

UNITED STATES PATENT OFFICE

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PRINTING PROCESS EMPLOYED IN COLOR PHOTOGRAPHY

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This invention comprises improvements in or relating to printing processes employed in color photography.

5 The invention is concerned with a process of the kind in which relief images are formed by differential hardening, by light or chemical action, upon colloid layers.

According to this invention a process of the above type is characterized by the employment, as a support for the relief image, of a sheet of material which is transparent, homogeneous, permeable to water, and retentive of its mechanical strength and toughness when wet. The transparent water-permeable sheet may be used as a support for the colloid layer during the development of the relief image, or as a final support therefor, or as both a development and a final support.

20 The invention is particularly applicable to a process of the so-called "carbon" or "carbro" type in which a picture in natural colors is obtained by printing from negatives taken through colored filters on to carbon tissues dyed in the complementary colors. Usually in carrying out a process of the above type the following procedure is followed. The tissues, which consist essentially of a paper base coated with a mixture of soluble gelatine and the appropriate coloring matter, are rendered sensitive to light by treatment with alkali di-chromate solutions. The tissues after exposure are soaked in water, squeegeed into contact with celluloid or other impervious support and later immersed in warm water, when the paper backing and unexposed gelatine leaves the support and a colored image in hardened gelatine is left. The separate images (colored respectively magenta, yellow and blue-green in a three-color photography process) may now be dried on their celluloid supports and mounted in register. More usually however, they are transferred in turn to a final paper support. This has been found desirable because the result obtained by binding together images on celluloid has many disadvantages. For example in practice the minimum thickness of celluloid which can be used is such that parallax effects are seen

in the picture. Further the three sheets of celluloid, not being completely colorless or transparent, degrade and alter the colors as seen in the finished picture and render it almost impossible to record fine detail. Again celluloid is a comparatively expensive material and there is difficulty in cementing the celluloid sheets together in a satisfactory manner. This is due to the fact that celluloid is not water-permeable.

On account of the above difficulties it has been found preferable to transfer the images from their celluloid supports to a final paper support, but such a method also suffers from considerable disadvantages and moreover great care is required in order to prevent the images from frilling off the celluloid during development.

One object of the invention is to eliminate or materially reduce the difficulties which have hitherto been experienced in connection with the above type of process, with particular reference to reducing the number of operations involved, with a consequent reduction in the time taken in carrying out the process.

The invention, as applied to a process of the "carbon" or "carbro" type, resides in the employment, as a developing and/or final support for the pigmented gelatine images, of sheets of material which, as hereinbefore described are transparent, homogeneous, permeable to water, and retentive of their mechanical strength and toughness when wet. Preferably in this and other applications of the invention the transparent water-permeable material is constituted by regenerated cellulose. In practice the material known under the registered trade-mark "Cellophane" has been found to give particularly good results. It is found that "cellophane" can be used in much thinner sheets for this purpose than is the case with celluloid. Thin sheets of celluloid tend to buckle in the developing solution, but this is not so in the case of "cellophane". Consequently, the use of "cellophane" sheets to support the relief image has the advantage that the sheets can be made thin enough to avoid parallax effects in the picture when three such sheets,

each bearing a relief image, are mounted in register. Thus by employing supports of this nature in the "carbon" or "carbro" process the final transference of the separate images to a single support may be avoided, the cause of frilling is reduced, and correct color rendering can be made readily obtained.

The fact that "cellophane" sheets are water-permeable enables the three supports to be readily attached together by means of a gelatine cement. Further, "cellophane" when swollen in water becomes elastic, and thus properly enables accurate registration to be effected during mounting of the images, by slight local stretching of the "cellophane" where required.

Material of the type generally described by the word "cellophane" absorbs water readily when soaked and exhibits all of the properties hereinbefore mentioned. This material is alternatively referred to as regenerated cellulose and in the form preferred in connection with the present invention, cellulose, or cellulose and cellulose xanthate mixtures regenerated from viscose and cast into thin sheets which are rendered sufficiently non-brittle for handling by the incorporation of small quantities of glycerol, are commonly used.

Variations due to unequal swelling of the "carbon" tissues can thus be compensated, which is not possible in the prior processes in which supports, such as celluloid or cellon, which are not water-permeable or elastic, are employed.

The foregoing and other features of the invention are embodied in some examples which will now be described.

Example 1

A piece of carbon tissue is sensitized and exposed behind a negative in the usual manner. Instead of transferring the gelatine coating to celluloid for development as has hitherto been the practice the following procedure is adopted. A sheet of cellophane is swollen in water and squeegeed on to a piece of white paper coated with soluble gelatine. The exposed carbon print is soaked in water and squeegeed face downwards on to the cellophane sheet and the united sheets allowed to stand for some time between blotting boards. They are then placed in warm water when the paper backing of the carbon tissue may be peeled off and development occurs in the usual manner. When development is complete the paper backing of the cellophane sheet is itself peeled off and the print is ready for assembly in register with the other color print or prints.

Example 2

Sheets of cellophane are soaked in water until swollen, squeegeed into contact with

glass and coated with a gelatine layer of the following composition:—

Nelson's No. 2 flake gelatine	100 grammes	
Brown sugar	10 grammes	70
Honey soap	10 grammes	
Glycerine	20 c. c.	
Water	400 c. c.	

A suitable quantity of the appropriate pigment is incorporated in the above mixture before application. After the cellophane sheets have dried they are sensitized by immersion in a solution of the following composition:—

Potassium dichromate	22 grammes	80
Citric acid	5.5 grammes	
.880 ammonia about	16.5 c. c.	
Water	1000 c. c.	

and then dried on the glass (substantially as described in United States application Serial No. 358,749 in the names of W. T. L. Becker and L. W. Oliver filed 27th April, 1929, the last named application being assigned to the assignee of the present application). When dry the sheets are stripped from the glass and exposed behind the appropriate negative, the exposure being made through the cellophane support. After exposure the cellophane sheets are developed by soaking in warm water, cleared by immersion in 5% potash alum and mounted in register by means of 4% gelatine. It is not necessary to dry the images before mounting as is the case in the process hitherto employed, and the adhesion between the gelatine of the image and the cellophane is considerably greater than is the case when celluloid is used. Cellophane in the thickness used is substantially colorless and in no way interferes with the brilliance or color rendering of the finished picture. Moreover, by immersing the cellophane sheets before use in for example dilute solutions of acid permanganate followed by solutions of potassium metabisulphite the cellophane can be bleached to water white. Such oxidizing bleaching treatments are not of course applicable to non-water absorbent supports such as celluloid.

Owing to the staining of the mass of the cellophane by the sensitizing bath this method gives prints of hard contrast. This may be avoided by substituting for cellophane in the examples quoted and particularly in the case of Example 2, sheets of cellulose acetate whose surfaces have been rendered water absorbent by superficial conversion to regenerated cellulose. With such sheets the penetration of the light absorbing sensitizing bath is limited to the surface layers of the sheets only.

In those cases where sensitizing is accomplished by immersion of the cellulosic support rather than by brushing, the unwanted

dichromate which stains the outer surface of the cellulosic support can be destroyed by treating with reducing agents such as acidified ferrous sulphate whereby the yellow color is destroyed.

Example 3

In order to eliminate the special preparation of the cellophane sheets involved in Example 2 the following procedure is in this case adopted. Sheets of cellophane which may be bleached as in Example 2 are swollen in water and squeegeed on to glass plates. Sheets of colored carbon tissue are soaked in a 2-4% aqueous solution of alkali dichromate and superfluous sensitizer is removed by squeegeeing the carbon sheets face down upon a glass plate. The carbon sheet is then laid face down upon the cellophane sheet and the two are squeegeed into contact and dried. After drying exposure is made as before, through the cellophane, the exposed sheets being developed in water as usual, when the backing paper and unhardened gelatine leave the cellophane surface. The cellophane image-bearing sheets are mounted as before.

Owing to the fact that the combined tissues are dried upon glass, water is evaporated from the paper backing of the carbon tissue only. This prevents any undue diffusion of the dichromate into the cellophane. Such diffusion would result in the final picture being too contrasty and would increase the exposure required owing to the light screening effect of the yellow dichromate which has penetrated the cellophane. This light screening effect is a drawback to the method described in Example 2, where the cellophane is immersed in the sensitizing bath. It is considerably reduced by the method of preparing the combined tissues described above and it can be rendered negligible by the following modifications.

1. 10% cane sugar is added to the dichromate sensitizing bath.
2. 10% of sodium or potassium chloride or sulphate is added to the water in which the cellophane is swollen and to the dichromate sensitizing bath.
3. One thirtieth part by weight of chromic acid is substituted for the normal weight of potassium dichromate in the sensitizing solution.

The object of the first two modifications is to hinder the diffusion of soluble dichromate from the carbon tissue to the cellophane during mounting and drying.

The object of the third modification is to provide a sensitizer which, whilst as efficient as the dichromate sensitizer from the point of view of speed and general printing depth is nevertheless much less strongly colored and so does not act as a filter to the printing light.

Example 4

Instead of exposing the three carbon tissues to light the gelatine can be hardened as in the well known "Three color carbro" process by placing carbon tissue in dichromate formaldehyde solutions and squeegeeing into contact with bromide prints made from three color selection negatives. When the bromide print has bleached, the carbon tissue is stripped off in the well-known manner, but, instead of applying the resultant image to a celluloid support for developing, it is transferred to damp stretched cellophane as described above, developed thereon and the three resultant images mounted in register by means of 4% gelatine solutions.

Unlike the normal three color carbon or carbro process, the use of cellophane both as a developing and final support for the image has the advantage that the finished result may be judged before the images are finally cemented together. It is, therefore, desirable to use as coloring matters in the preparation of the tissues described, substances (such for example as lead chromate) which as is well known are capable of being dissolved and removed by appropriate chemical treatment. It then becomes possible to adjust the depth of color in one or more of the tissues should this appear desirable when the cellophanes have been temporarily assembled in register. Such an adjustment is impracticable when the temporary celluloid supports of the normal process are used since these supports falsify and degrade the colors and any delicate color balancing required is difficult to judge.

I claim:—

1. In color photography, a printing process which comprises the steps of exposing a carbon tissue consisting of a fibrous base and a sensitized coating, swelling a sheet of regenerated cellulose by soaking in water, pressing the sensitized face of the exposed tissue against the water soaked sheet of regenerated cellulose, removing the fibrous base of the carbon tissue, and developing the sensitized coating.
2. In color photography, a printing process which comprises the steps of exposing a carbon tissue consisting of a fibrous base and a sensitized coating, swelling a sheet of regenerated cellulose by soaking in water and applying the same to a support, pressing the sensitized face of the exposed tissue against the cellulose sheet, removing the fibrous base of the carbon tissue, developing the sensitized coating, and thereafter stripping the support from the cellulose sheet.
3. In color photography, a printing process which comprises the steps of swelling a sheet of regenerated cellulose by soaking in water and pressing the swollen sheet against a support, coating the sheet with a sensitized

layer, drying the coated sheet and stripping the same from the support, and exposing and developing the coated sheet.

4. In color photography, a printing process which comprises the steps of swelling a sheet of regenerated cellulose by soaking in water and pressing the swollen sheet against a support, coating the sheet with a sensitized layer, drying the coated sheet and stripping the same from the support, exposing and developing the coated sheet, and applying an oxidizing bleaching treatment to the sheet.

5. In color photography, a printing process which comprises the steps of swelling a sheet of regenerated cellulose in water, pressing the swollen sheet against a support, applying a carbon tissue consisting of a fibrous base and a sensitized coating to the sheet, drying the sheet and the applied tissue and removing the same from the support, exposing the sensitized coating through the sheet, and removing the fibrous base.

6. In color photography, a printing process which comprises the steps of soaking a sheet of regenerated cellulose in water to swell the same and pressing the swollen sheet against a support, treating a carbon tissue consisting of a base and gelatine coating with a sensitizing solution containing dichromate and formaldehyde and pressing the same against a bromide print to form an image, stripping the carbon tissue from the print, applying the carbon tissue to the swollen cellulose sheet, and developing the image.

7. In color photography, a printing process

which comprises the steps of soaking a sheet of regenerated cellulose in aqueous solution to swell the same, pressing the sensitized emulsion face of a carbon tissue against a bromide print to form an image, stripping the carbon tissue from the bromide print, applying the emulsion face of the carbon tissue to the swollen regenerated cellulose sheet, and developing the image.

8. In color photography, a printing process which comprises the steps of forming a hardened image in the outer face of the sensitized emulsion of a carbon tissue, soaking a sheet of regenerated cellulose in aqueous solution to swell the same, pressing the outer emulsion face of the carbon tissue and the swollen regenerated cellulose sheet together to intimately contact the coating and the sheet, and developing the image.

9. In color photography, a printing process which comprises the steps of forming a hardened image in the outer face of the sensitized emulsion of carbon tissues, soaking sheets of regenerated cellulose in aqueous solution to swell the same, pressing the outer emulsion face of the carbon tissues and the swollen regenerated cellulose sheets together to intimately contact the coatings and the sheets, developing the images and removing the carbon tissues from the regenerated cellulose sheets, and assembling the latter in register while in the wet swollen condition.

In testimony whereof I affix my signature.

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