[Second Edition.]

PATENT SPECIFICATION

Convention Date (United States) : April 30, 1926. **270,279**

Application Date (in United Kingdom): April 19, 1927. No. 10,522/27.

Complete Specification Accepted : July 19, 1928.

COMPLETE SPECIFICATION.

Preparation of Coloured Reproductions by Imbibition.

We, TECHNICOLOR MOTION PICTURE CORPORATION, a corporation organised under the laws of the State of Maine, United States of America, of 120, Brookline Avenue, Boston, Massachusetts, United States of America, Assignees of BERTHA SUGDEN TUTTLE (formerly Bertha Sugden), a citizen of the United States of America, of 114, Riverway, Boston, Massachusetts, United States of America, formerly of 66, St. Stephens Street, Boston, aforesaid, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the preparation of coloured reproductions, especially upon transparent surfaces such as gelatine or the like, and to the resulting product.

In the art of preparing colored reproductions, especially upon absorptive surfaces such as gelatinous films and coatings, it has heretofore been proposed to print such surfaces from hardened films, or matrices so-called, which bear the developed image or complemental portions of the image to be reproduced. This process depends upon the selective wetting of the developed areas of the matrix film (which may also stand in relief) by the dye solution and the non-wetting of the undeveloped areas. It also depends upon the direct transfer of the dye as thus distributed to the relatively soft gelatinous surface—which takes place upon effecting intimate contact between the two surfaces—by imbibition. Hence this general method of procedure is known in the art of colour photography as the imbibition process.

In the practical application of this procedure even though the film printed is opaque and the reflected colors only are desired, it is found difficult to secure and maintain accuracy of registry, relative color values, definition, and like characteristics. When the reproductions are made upon transparent materials, however, and are intended for projection purposes as in cinema films, the relative depths and contrasts of the several shades and tones of coloration produced upon and in the surface (with respect to their several and composite light transmission values) also become of primary importance. In such instances it is necessary that the coloring agents (usually dyes) shall not only be proportionately and accurately distributed with respect to their relative color values and contrasts upon the matrix, but that they shall also be quickly and accurately transferred and fixed to the printed film surface.

It is further important that the relative contrasts or shades of a given color when thus transferred to the printed film shall manifest themselves with respect to transmitted light according to the corresponding contrasts or degrees of development of the several portions of the image upon the matrix films. When two or more colors are to be used, it is essential that they be mutually inert in order that their several and composite color values shall be maintained and shall not be deleteriously affected or altered.

Accordingly it is an object of the present invention to provide an improved method as typified by the more exacting application to cinema films. Other and more specific objects of the invention will appear from the following disclosure.

It is found, as a part of the present invention, that whereas a matrix film may be developed to present degrees of density or contrast corresponding to the complete range of the (H. & D.) scale, these gradations may not be reproduced by corresponding intensities or concentrations of a dye solution absorbed upon them, or, if such relative distribution of dye is accomplished on the matrix, that it is not preserved and maintained in the image which results upon transferring the dye to the second relatively soft gelatine surface, as, for example, by imbibition printing.

These difficulties are in part overcome by highly purifying the dye composition used as by a preliminary treatment of the dye solution with a colloid, for example, by the addition of albumin or other amphoteric colloid thereto, followed by the coagulation and removal of the

[*Price* 1/-]

colloid, together with those components of the dye which are susceptible to precipitation or selective segregation upon contact with a surface such as the gelatine matrix.

The dye solution so treated is more uniformly distributable over the developed matrix surface and is adsorbed thereby more nearly in proportion to the relative contrasts or degrees of development which it presents. Moreover, it is susceptible of being completely transferred from the wet matrix to the soft gelatine surface, by imbibition, and consequently a wider range of color values and contrasts is made possible in the printed image produced. It is also found that this treatment tends to promote the penetrability of the dye solution into the soft gelatine film surface.

In connection with the dye imbibition process generally it may here be remarked that in colored transparent films where the transmitted light effect obtained by a given dye is due to its absorption of the remaining elements of the spectrum, it is essentially desirable that through an area of any given transmission color, for example an area containing a single dye, the transmitted color shall be of the specifically appropriate portion of the spectrum and that the absorption of colors in other portions of the spectrum shall be complete, or substantially so, in this area. It is further desirable however, that the transmitted light in such areas shall not be reduced in intensity except in proportion to the contrast or shade of the transmitted color which is desired.

It is a characteristic of most dyes that when color contrasts are sought to be obtained therewith corresponding to the deeper shades of the transmitted colors (for example, optical density of 2.0 or more on the H. & D. scale), they are visually indistinguishable. This is probably due to total light absorption or reduction of light intensity instead of selective absorption of other spectral colors only and the continued transmission of the color of the dye. This may also be caused by a concentration of the dye substance at or near the surface in a concentrated and resultingly solid and relatively opaque formation. The shades of red, for example, having a depth of color corresponding to the darker zones of the H. & D. scale are by transmitted light indistinguishable in printed films heretofore made, and may appear black or may show an imperfect or relatively lower light absorption in some other part of the spectrum, for example, blue, thus shifting the color quality of such light as is transmitted away from the red, giving purplish tones. Such a circumstance may arise, for example, in reproducing the image of a red curtain in which the folds actually present all gradations of red from a brilliant carmine to an effective or possibly a true black. In the reproduced print or image of such a color range, as heretofore obtained the higher numbers or darker shades, as represented by proportionately greater densities of the dye substance, appear alike and substantially black.

By employing a dye which has been highly purified and which is characterized by fixation with the gelatine substance and by freedom from self-agglomerating components which deposit upon the surface, but which penetrates freely and preferably at a substantially uniform degree of dispersion or concentration throughout the depth or depths to which it reaches into the gelatine (thereby avoiding segregated layers of dye and also leaving the normal transparency or the gelatine unimpaired) improved color contrast effects are obtained by the present invention. It may be considered that by thus spacing the dye through an appreciable depth of the gelatine substance, substantially proportionate to the amount of dye imbibed in any unit or area, the intensity of light may be transmitted through the gelatine and dye undiminished and also be reflected from one minute dye surface to another, thus passing through intermediate paths of relatively transparent media. In this manner the transmitted light, which might be substantially excluded by a relatively thin but compact layer of dye—as manifested more particularly in the deeper shades and hence greater thicknesses and/or concentrations—may be permitted to pass relatively freely, by transmission and reflection, through a film in which the same absolute amount of dye substance is applied per unit of area but is distributed through an appreciable depth or thickness of the film with an intervening medium of transparent gelatine.

It is often found, however, that even with dye solutions which exhibit a satisfactory degree of relative absorption towards matrices and proportionate penetrabilities into the gelatine films to be printed therefrom (and hence make possible a wide range of contrasts, equal e.g. to the full H. & D. scale) tend also to present diffused or indistinct margins—in short poor definition. This is thought to be attributable to the very factor of ready penetrability or absorption or imbibition into the gelatine film—but possibly also to lateral dispersion of the dye.

By the present invention, this difficulty is overcome by further employing in the dye solution a viscosity agent capable of retarding dispersion of the solution, such as a second dye characterized by good definition and appropriate color value, without regard to (or possibly advantageously of) low penetrability. Such addition is preferably made in relatively small proportions—and introduces the effect of arresting marginal creeping or diffusion of the first dye which may be caused either by imposing its own viscosity upon the dye solution or by quasi-chemical reaction with the first dye and forming a less diffusible dye molecule, thereby tending to restrain its marginal dispersion. Preferably, however, it does not appreciably diminish penetrability into the gelatine film, or effects such diminution uniformly throughout the several relative degrees of penetration.

This checking of the degree of penetration; and especially of extraneous dispersion through or upon the printed surface above alluded to, may be attributed to a slight retardation of the normal capillary or osmotic flow or diffusion of the dye with the gelatine substance—which is more especially effective and more observable in the weaker or less active areas of dispersion, extraneous of the areas directly printed by imbibition contact. By way of comparison, such retardation of the normally liquid flow of the dye may resemble the flow of plastic substances which is more restricted—and which ceases abruptly when the activating force is removed or falls below a definite value.

Briefly defined, the method of the invention includes wetting a developed matrix film, typically presenting in its developed areas, a wide range of image contrasts (corresponding, e.g. to the full H. & D. scale), with a dye solution highly purified in such a way as to remove any solid matter or impurities and which in consequence manifests selective and relatively proportioned adsorption toward such developed areas of the matrix on the one hand, and, on the other, a rapid and uniformly penetrative and distributive absorption into a relatively soft (i.e. dye-absorptive) and preferably wet surface of a gelatine film (with or without qualifying agents as hereinafter set forth) and firmly contacting the thus wet matrix surface with the soft gelatine surface to be printed, preferably under water and for a short interval of time followed by separating the two surfaces—and repeating the printing operation thereon, if desired, with other printing matrices carrying images, usually complemental to the first and with a dye or dyes of complementary colors.

More specifically, the invention is directed to reproductions upon surfaces of a gelatinous composition such as those provided on transparent celluloid films and the like by coating with a gelatine solution. It is further desirable and, for purposes of highly satisfactory cinema production, practically essential that the coloring agent or dye shall be of marked though relatively uniform adsorption or penetration characteristics, with respect to the gelatinous surface, without appreciable tendency to diffuse laterally either through or over the gelatine surface, upon contacting therewith. A further desirable qualification of the dye is that it shall promptly become and thereafter remain permanently fixed in situ, as by a more or less stable chemical or physical association, with the gelatinous substance.

For example, the dye solution should not tend to adhere to nor be withdrawn by the matrix surface, upon separation from the printed gelatine surface therefrom. And moreover it should attain its maximum depth of penetration relatively promptly, leaving a uniform distribution of dye therethrough, without subsequent tendency to disperse through the film, nor leave any superficial liquid to disperse laterally between the contacting surfaces.

The process of the invention will be described in its application for the preparation of multi-colored reproductions on films for moving pictures and the like. For such purposes a cellulosic film, of celluloid or other transparent material, is first prepared, such as is generally employed for photographic use. To this is applied a coating of a solution containing gelatine, a hardening agent such as potassium bichromate and usually an organic acid such as acetic acid. The coating thus formed is then allowed to dry rapidly and is subsequently hardened to the desired degree in known ways (for example as disclosed in Specification No. 270,280).

A plurality of matrix films, each bearing an image to correspond to one (or more) of the primary colors or to each of two (or more) complemental colors appearing in the reproduction to be made, is next prepared, as by suitably exposing and developing or light printing and developing a photographic film therefor. For example, where the complementary colors red and green are to be provided, a film matrix may be prepared and developed to correspond to the red portion of the images in the subject to be reproduced and a second matrix film may

be developed to correspond to the green portions thereof. This may be effected in any suitable manner, according to the appropriate photographic technique, which has been fully established for such purposes and is well known in the art.

For the purpose of making cinema reproductions, the matrix surface is most conveniently prepared by suitably developing the images upon the usual strip or reel of photographic film. The images may be so developed upon the film that the several degrees of light contrast which they present are differentiated by corresponding proportionate degrees of alteration of the film substance only. In this case the more intensely developed areas will severally absorb dye solutions in proportionately greater amounts than the relatively less developed areas throughout the range of the H. & D. scale. The dye is not permanently absorbed by the matrix film, but may be transferred to a softer gelatine surface (as above defined) by contact. Hence, such matrices may be satisfactorily used for imbibition printing. However, it may be desirable that the dye-wet or printing areas shall also stand in relief above the non-dyed portion of the matrix. To this end it is common practice to dissolve off the undeveloped areas of gelatine, which also removes gelatine from the partially developed areas substantially in proportion to their respective degrees or amounts of non-developed components. This leaves the image or images on the matrix surface—which are already developed, according to the corresponding initial light contrasts in the original, and hence with respect to the relative capacity of the surface to absorb the dye solution—still further developed by physical relief.

In the application of the invention to the preparation of colored films these matrix images will be developed to represent the relative intensities of a single primary or complementary color component of the original or of the colored reproduction which is to be made. For this purpose, where multi-colored reproductions are to be made, the following dyes have been found especially appropriate for producing complementary reds and greens:

"Definition Red."

Fast red S Cone (3% egg-treated solution)	10,000 c.c.
Acid magenta B N (6% solution egg-treated) 25.0%	4500 cc.
Metanil yellow 1%	30 grams
Glacial acetic acid 5.0%	900 cc.

made up to 18,000 cc. with water.

Green.

Pontacyl green S N (4.5% egg-treated)	6000 cc.
Metanil yellow	22 grams
Glacial acetic acid	600 cc.

Made up to 18,000 cc. with water.

The "egg-treatment," mentioned above and referred to in the formulæ, consists in the addition of the white of egg or a like amphoteric colloid to the dye solution, followed by coagulation of the colloid as by boiling and removal of the coagulated colloid together with extraneous solids or solid-forming constituents, from the solution.

The matrix film, bearing the images which are to be reproduced in red, is now immersed in the red dye solution, rinsed, and brought into firm and intimate contact with the gelatinized surface of the blank film (preferably under water to eliminate gaseous enclosures of air) and a slight pressure is applied between the contacting surfaces, as by passing between pressure rollers. Such contact is maintained for an appreciable period of time, as determined by experiment to be sufficient for complete transfer of the dye from the matrix to the blank film. The films are then separated. The printed film is preferably dried, and next brought into contact with the matrix film bearing the images to be reproduced in green, which has been similarly wet by passing through the green dye solution and then rinsed. The two films are preferably brought together under water as before and pressed firmly together. Thereupon the green dye is transferred from the matrix to the gelatine surface and, by virtue of its complementary relationship thereto, forms a complete composite color reproduction on the gelatine film. The printed film is then dried in the usual manner and is ready for use.

In a printed film as thus produced it is found that the definition, i.e. accuracy of transfer in the narrow areas and margins of the several images and in the overlapped color areas, is greatly improved. It is also observed, upon passing light through the colored film and focusing the same upon a white surface, that the transmitted light is of purer color value than usually attained, manifesting a lower absorption of the color transmitted and a higher absorption in other portions of the spectrum, throughout the ranges of density and concentration ordinarily encountered, and extending through substantially the entire H. & D. scale. The addition of metanil yellow and fast red S conc. also reduces the apparent tendency of other dyes to creep and disperse beyond their margins into the film surface, so

that a marked improvement in definition of the margins of images and overlapping of color zones is effected.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In a process of imbibition printing from a dyed gelatine matrix on to a gelatine film, the use of a fluid dye composition which has been highly purified in such a way as to remove any solid matter or impurities.

2. The method of printing gelatinous films in accordance with Claim 1, characterized by the fact that the dye composition employed is first treated with a colloid, which is subsequently coagulated by physical means and removed, with associated impurities, therefrom.

3. The method of printing gelatinous films in accordance with Claim 1 or 2, characterized by adding to the dye composition a viscosity agent, substantially as described.

4. The method of printing gelatinous films in accordance with Claim 3, characterized by adding to the dye composition a second dye having relatively low penetrability or dispersion with respect to the film to be printed.

5. The method for the printing of gelatinous film in accordance with Claim 4, further characterized in that the colors of the dyes are substantially complemental.

6. The method for the printing of gelatinous films in accordance with Claim 4 and further characterized in that the second dye is metanil yellow.

Dated the 19th day of April, 1927.

WM. BROOKES & SON,
London & Lancashire House,
5, Chancery Lane, London, W.C.2,
Chartered Patent Agents.

Abingdon: Printed for His Majesty's Stationery Office, by Burgess & Son.
[Wt. 8138.—50/6/1939.]