Nov. 19, 1940. H. SARTOV ET AL 2,221,849

COLOR PHOTOGRAPHY

Filed Jan. 21, 1939

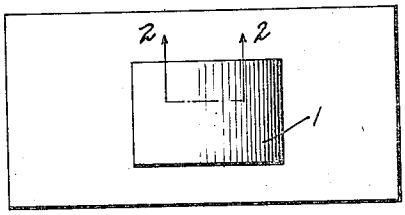


Fig. 1.

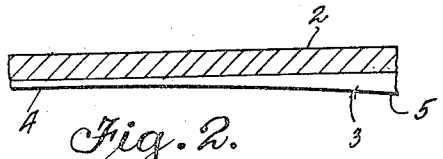


Fig. 2.

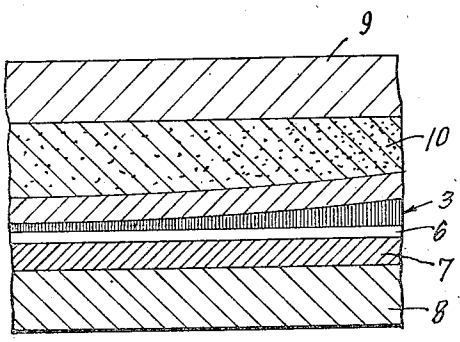


Fig. 4.

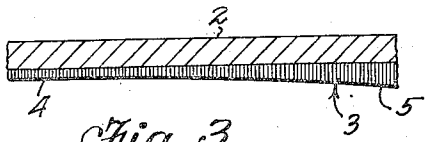


Fig. 3.

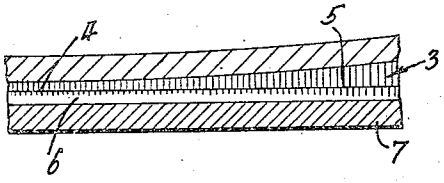


Fig. 5.

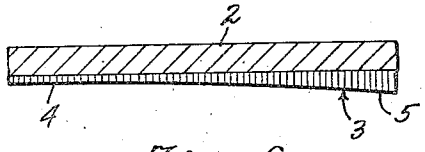


Fig. 6.

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COLOR PHOTOGRAPHY

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6 Claims. (Cl. 101—149)

This invention relates generally to the three-color process for the production of prints or films in natural colors, and more particularly to the practice of such processes by dye-transfer printing from gelatine relief films or matrices.

Gelatine matrices are wellknown in the art and consist of the usual support of Celluloid, glass, or the like, having a gelatine coating thereon which varies in thickness to define the picture in relief, the gelatine being thick in the dark portions of the picture and thin in the highlights. When such a matrix is immersed in a dye bath the gelatine absorbs the dye to substantially a uniform density throughout so that the total amount of dye in any part of the gelatine coating is proportionate to the thickness of the coating at that point. If such a dyed matrix is then pressed against a wet gelatine coated paper or film, some of the dye is transferred to the latter to produce a finished picture in the color of the dye. By making a set of matrices from a set of three color separation negatives, dyeing the three matrices red, yellow and blue, respectively, and transferring the dye from the three matrices to the same gelatine coated paper or film in proper registration with each other, a picture in natural colors may be obtained.

The general process just described has been known for many years, but due to inherent defects it has been difficult to produce satisfactory color prints by the process. The chief difficulties have been in the production of matrices of suitable depth in all portions of the picture and in dyeing the matrices so that the three colors transferred to the finished print would be in proper balance over all portions of the picture. Obviously correct natural color values cannot be obtained by the three-color process unless the three colors are in proper balance. In accordance with the prior practice, there was practically no latitude of exposure in producing the matrices, the slightest over-exposure resulting in too great a thickness of gelatine in the highlights with resultant heavy tones in the lights of the finished print and consequent loss of brilliancy, and the slightest under-exposure resulting in no gelatine at all in the highlights and consequently no detail and no color in the lights of the finished print. The best previously known solution for this trouble, of which we are aware, was to slightly over-expose the matrices to insure that some gelatine would be left in the highlight portions and then reduce the overtone in the lights of the finished print by washing the dyed matrix in plain water until the highlights reached the proper depth. The principal objection to this treatment is that it destroys the balance of the dye in the matrix because it reduces the color density of the thin portions (highlights) of the gelatine coating to a much greater degree than the thick portions. Finished prints made from three matrices treated in this way will in general have the colors thrown badly out of balance so that the final colors are distorted in some portions of the picture, even though the color may be right in the highlights. Furthermore, reduction of the color density in the highlights without proportionate reduction in the darker portions of the picture, results in excessive contrast and loss of detail in the shadows.

A general object of the present invention is to provide a simple and practicable method of producing balanced dyed matrices of proper average density so that a finished color print made from such matrices will have true color values and have satisfactory detail in both the highlights and shadows.

A more specific object is to provide a practicable and reliable method of varying the color density of a dye gelatine matrix proportionately in both the dense and thick portions of the matrix.

The manner in which the foregoing objects are achieved, together with other more specific objects and features of the invention, will be fully apparent from the following detailed description, with reference to the drawing of a particular procedure that may be employed in the practice of the invention.

In the drawing:

Fig. 1 is a plan view of a gelatine matrix bearing in relief a picture of a simple object, namely the curved surface of a cylinder illuminated from the left side;

Fig. 2 is a detail cross sectional view, greatly magnified, through a portion of the matrix in Fig. 1, the section being taken approximately in the plane II—II;

Fig. 3 is a detail section, similar to Fig. 2, but showing the gelatine coating dyed to a predetermined density throughout;

Fig. 4 is a sectional view, similar to Fig. 3, but showing the dyed matrix pressed into contact with a gelatine coated paper for reduction of the dye density;

Fig. 5 is a section similar to Fig. 4 at a later time, showing the transfer of the dye from the gelatine of the matrix to the gelatine of the paper; and

Fig. 6 is a sectional view showing the gelatine

matrix removed from the dye-reducing transfer paper.

In the practice of three-color photography by our process, we first produce three color separation negatives in accordance with established practice, these three negatives representing respectively the red, blue and yellow components of the color in the subject photographed. We then make three gelatine matrices from these three color separation negatives, by either contact printing or projection, on gelatine relief film, which is a photographic film made especially for dye-transfer printing. After being exposed, the gelatine relief films are developed like ordinary photographic films but are afterwards subjected to a treatment of bleaching, wellknown in the art, which bleaches out the black silver image. Thereafter the films are washed in hot water, which dissolves and washes out the gelatine from the lighter portions of the picture, leaving what was once the black image standing out in relief in proportion to the densities and graduations in the negatives from which they were made.

The foregoing steps are wellknown and in accordance with accepted practice. But, contrary to accepted practice, we expose each matrix to a point far beyond where the lights would have a slight tone, thus insuring the most complete possible reproduction of the tone-graduations contained in the negative from which it was made and thereby leaving a substantial thickness of gelatine covering the lights.

Thus referring to Fig. 1, it will be observed that the cylinder 1 which forms the only object in the picture, is illuminated from the left side and shows substantially pure white on that side, (this reference is, of course, to the black and white drawing, where as the cylinder 1 is actually assumed to be of some color requiring the use of two or three of the primary colors for its reproduction). The extreme right side of the cylinder 1 in Fig. 1 is in shadow and the tone changes gradually from light to dark at the midportion of the cylinder where the sections are taken.

As shown in Fig. 2, the matrix comprises a Celluloid backing 2 and the gelatine coating 3, which is of varying thickness to define the picture in relief. The relative thickness of the backing 2 and the gelatine coating 3 are not necessarily correctly represented in Fig. 2, since the thickness of the backing 2 is of no moment. However, Fig. 2 shows that the film 3 has a material thickness at point 4 corresponding to a highlight of the picture and further increases in thickness or depth as the tone increases to the right, as indicated at 5.

As shown in Fig. 2, the gelatine coating 3 has been prepared ready for dyeing and is substantially clear. It is next dyed by submersing it in a dye bath for a sufficient length of time to permit penetration of the dye completely through the gelatine film in the thicker portions thereof. This may require a time of approximately 20 minutes. Submersion of the matrix in the dye for a longer period produces no effect since a condition of equilibrium is reached as soon as the dye has penetrated through the thickest portions of the gelatine.

The dyed matrix is indicated in Fig. 3, the gelatine coating 3 being lined to indicate the color red. If the dyed matrix as shown in Fig. 3 were directly applied to the gelatine coating of the finish print, the latter would be entirely too dark, the highlights being materially overprinted by virtue of the excess thickness of the gelatine at the point 4 (due to the intentional over-exposure of the matrix), and would also be too dark in the shadows, so that detail would be lacking at those points. If the prior practices were followed, the dyed matrix as shown in Fig. 3 would be simply washed in water to reduce the density of the dye in the thin portions 4 to a value such that they would not over-print and make the highlights in the finished print too dark. However, this washing would reduce the density of the dye in the thicker portion 3 of the matrix very little, so that the resultant print would have excessive contrast and much of the detail would be lost in the darker portions of the picture. Furthermore, if three matrices representing the three primary colors, all washed to reduce the highlights, are superposed on the final print, the relative change in the dye densities in the thin and thick portions of the matrices, will badly upset the color balance so that natural colors will not be obtained in all portions of the picture.

In accordance with the present invention, we reduce the density of the dye uniformly in all portions of the matrix by contact transfer of a portion of the dye to a gelatine surface. The gelatine surface may be ordinary gelatine-coated paper or film, against which the matrix is pressed into contact for an interval of time.

In Fig. 4 the matrix of Fig. 3 is shown with its gelatine face in contact with a gelatine coating 6 on a sheet of paper 7, the gelatine coating being of substantially uniform thickness throughout its area. As shown in Fig. 4, the paper 7 is supported upon a rigid slab 8 and the matrix is pressed thereagainst by a weight 9 acting against the matrix through a resilient pad 10. Immediately upon contact between the gelatine 3 of the matrix and the gelatine 6 of the paper, the dye in the matrix begins to flow or imbibe into the gelatine 6 in contact therewith. This movement of the dye proceeds quite rapidly and uniformly, the total amount of dye transferred from the matrix depending mainly upon the length of contact period.

As shown in Fig. 5, which represents the condition at the end of the contact period, a substantial portion of the dye has been transferred from the gelatine 3 of the matrix to the gelatine 6 of the paper and consequently the density of the dye in the matrix has been reduced. The matrix is then removed from the paper and is in condition, as shown in Fig. 6, for transfer of the color separation image represented by this matrix, to the final print. Transfer from the matrix as shown in Fig. 6 to the gelatine coated paper or film of the final print, is effected in accordance with well established practice by pressing the matrix into contact with a film or paper substantially as was described in connection with Fig. 4.

The important principle or feature of the method described of reducing the dye density in the matrix is that the reduction in the density of the dye is substantially proportional in both the thick and thin portions of the matrix. Thus if the contact period is such as to reduce the density of the dye in the thin portions 4 of the matrix by one-half, then the dye density in the thick portion 5 of the matrix will also be reduced by substantially one-half. This preserves the original proper balance of the matrix so that the highlights are reduced to the proper printing values and likewise the shadows are proportionately reduced to restore the detail in the shad-

ows which would otherwise be lost as a result of the over-exposure of the matrix.

As shown in Fig. 5, the dye has penetrated the transfer gelatine 6 to a greater depth opposite the thick portion 5 of the matrix than opposite the thin portion 4. This is a convenient graphical way of showing that more dye is transferred from the thick portion of the matrix than from the thin portion, which fact we have established, but it is to be understood that the dye may actually diffuse uniformly through the gelatine 6 to the full depth thereof, being denser opposite the thick portion 5 of the matrix than opposite the thin portion 4.

Although the process has been specifically described with reference to the red matrix, in a three-color process, it is to be understood that the same procedure is followed in preparing the blue and the yellow matrices.

Our method of reducing dye density in the matrices is superior to the former practice involving merely washing the matrix in water, not only because it preserves the balance between the highlights and shadows (which the washing process destroys), but because the washing often causes the dye to spread or run more or less in the matrix. Any possible tendency of the dye to run in our process is obviated by the fact that the dye density reduction is effected by means of contact transfer, and since the intimate contact brought about during transfer necessarily forces all surface wetness from between the matrix and the gelatine transfer surface it follows that when the matrix is lifted off it is practically surface dry.

A great advantage of our method is that it makes possible putting into practical use a peculiar property of the gelatine relief film, namely that of building up the image to greater vigor and roundness when subjected to over-exposure. This may be carried to a point where the image becomes almost stereoscopic, the varying degrees of over-exposure necessary thereto being easily compensated for by varying the time of contact between the matrix and the gelatine coated paper or film used to absorb the excess dye. In using our process it is desirable to overexpose the gelatine relief film to a point where the resultant matrix would be worthless for printing by the prior known procedure.

The time for reduction transfer of the dye by our process will vary from a few seconds to approximately an hour, according to the density of the matrix, the exact time being determined for each matrix by a trial test. If, as a result of the trial test, the finished print is too dark, the matrix is re-dyed and the transfer time increased, and if the finished print is too light, the matrix is re-dyed and the transfer time decreased. In general, if the dyes now developed and supplied by the Eastman Kodak Company for dye transfer three color printing, and Eastman gelatine relief film are employed, we have found (in still work) that if a 3-minute reduction transfer leaves the matrix too light for a finish transfer, the matrix has been under-exposed and a new matrix should be made.

After the optimum dye reduction transfer time for each matrix has been determined, any desired number of perfect finish prints can be made by routine repetition of the process, each matrix being re-dyed and reduced to the proper color density prior to the making of each finished print.

Although the three-color process requiring three matrices dyed with the three respective primary colors has been specifically mentioned, our process is also applicable to color work in which only two matrices are employed, it being recognized that two-color processes can only give relatively crude proximations of natural colors as compared to the three-color process.

It has been previously mentioned that the transfer gelatine for reducing the density may be on either film or paper, any preference between the two will depend entirely on individual taste and the type of work done. Although the film, when properly hardened, has the advantage of being capable of repeated use by simply washing out the absorbed dye in weak ammonia solution, it requires greater care in handling, and we therefore prefer the paper for still work, while for motion picture work the film is of course the most suitable.

Whether paper or film is used for the reduction transfer, it should be moist, or wet to the point of limpness, prior to the application of the dyed matrix thereto.

For the purpose of explaining the invention, a procedure applicable to still photographs has been described. It is to be understood, however, that the process is adapted for the making of still transparencies, and also for the making of motion picture transparencies by making the finished prints on gelatine coated film, instead of paper. Necessary changes in the mechanics of the process to adapt it for motion picture films of substantial length, will be apparent to those skilled in the motion picture art, the essential requirements for the production of true color values being described hereinabove.

No attempt has been made to describe in detail the procedure for the preparation of the matrices up to the point where they are dyed, or the details of the final transfer from the dyed matrices to the finished print, since those details are well-known in the art and fully described in various treatises, one of which is Color printing with Eastman wash-off relief film, published by the Eastman Kodak Company of Rochester, N. Y., in 1936.

We claim:

1. The method of reducing the color density of a dyed gelatine matrix for use in dye transfer printing, which consists in pressing the matrix into intimate contact with a solid material capable of imbibing dyes, for a predetermined period, retaining sufficient of the dye in the matrix to allow said matrix to be used directly for transfer printing.

2. The method of reducing the color density of a dyed gelatine matrix for use in dye transfer printing, which consists in pressing the matrix into intimate contact with a colloidal substance capable of absorbing dyes, retaining sufficient of the dye in the matrix to allow said matrix to be used directly for transfer printing.

3. The method of reducing the color density of a dyed gelatine matrix for use in dye transfer printing, which consists in pressing the matrix into intimate contact with a gelatinized surface capable of absorbing dyes, retaining sufficient of the dye in the matrix to allow said matrix to be used directly for transfer printing.

4. The method of preparing a gelatine matrix for dye transfer printing, which comprises the steps of first subjecting the matrix to dye for a period at least sufficient for complete penetration of the dye into the thickest parts of the matrix, and then reducing the color density of the gela-

tine in all portions of the matrix substantially by the same geometric factor independently of variations of thickness of the gelatine.

5. The method of preparing a gelatine matrix for dye transfer printing, which comprises the steps of first subjecting the matrix to dye for a period at least sufficient for complete penetration of the dye into the thickest parts of the matrix, and then reducing the color density by pressing the maxtrix into intimate contact with a solid material capable of imbibing dye, for a predetermined period, retaining sufficient of the dye in the matrix to allow said matrix to be used directly for transfer printing.

6. The method of producing natural color photographs comprising: preparing a plurality of color separation negatives; over-printing a gelatine relief matrix from each color separation negative, whereby detail in the highlights is insured; uniformly dyeing each different matrix with a dye appropriate with respect to the associated color separation negative; uniformly reducing the dye density of all portions of each matrix by approximately the same geometric factor; and successively transferring a portion at least of the reduced dye in said matrices onto a gelatine surface in common registration.

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