Nov. 29, 1932. W. VAN D. KELLEY 1,889,124

COLOR PHOTOGRAPHY

Filed April 24, 1929

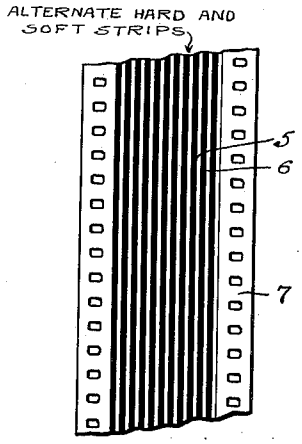


Fig. 1.

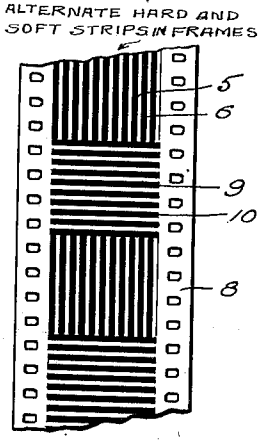


Fig. 2.

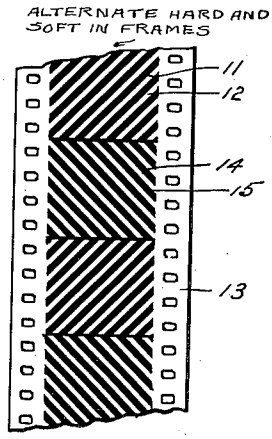
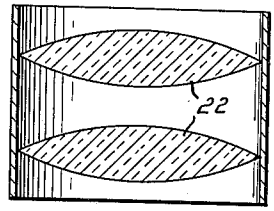


Fig. 3.



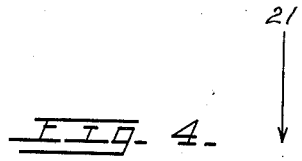
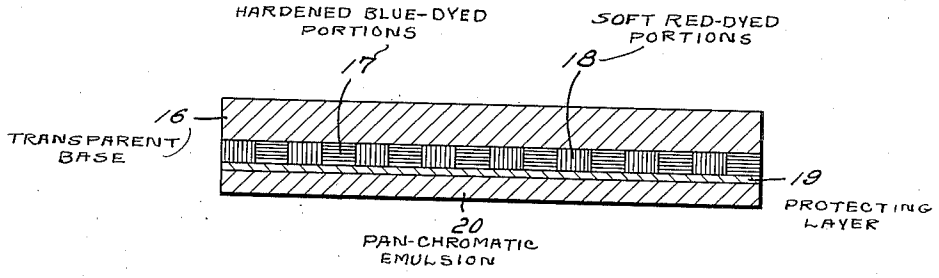


Fig. 4.



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Attorney.

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UNITED STATES PATENT OFFICE

WILLIAM VAN DOREN KELLEY, OF HOLLYWOOD, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DU CHROME FILM SYSTEM LTD., OF HOLLYWOOD, CALIFORNIA, A CORPORATION OF CALIFORNIA

COLOR PHOTOGRAPHY

Application filed April 24, 1929. Serial No. 357,702.

In this specification, and the accompanying drawing, I shall describe and show a preferred form of my invention, and specifically mention certain of its more important objects. I do not limit myself to the forms disclosed, since various changes and adaptations may be made therein without departing from the essence of my invention as hereinafter claimed; and objects and advantages, other than those specifically mentioned, are included within its scope.

This invention relates to color-photography and the allied photographic arts. Its principal objects include: first, to provide new and improved means for producing photographic representations of objects in their natural colors; and, second, to supply a new type of photographic film or plate, that is particularly adapted for use in connection with this art.

My objects are attained in the manner illustrated in the accompanying drawing, in which—

Figures 1, 2, and 3 are front elevations of portions of a motion picture film, illustrative of intermediate step in the process of modifying it to employ the principles of my invention; and

Figure 4 is an enlarged cross-section of the above film when completed.

All of the figures are diagrammatic, and are greatly distorted as to scale for convenience of illustration. Similar reference numerals refer to similar parts throughout the several views.

Proceeding to a detailed description of my invention, we will assume that it is to be used in connection with a standard positive motion picture film of commerce. The first step will be to produce in the emulsion of such a film, very closely spaced parallel lines of reduced silver, throughout its area; the width of the lines being approximately equal to the width of the spaces therebetween. This may be accomplished in various well known ways. For instance, an original line screen may be made on glass by ruling lines thereon with a diamond point, and then blackening such lines. The number of lines may be anywhere from 400 to 1200 per inch, and their width in any case is made equal to that of the spaces between them. Thus one half the total area of such a screen will comprise very narrow parallel strips of clear glass, and the other half of the area will comprise narrow black bands of the same width, between the clear strips.

If a photosensitized emulsion is exposed through such a screen, in contact therewith, and then developed, metallic silver will be formed in the emulsion in narrow parallel lines, corresponding in width and pitch to the clear strips of the screen. Any suitable developer may be used; but one that gives contrast, a fine grain, and that has no hardening action on the emulsion, is to be preferred After development, the unexposed silver in the emulsion is removed in a bath of sodium thiosulfate.

The film is then placed in a bath composed of: potassium bichromate 8 grammes; cupric chloride 24 grammes; sodium chloride 80 grammes; and water 1 liter. Such a bath acts to bleach the reduced silver lines of the film, and to harden the gelatine in the immediate vicinity thereof. The hardened portions of the gelatine will have had two properties imparted to them, viz.: the property to absorb and fix certain classes of dyes, that do not stain or affect the interposed soft portions of the gelatine; and the property to repel certain other dyes of a different class, that are capable of being absorbed by, and of coloring, said soft portions. The film is then placed in a bath of sodium thiosulfate, for removing the bleached image, and is dried afterward. At this stage of the process the film is perfectly clear and transparent; but, nevertheless, is in effect a species

of diffraction grating, by reason of its alternate strips of hardened and soft gelatine.

The next step in the process is to treat the film in a bath comprising 3 grammes of "Patent blue" dye stuff (Color Index Number 712), and 20 grammes of "Congo red" dye stuff (Color Index Number 370), in 4 liters of water. These dyes are well known to the art by the names just stated. They belong in different chemical groups, namely, amino-hydroxy-derivatives of triphenylmethane and the dis-azo group of coloring matters respectively, and have quite distinct, and in some respects opposite, properties. During the immersion in the dye bath, the blue dye will stain, and become fixed in, the hardened strips of the gelatine; and the red dye will stain the soft gelatine. There will be a remarkably sharp separation of the colors in the film, by reason of the treatment to which the gelatine has been subjected, and the inherent properties of the dyes. The red dye will have but very little, if any, tendency to stain the hardened portions of the gelatine; and the blue dye will have correspondingly little tendency to stain the soft portions. After dyeing in this manner, the film is thoroughly washed, dried, and given a thin coat of transparent varnish to protect the dyed emulsion from alteration during subsequent processes.

The final operation in the preparation of the film to adapt it to the purposes of my invention, is to apply a photosensitized emulsion to the varnished surface. Such emulsion should be one that is sensitive to the colors used for dyeing the strips of the film described above, that is, the emulsion should be panchromatic.

Films, produced in the manner described, are illustrated diagrammatically in the accompanying drawing. The figures are greatly distorted in scale, as stated above, in order to disclose the invention more conveniently. Many variations of detail of the process described, may be utilized without affecting the results essentially, or departing from the scope of the invention. Thus in Fig. 1, the hardened strips 5 of the gelatine, after treatment in the bichromate and fixing baths, and the soft interposed gelatine strips 6, are shown as running longitudinally of the film 7. In Fig. 2, similar hard and soft strips, 5 and 6 respectively, are shown running longitudinally of the film 8 on alternate frames; and corresponding hard and soft strips 9 and 10 respectively are shown as running transversely of the film on the interposed frames. In Fig. 3 the strips 11 and 12 run diagonally of the film 13 in one direction in alternate frames, and corresponding strips 14 and 15 run diagonally in the other direction on the interposed frames. In such films as those illustrated in Figs. 2 and 3, where the strips of alternate frames run in different directions, it is desirable that the angle between the respective directions should be about ninety degrees. It is to be noted that a film having diagonal strips, arranged in the manner of Fig. 3, is usually to be preferred to one having transverse or longitudinally arranged strips.

It is also to be remarked that, instead of altering the material of the film so as to be composed of alternate hard and soft straight strips, use may be made of otherwise shaped areas of regular or irregular form. The important thing is to have about half the gelatine area hardened and divided into small spaced areas, evenly distributed; and the other half of the gelatine area soft, and occupying the spaces between the hardened portions.

When use is made of strips arranged as shown in Figs. 2 or 3, there is an advantage gained by reason of the additive color effect due to persistence of vision. Thus, in addition to the two elementary colors of the strips, there will be composite colors due to the apparent crossing of the strips resulting from persistense of vision. That is to say, where the strips appear to cross, the colors therein will appear to be superposed, at the intersections, and will produce a composite color effect. Further variation of color effects may be obtained by making the density of the primary colors of one set of alternate frames, slightly different from the density of the colors in the intermediate frames.

Fig. 4 is a much enlarged and distorted cross-section of such a film as has been described herein, wherein the transparent base is shown at 16, hardened blue-dyed portions of the treated gelatine at 17, soft red-dyed portions of the gelatine at 18, the protecting varnish layer at 19, and the panchromatic photosensitized emulsion at 20.

Having prepared a film as above described and illustrated, it may be used in various ways related to the art of color photography. As an example, two black and white negatives could first be prepared, in every respect similar to each other except as to the exposure values in those areas where colors were photographed. Thus, if panchromatic negatives are used, one could be exposed through a blue-green screen, and the other through a red-orange screen. One negative will then be minus the red-orange color values, and the other will be minus the blue-green values. Each negative will have failed to record certain colors but did photograph everything else. The other negative did the same thing with respect to the complementary group of colors.

Such negatives are then employed for print-exposing emulsion 20 of my specially prepared film. Both the red-minus and the blue-minus negatives are used for this purpose, the exposures being made in superposed registering positions, and through trans-

parent base 16. The exposures may be effected by direct contact printing, white light for the purpose coming in the direction of arrow 21; or the exposures may be accomplished in other well known ways, as by the use of lenses at 22. The red-minus negative is printed with red light, and the blue-minus negative is printed with blue light; each light being of such character that no printing will occur under the film strips of complementary color.

After being exposed as above, emulsion 20 is developed and fixed in the usual photographic manner. We will then have a film comprising very narrow transparent bands, colored alternately with complementary colors; and a black and white image behind the bands, resulting from two color-selective exposures through them. Such a film when viewed by transmitted light which originally comprises the full spectrum, will show the object photographed in its natural colors, both elementary and composite. It may also be used to project a naturally colored picture upon a screen. Still other uses will suggest themselves to those who are interested in this art.

In the case of a motion picture film, the successive frames may carry different combinations of colors that are not necessarily complemental as to each frame; but the additive effect of all the colors of adjacent frames should be such that, upon projection, a substantial white will apparently be seen, by reason of persistence of vision. Thus one frame might carry blue-violet and orange areas, and appear to be of magenta color. The succeeding frame might then carry red and green, resulting in a yellowish green shade. These four colors when effectively superposed upon a screen, by reason of persistence of vision, will appear as white.

It will readily be understood that the generic invention that I have disclosed is susceptible of many specific variations. Some of these have been described herein, and others will occur to those familiar with the art involved. Other dyes may be used in the places of those mentioned; and other chemical treating baths, adapted for producing the desired effects, may be employed. The complementary colored portions of the film may be variously shaped, disposed, and proportioned; and the color-selective exposures of emulsion 20 may be effected in several well known ways. Therefore I claim the generic invention broadly, and do not limit myself to the specific disclosures herein, except as set forth in the appended claims.

I claim as my invention:

1. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing, developing and bleaching it in turn, in a manner to harden the exposed portions; removing all silver and its products from the film; and dyeing the exposed portions one color; and dyeing the unexposed portions a complemental color.

2. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing, developing, bleaching, and fixing it in turn, in a manner to make the exposed portions dye-selective; and then dyeing the emulsion in a bath containing two dyes; one of said dyes being adapted to color said exposed portions only; and the other dye being adapted to impart a complemental color to the unexposed portions only.

3. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing, developing, bleaching, and fixing it in turn, in a manner to harden the exposed portions only and to make them dye-selective; and then dyeing the emulsion in a bath containing two dyes, of which one is red-orange and the other blue-green; one of said dyes being adapted to color said hardened portions only; and the other dye being adapted to color the unhardened portions only.

4. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing and developing it in a manner to produce a multiplicity of small uniformly distributed spaced images; bleaching the reduced silver of said images in a manner to give the corresponding portions of the emulsion dye-selective qualities; fixing the emulsion; and then dyeing the emulsion in a bath containing two dyes of complemental colors and different characteristics; one of said dyes being adapted to color said portions only; and the other dye being adapted to color the remaining portions of the emulsion only.

5. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing and developing it in a manner to produce a multiplicity of small developed images that are spaced and uniformly distributed; bathing the emulsion in a solution adapted to bleach the reduced silver of said images and to impart to corresponding portions of the emulsion an ability to absorb dyes of a certain group while repelling dyes of another group; fixing the emulsion; dyeing said portions by means of a suitable dye of the first said group; and dyeing the remaining portions of the emulsion by means of a dye of complemental color of the second said group.

6. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing and developing it in a manner to produce a multiplicity of small developed images that are spaced and uniformly distributed; bathing the emulsion in a suitable solution of potassium, copper, and sodium salts, that is adapted to bleach the reduced silver of said images and to impart to corre-

sponding portions of the emulsion an ability to absorb dyes of a certain group while repelling dyes of another group; fixing the emulsion; and then bathing the emulsion in a solution containing a dye of each of said groups; the dyes in the last said solution being of complemental colors.

7. The method of treating a photo-sensitized silver-halide emulsion which consists in exposing and developing it to produce a multiplicity of small and uniformly distributed spaced images; bathing the emulsion in a solution of copper bichromate and sodium chloride to bleach the reduced silver, and to make the corresponding portions of the emulsion absorbent to an acid dye; fixing the entire emulsion in such manner as to remove all products of said preceeding operations; and dyeing said bleached portions one color, and the unbleached portions a complementary color, by means of dyes that will affect only said portions respectively.

WILLIAM VAN DOREN KELLEY.