modification;

Figure 5 is an elevation of one form of mechanism that may be used to give intermittent feeding motion to the film;

Figure 6 is an elevation of another feeding mechanism that may be employed, and

Figures 7 and 8, respectively, are sections on the lines 8—8 and 7—7 of Figure 6.

Similar reference numerals throughout the several views indicate the same parts.

Referring more particularly to the drawings, 1 indicates the double gate of a duplex film strip feeding machine that may in other respects be substantially the usual cinematograph

apparatus for running film except as hereinafter noted. Two separate guiding mechanisms, typified by the rollers 2 and 3, are provided, but one gate aperture 5 is the usual size corresponding to one picture area of the strip while the other, 4, is double the size so as to expose two picture areas at once. For a film strip A transversing the aperture 4 an intermittent movement of two pictures at a time is provided, while a laterally offset but parallel film strip B is fed intermittently one picture at a step, as usual. The two films are made to travel in opposite directions as indicated by the arrows.

Suitable reflectors such as the prisms 6 and 7 are placed upon opposite sides of the aperture 4 and of the film A, one in alignment with the upper picture exposed and the other in alignment with the lower picture exposed so as to simultaneously project the images of these latter in opposite directions with a common source of light arranged at C, along lines *a* and *b*. Both of the beams *a* and *b* are further projected twice at right angles through reflecting prisms 8—8 and an intermediate lens system 9, on the one hand, and prisms 10—10 with a lens system 11 on the other, until, emerging on the lines *a'* and *b'*, they are finally recorded upon opposite sides of that picture area of film B which is exposed in the gate aperture. As the two pictures in the gate aperture 4 are laterally offset, the beam projected from one or the other must be lifted or lowered so that both will ultimately coincide at the other gate aperture 5. A prism shown at 12 constitutes one means for accomplishing this result.

In the practice of my invention as applied to the printing or reproduction in colors of motion picture positive films in continuous strips, I first prepare on panchromatic film an ordinary negative strip consisting of successive views consecutively arranged by means of the usual taking apparatus, except (with a two color system which I will first describe), that adjacent negatives are composed of different color sensation records so that the strip comprises a plurality of adjacently arranged pairs of substantially identical outline images. In other words, one picture is made through a red filter, the next through a green filter, the next through the red, and so on. I then convert the whole record into a positive by contact printing it,

or otherwise, upon a second film strip. This positive is the film strip A previously described which may be termed the "master" record.

5 The master record is run through the gate 1 with that degree of intermittent movement which will present, for a brief period, each pair of red and green sensation pictures to the opening 4 at one and the same time.

10 Through the guides 2 of the double gate, I run, in the opposite direction, a sensitized film strip B on which the printing is to be done and which finally emerges from the entire process as the colored product sought.

15 This strip is double coated with sensitive emulsion, that is, it carries a sensitive medium on each side and it is fed intermittently past the single opening 5 in the gate 1 in such manner that one picture area is exposed at the same time that a pair of pictures appear in the double opening 4.

20 From the foregoing, it is believed that the printing scheme is apparent. Under the control of suitable shutters 13 of the usual  
25 type, the image of the red sensation record on the master strip A is projected along the lines  $a-a'$  and cast upon one side of the single picture area of the double coated film B that appears in the gate aperture 5 while,  
30 preferably at the same time, the image of the green sensation record of the particular pair that occupies the double gate aperture 4 is projected along the lines  $b-b'$  and cast upon the opposite side of the same picture area  
35 of the sensitive film B. The optical adjustments are such that the images register exactly on the film B and there is thus obtained, in effect, a single compound record on each picture area of film B that shows  
40 both red and green color sensations, all of the former being on one side of the strip and all of the latter on the other. The finished strip B is, therefore, half the length of the master strip A from which it was printed  
45 though it contains all of its subject-matter. The exposure of one sensitive face of the double coated film to one beam of light does not conflict with the exposure of the other face or materially fog the other sensitive  
50 coating, because of the natural resistance to the transmission of light of the emulsion first acted upon, but if difficulties of this nature arise, a further barrier may be imposed by staining the emulsions with a suitable  
55 substance that may be later removed in connection with some subsequent operation. After the exposure of one picture area on B in this manner, the latter strip is fed one step to present a fresh picture area and the  
60 strip A is simultaneously fed two steps in the opposite direction to present the next succeeding pair of pictures at the gate aperture 4.

65 The film B is removed and developed as usual. The compound photographic images

thereon are negative images and these are converted into dye-positives by any suitable method such as that described in my Patent, No. 1,196,080 dated August 29, 1916 entitled  
70 "Photographs in color and method of making the same." By my said method, the film is next bleached on both sides at once and then, after drying, the silver images on its two sides are converted into dye images by  
75 separately treating them to the respective dye-baths, the red sensation records on one side of the double coated film being all dyed blue-green at the one operation and the green sensation records on the other side being  
80 similarly all dyed orange-red.

When the colored film B is projected in the ordinary manner, the transmitted light will cast images on the screen in the natural colors of the original subject without the use  
85 of color filters in connection with the projecting machine. In other words, the coloring is an inherent characteristic of the picture itself.

Among the many advantages derived from my process it is to be noted, first, that  
90 both the taking and projecting machines required may be of the ordinary type now in general use with the exception of the addition of the color filters to the former; secondly, the ordinary single width film is used  
95 throughout; third, any desired number of color reproductions can be made from a single negative or the master film printed therefrom, and fourth, except in the case  
100 of the original negative where the color sensations are recorded direct from the subject, the films used and particularly the film B, do not require to be color sensitive, the ordinary emulsions for black and white cinematograph pictures being readily used.  
105

To gain the very best results, the red and green sensation records of each pair taken on the original negative should, of course, be exact duplicates of each other in image  
110 outline, taken through the same lens during one position of the subject and from the same point of view, but for practical uses the successive exposures on a cinematograph film reproducing an object in motion in the  
115 ordinary way, vary so little in image outline that their differences, when such components of a colored compound picture are superposed, is hardly, or in some instances, not at all, perceptible.

I have described the method herein with  
120 more particular relation to the use of my particular coloring process, previously referred to, in conjunction therewith for the purposes of which coloring process it is necessary to produce a negative print at B,  
125 but it will be understood that, in the event of some other coloring scheme being utilized which is of a nature permitting or requiring it to be worked upon a positive print, such a positive could be produced at B from the  
130

original negative in the position of strip A instead of a print thereof. The said original negative would thus itself be used as the master strip.

5 In the event that the master strip or that strip from which the printing is done should be destroyed or for any reason it should be required to reproduce it with only a colored print B at hand for the purpose, it is obvious that the method described  
10 could, in a way, be worked backwards to that end by a slight modification of the present machine. With the addition of two reflecting light filters arranged at 45° angles on opposite sides of the strip B as indicated in full lines at D and E in Figure 4, and the prisms 6 and 7 eliminated, a common source of light traveling from F against  
15 both of them would simultaneously project red and green sensation images back to side by side positions along the length of a double coated panchromatic film arranged at A. Other mechanical and timing arrangements of the apparatus would remain  
20 as before.

Any suitable feeding mechanism may be employed for intermittently moving the film strips to present successive picture areas in  
30 the gates 4 and 5, the film A, as previously explained, being fed two steps to one step of the film B. In Figure 5, I have shown, for instance, the feeding mechanism of the patent to R. T. Haines, No. 861,832 of July  
35 30, 1907, which is adapted for the purpose in hand. Briefly described, this mechanism consists of a feed arm 14 for the film A in the double gate and the feed arm 15 for the film B in the single gate. Each arm is provided with pins 16 to engage with the  
40 usual marginal perforations 17. The arms 14 and 15 are fixed to frames 18 and 19, respectively, within which operate cams 20—21. The swing of the cam 20 is twice that of the cam 21, the frame 18, of course, being correspondingly larger than the frame 19, so that as the frames are reciprocated by the rotation of the cams on the shaft  
45 or center 22, the arm 14 is given a reciprocatory movement twice as great as the arm 15 and moves the film A two picture areas or twice as far. The frames 18 and 19 are slidable longitudinally of the shaft 23 arranged in bearings 24 and they also have  
50 a rocking movement on the shaft to engage and disengage the pins 16 from the film perforations at the proper time. This rocking movement is controlled by pins 25 on the cams engaging cam surfaces 26 on the frames. With the parts as shown in full  
60 lines in Figure 5, both films are fed in the same direction, but to feed them in opposite directions, the arm 15 is disposed on the opposite side of the strip B, as shown in  
65 dotted lines, and the timing of the cam 21

is altered to the extent shown in dotted lines.

I may also employ feeding mechanism shown in Figures 6 to 8 which is the commonly used type of construction found in  
70 present day motion picture machines. In that device, the film B is drawn through the gate 5 by a sprocket 27 which is half the diameter of a sprocket 28 that draws the film A through the gate 4. Motion is  
75 communicated to each sprocket by the usual intermittent driving mechanism indicated generally at 29, in each instance. A drive shaft 30 having a driving pulley 31 turns a cross shaft 32 through worm gears 33 and  
80 34. A worm 35 on the cross shaft turns the shaft 36 of the intermittent gearing for the small sprocket 27 while a worm 37 turns the shaft 38 of the intermittent gearing for the large sprocket 28. Another  
85 worm 39 on the drive shaft 30 meshes with a worm 40 on a shutter shaft 41 carrying the shutters 13 which are thus coordinated with the shifting movements of the film strips. In other words, I use two of the  
90 usual film feeding mechanisms of the motion picture art with an enlarged sprocket on one so that it will feed twice the amount of film fed by the other.

I claim as my invention:

95 1. A method of preparing photographic reproductions which comprises optically projecting duplicate images upon opposite sides of a transparent support having a sensitive medium on each side, the images  
100 emanating from points out of register with the support and out of register with each other and being recorded in register with each other upon the respective mediums.

105 2. A method of preparing photographic reproductions in color which comprises optically projecting, simultaneously, two positive prints from two color-sensation negatives that are substantial duplicates of each other except as to the color sensations they  
110 record, while said positive prints are lying in the same plane but side by side out of register, upon opposite sides of a transparent support which carries a sensitized medium on each of said sides, the images being  
115 projected and recorded in register with each other upon the respective mediums, developing the latter and coloring the different color-sensation records thus last obtained appropriate hues.

120 3. A method of producing continuous strips of motion picture film in colors which comprises preparing a continuous motion picture strip in which successive groups of adjacent pictures arranged end to end,  
125 represent different color sensation records of substantially the same image, optically projecting one such color sensation record of each group upon one side of a double coated sensitized film while arranged out of register 130

with said strip and another color sensation record of that group upon the other side of the said film so that the two images register with each other on a single picture area and

5 light color sensation records all appear on the same side of the film, developing the latter and coloring the opposite side of the film appropriate hues by the bleaching and dyeing process.

10 4. A method of producing continuous strips of motion picture film in colors which comprises preparing a continuous motion picture strip in which successive groups of adjacent pictures arranged end to end, represent different color sensation records of substantially the same image, optically projecting, by reflection, one such color sensation record of each group upon one side of a double coated sensitized film and similarly

15 and simultaneously projecting another color sensation record of that group upon the other side of the said film while the strip and film are out of register so that the two images register with each other on a single

20 picture area of the film and light color sensation records all appear on the same side of the film, developing the latter and coloring the opposite sides of the film appropriate hues.

25 5. A method of producing continuous strips of motion picture film in colors which comprises preparing a continuous motion picture strip in which successive groups of adjacent pictures arranged end to end, represent different color sensation records of substantially the same image, arranging the said strip in laterally spaced but parallel relationship with a double coated sensitized film, projecting by reflection, one such color sensation record of each group upon one side

30 of the said film and another color sensation record of that group upon the other side of the film so that the two images register with each other on a single picture area and like color sensation records all appear on the

35 same side of the film, developing the latter, and coloring the opposite sides of the film appropriate hues.

40 6. A method of producing continuous strips of motion picture film in colors which comprises preparing a continuous negative strip in which successive groups of adjacent pictures arranged end to end, represent different color sensation records of substantially the same image, printing a like positive strip from such negative, optically projecting one color sensation record of each group from the positive strip upon one side of a double coated sensitive film not in alignment with said strip and another color sensation

45 record of the group upon the other side of the said film so that the two images register with each other on a single picture area and like color sensation records all appear on the same side of the film, developing the latter,

50 and coloring the opposite sides of the nega-

tive film thus produced, appropriate hues by the bleaching and dyeing process whereby it is converted into a dye-positive.

7. A method of preparing photographic reproductions in color for the projection of motion pictures which comprises obtaining in a taking camera, two complementary color sensation records of substantially the same subject, arranged upon adjacent picture areas of a continuous panchromatic film, printing a black and white positive master film from the black and white negative so obtained, printing from the positive master film a duplex black and white negative product film on a strip having a sensitive body upon each of its two sides by optically projecting, with light transmitted in opposite directions through the respective picture areas of the positive master film, the component color images into register upon opposite sides of the same picture area of the said product film, developing the latter and finally dyeing the two negatives on the product film appropriate colors.

8. A method of printing photographic motion picture film which comprises preparing a printing strip in which records of complementary color sensations of the same subject alternate, projecting the adjacent records thereof simultaneously and into register upon opposite sides of a double coated product strip, sensitive on each side, developing the latter and imparting complementary colors to its respective sides.

9. A method of printing photographic motion picture film which comprises preparing a positive printing strip in which records of complementary color sensations of the same subject alternate, projecting the adjacent records thereof simultaneously and into register upon opposite sides of a double coated product strip sensitive on each side whereby negatives of sensations all of one color are arranged in succession on the respective sides, developing the product film and converting each set of negatives into dye positives of a color complementary to that of the other set of negatives.

10. A method of printing photographic motion picture films which comprises preparing a negative strip in the taking camera upon which records of complementary color sensations of the same subject alternate, printing therefrom a master positive strip having the same arrangement of the color sensation records, projecting the adjacent records thereof simultaneously and into register upon opposite sides of a double coated product film sensitive on each side whereby negatives of sensations all of one color are arranged in succession on the respective sides, developing the product film and converting each set of negatives into dye positives of a color complementary to that of the other set of negatives.

11. In a photographic printing apparatus for the purpose described, the combination of positive and negative film gates, means for projecting images from a film in the negative film gate upon opposite sides of a film in the positive film gate, and step-by-step film-feeding mechanism adapted to advance the negative film two image-spaces and the positive film one image-space in each cycle of operation.

12. In a photographic printing apparatus for the purpose described, the combination of positive and negative film gates, means for projecting upon the opposite sides of a film in the positive film gate images from a film in the negative film gate while both films are at rest, and step-by-step film-feeding mechanism having means to advance the negative film two image-spaces and the positive film one image-space in each cycle of operation.

13. In a photographic printing apparatus for the purpose described, the combination of positive and negative film gates, means for projecting images from a film in the negative film gate upon opposite sides of a film in the positive film gate, shutters arranged to expose the opposite sides of the positive film alternately, and step-by-step film-feeding devices operating while both sides of the positive film are obscured and adapted to advance the negative film two image spaces to one image-space of the positive.

14. In a photographic printing apparatus for the purpose described, the combination of positive and negative film gates, optical means to project successive images, arranged end to end, from a film in the negative film gate upon opposite sides of a film in the positive film gate and in suitable registry with each other, and mechanism for advancing the film step by step through the film gates.

15. In a photographic printing apparatus for the purpose described, the combination of positive and negative film gates, optical means, including a plurality of reflectors, for projecting upon opposite sides of a film in the positive film gate and in suitable registry with each other successive images upon a film in the negative film gate, step-by-step film-feeding mechanism to advance the films through the film gates and adapted to advance the film in the negative film gate at a faster rate than the film in the other, means to illuminate the film in the negative film gate, and means to expose the film in the positive film gate only while both films are at rest.

16. In a photographic printing apparatus for the purpose described, the combination of positive and negative film gates, feeding devices to advance films through the film gates, mechanism for actuating the feeding devices to advance a film in the negative film gate two image-spaces to one image-space of the film in the other film gate, optical

means to project upon opposite sides of the film in the positive film gate, and in suitable registry with each other, successive images from a film in the negative film gate, means to illuminate the film in the negative film gate, and shutter-mechanism operating in harmony with the aforesaid actuating mechanism to permit printing light from the film in the negative film gate to strike the other film only while the films are at rest.

17. In a photographic printer for projecting suitably registered images from a negative film upon opposite sides of a positive film, in combination, negative and positive film gates arranged to support two independent films, means to illuminate the sides of a film in the negative film gate, reflectors arranged to reflect light rays from the two sides of the illuminated film in the negative film gate to the two sides of a film in the positive film gate, and projecting lenses in the paths of said rays.

18. In a photographic printer for projecting suitably registered images from a negative film upon opposite sides of a positive film, in combination, negative and positive film gates arranged to support two independent films, optical means for projecting upon the two sides of a film in the positive film gate images from opposite sides of a film in the negative film gate, and exposure-shutters in the paths of the light rays from the film in the negative film gate.

19. In a photographic printer for projecting suitably registered images from a negative film upon opposite sides of a positive film, in combination, negative and positive film gates arranged to support two independent films, means for illuminating a film in the negative film gate, optical means to project images from opposite sides of a film in the negative film gate upon opposite sides of a film in the positive film gate, and exposure shutters working on opposite sides of the positive film gate to alternately expose and obscure a film therein.

20. The combination with a member having doublet negatives thereon side by side, of means for photographically printing said doublets upon the opposite surfaces of a sheet, said means comprising obliquely disposed reflecting surfaces for diverting the rays from the negatives outwardly parallel with said member, then at right angles to said member, and finally inwardly to the opposite sides of said sheet, the last-named reflecting surfaces being located at distances from said sheet many times in excess of the distance between the negatives.

21. In an apparatus for printing positive films from a negative film having successive pairs of displaced pictures or images, in combination, a negative film gate having an exposure opening adapted to expose a pair of pictures, a positive film gate, optical pro-



jecting means between the two film gates to project displaced negative pictures, from a film in the negative film gate, into registry with each other upon opposite sides of a film in the positive film gate, and feeding mechanism to pass films through the respective film gates.

22. In an apparatus for printing positive films from a negative film having successive pairs of displaced pictures or images occupying different planes, in combination, a negative film gate having an exposure opening adapted to expose a pair of pictures, a positive film gate having an exposure opening in the plane of one of the pictures in the negative film gate, optical means for projecting a picture from the negative film in its own plane upon one side of the positive film, optical means for projecting the other image from the negative film and displacing it from its own plane into the plane of the first and upon the opposite side of the positive film in registry with the first, and means for feeding the negative and positive films through the respective film gates.

23. In an apparatus for printing positive films from a negative film having pictures or images displaced longitudinally of the film, in combination, a negative film gate having an opening adapted to expose a pair of pictures, a positive film gate on a level with one of the pictures in the other film gate, optical means to project upon one side of a positive film in the positive film gate an image from the corresponding negative picture in the negative film gate, optical means for projecting light from the other negative picture and displacing the same to the level of the first to produce an image on the opposite side of the positive film in registry with the first, and feeding mechanism to pass the films through the respective film gates.

24. In an apparatus for printing positive films from a negative film having successive pairs of displaced pictures or images occupying different planes, in combination, a negative film gate having an opening adapted to expose a pair of pictures, a positive film gate having an exposure opening in the plane of one of the negative pictures, means for projecting an image from one of the negative pictures of the negative film upon one side of a film in the positive film gate, means for projecting from the other negative picture an image upon the other side of the film in the positive film gate, the last mentioned means including reflecting devices part in the plane of the second negative picture and part in the plane of the first whereby the light from the second is displaced into the plane of the first, and feeding mechanism for passing the films through the respective film gates.

25. In a photographic printer for pro-

jecting adjacent images from a master film into register upon opposite sides of a product film, in combination, two film gates arranged to support two independent films, means to illuminate two images arranged end to end on a film in one film gate, and optical means for projecting such images from the illuminated film into register upon opposite sides of the other film.

26. The method of producing color cinematographic positives from a single negative film having two series of negative images in alternating sequence one series recording an object in light of one color or color-group and the other recording the object in light of another color or color-group, which consists in printing alternate negative images on one side of a positive film sensitized on both sides and the intermediate negative images on the other side of the positive film in registry with the images of the first series, reversing the images of one series with respect to the images of the other in printing and shifting the negative film two image-spaces to one image-space of the positive in printing; and developing and coloring the two series of positive images on the positive film after both have been printed thereon.

27. The method of printing positives from a cinematographic film having two series of negative images in alternating sequence, one series recording the object in light of one color or color-group and the other series recording the object in light of another color or color-group, which consists in projecting the images of one series upon one side of a positive film sensitized on both sides, and projecting the images of the other series upon the other side of the positive film, the images of one series being reversed in the projection whereby the two images on the opposite sides of the positive film are brought into registry with each other, and developing and coloring the two series of positive images on the positive film after both have been printed thereon.

28. In an apparatus for printing positive films from a negative film having a pair of displaced images, in combination, a negative film support having an exposure opening adapted to expose a pair of images, a positive film gate, optical projecting means between the support and positive film gate to project displaced negative images, from a film in the negative film support, into registry with each other upon opposite sides of a film in the positive film gate, and feeding mechanism to pass film through the positive film gate.

JOHN G. CAPSTAFF.

Witnesses:

RUSSELL B. GRIFFITH,

AGNES NESBIT BISSELL...