Dec. 8, 1925. 1,564,753

J. G. CAPSTAFF

REVERSAL PROCESS

Filed Nov. 14, 1923

FIG. 1.

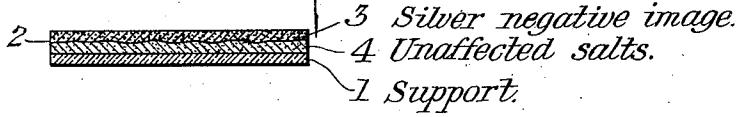


FIG. 2.

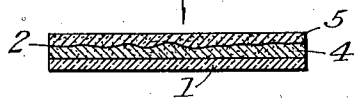


FIG. 3.

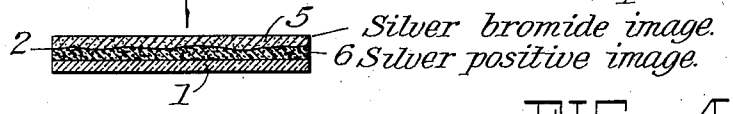


FIG. 4.

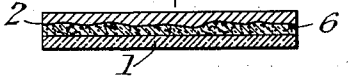


FIG. 5.

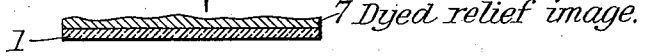


FIG. 6.

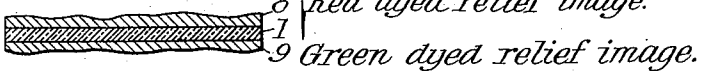
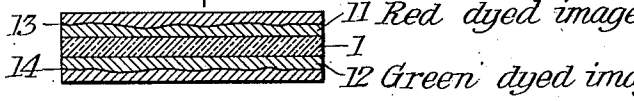


FIG. 7.



FIG. 8.



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Patented Dec. 8, 1925. 1,564,753

UNITED STATES PATENT OFFICE.

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REVERSAL PROCESS.

Application filed November 14, 1923. Serial No. 674,772.

To all whom it may concern:

Be it known that I, JOHN G. CAPSTAFF, a subject of the King of Great Britain, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Reversal Processes, of which the following is a full, clear, and exact specification.

This invention relates to a photographic reversal process. Such a process in general includes the formation of a silver negative image by familiar methods in a sensitive emulsion, the removal of the silver image and the transformation of the remaining silver salts into a positive image, usually of silver. Usually the bath or process by which the negative silver image is removed, known as a bleaching bath, has the property of desensitizing the remaining silver salts; and it is necessary to submit the emulsion to a clearing bath, removing the products of the bleaching bath and rendering the silver salts again sensitive. Moreover, the usual bleaching bath has a greater or less tanning action on the gelatine adjacent the original silver image, so that it is impossible to utilize with the final positive silver image a process depending on a differential tanning action.

I have discovered that, by known baths, the negative silver image can be transformed or "bleached", and that the resulting salts do not have the sensitivity that the remaining original silver salts have, that the baths do not have a tanning action on the gelatine and that they do not have a desensitizing action on the remaining original silver salts.

I have utilized this discovery in a reversal process that comprises the following steps:

A. The formation of a negative silver image in the usual way.

B. The transformation of this into a silver halide image, there being still present the residual unaffected salts.

C. Exposure to light, affecting the residual but not the transformed salts and development of the affected salts, yielding a positive silver image and a negative silver halide image.

Further steps depend on the particular use to which the plate or film is to be put, and various processes including the above steps will be described hereinafter.

Where possible the steps are illustrated, and reference will be made to the accompanying drawings in the several figures of which the same reference characters designate the same elements. In different embodiments the elements are somewhat differently related. Each of the figures is a cross section of a sensitized element on a magnified scale.

Fig. 1 shows a plate with the silver negative image;

Fig. 2 shows the plate with the silver image transformed into a silver bromide image;

Fig. 3 shows the plate after the second development;

Fig. 4 shows the plate after removal of the bromide image;

Fig. 5 shows the plate with the reversed image transformed into a dyed relief image;

Fig. 6 shows a double coated plate with dyed relief images made by my process;

Fig. 7 shows the plate with the reversed image transformed into a dye image;

Fig. 8 shows a double coated plate with dye images in both layers.

The several above mentioned steps will now be more fully described together with various other possible steps.

A. The process is carried out with a sensitized element, referred to as a plate, and comprising a support 1, which may be of glass, pyroxylin, paper or other usual material, upon which is a layer 2, comprising an ordinary photographic emulsion of gelatine and sensitive silver salts, principally silver bromide. This plate is exposed in any suitable photographic apparatus, such as a camera or printer, to a light image and the effected silver salts are developed in any known developer which, if later use is to be made of the tanning properties of gelatine, should be free from tanning effects. There is thus formed in the layer 2 a silver image 3 which is negative with respect to the light image, and there will also be present a positive image 4 of the undeveloped silver salts.

B. The plate is then submitted, after washing, to the following bath: potassium ferricyanide, 3 grams; potassium bromide, 5 grams; water to 1 liter. The silver image is transformed into one of silver bromide, so that there are in the layer 2, two images of silver bromide one, 4, being positive and the other, 5, being negative.

Other bleaching baths may be used which transform the image into silver bromide or silver chloride. Such baths are frequently mentioned in photographic literature, but it was not heretofore known that they rendered the salts produced by them apparently insensitive without affecting the sensitivity of salts of the same nature in the same emulsion; nor have they been proposed for processes such as I now describe. I contemplate as included within the scope of my invention any bath having the properties described and rendering possible the process outlined.

I have found that this step should be carried out until the silver image is completely rehalogenized. If there remain traces of the silver these appear to act as nuclei for redevelopment. The theory of the process is obscure.

C. The plate containing the two images is then exposed for a short time to light. I have discovered that the image 5 is not nearly so sensitive to light as the image 4 is. The latter is, therefore, rendered developable, while the image 5 is not.

For practical purposes the image 5 may be considered as insensitive to light, since under an exposure sufficient to render the image 4 completely developable it is affected, if at all, to an extent that is inappreciable in its effect upon the process. When I refer to it as insensitive it is to be understood that it may still have some sensitivity to very prolonged exposure, but as compared to the other image or the original salts such sensitivity is very slight indeed. When I refer to the original salts as being unaffected I mean that, while their sensitivity to light is probably less than it was originally, they are still highly sensitive to light and are rendered developable by short exposure to actinic light.

The plate is then submitted to any ordinary developer, transforming image 4 into a positive silver image. The process could be by development in ordinary light. The light could be controlled in the manner specified in my Patent No. 1,460,703, granted July 3rd, 1923. The nature of the developer is comparatively immaterial unless a later step is to make use of a tanning effect. A number of methods of utilizing my invention will be described and where a special type of developer is required it will be mentioned.

D—1. The simplest way of proceeding is by submitting the plate to the usual fixing bath, removing the silver bromide 5, and leaving the silver positive image 6. As a reversal process this has the advantage that no clearing bath after the "bleach" is necessary.

D—2. A second way of proceeding is by the wash-off process. In this event, the first developer must have been a non-tanning developer and the second one a tanning developer. Suitable baths are described in my co-pending application, Serial No. 574,364, filed July 12, 1922, which has matured into Patent, No. 1,525,766, granted Feb. 10, 1925, and this method of utilizing my discovery may be considered a modification of the invention covered by that patent. In this method the silver positive image 6 is obtained by a tanning developer and the upper untanned layer 5 is washed off in hot water leaving a relief image. The silver may be removed and the image dyed as described in that application, yielding a colored relief image 7 on the support 1. This process is particularly useful with a double coated transparent support. If complementary color images are printed in registration and the resulting images suitably dyed, there is obtained a two color record with dyed relief images 8 and 9, in colors such as red and green.

D—3. Another procedure is to submit the plate containing the silver image 6 either before or after the removal of bromide image 5 to a "bleaching bath" that will render the gelatine differentially dye adsorbtive. Such baths are described in my Patents Nos. 1,196,080, granted Aug. 29, 1916, and 1,315,464, granted Sept. 9, 1919. In this case both developers should be a non-tanning kind. The plate is then submitted to a bath of sodium thiosulfate, removing the bleached salts and the silver bromide image 5, if the latter has not previously been removed. It is then dyed yielding a color image 10 in the layer 2. This process is also particularly applicable to a color process carried out on a double coated transparent support, yielding in layers 13 and 14 registering images 11 and 12 of complementary color such as red and green. The color processes are completely described in the above mentioned patents.

This last described method has the advantage over the method described in my patents that the tanned gelatine is next the support instead of on the outer surface. In the latter case the dye does not easily penetrate the tanned or hardened surface, which is affected more or less all over, to reach the the more deeply affected parts, whereas in the present method the surface is readily penetrable by the dye.

It will be noted that all of the described methods of finishing the process involve at some point the step of removing the rehalogenized image 5.

It is obvious that numerous variations and applications of my invention are possible, and I contemplate as within the scope of my invention all such modifications and equivalents as fall within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a process of making a photographic image by reversal in a light sensitive element containing a silver image and a complementary image of sensitive silver salts, the steps of submitting the element to a bath that converts the silver image into a different insensitive image without rendering the sensitive salts insensitive, exposing the element to light and developing the affected sensitive salts to a silver image.

2. In a process of making a photographic image by reversal in a light sensitive element containing a silver image and a complementary image of sensitive silver salts, the steps of converting the silver image into an image of silver bromide, exposing the element to light and developing the affected sensitive salts into a silver image.

3. In a process of making a photographic image by reversal in a light sensitive element containing a silver image and a complementary image of sensitive silver salts, the steps of converting the silver image into an image of silver bromide, exposing the element to light and developing the affected sensitive salts into a silver image, and thereafter treating the element to remove the unaffected salts.

4. A process of making a photographic image in a light sensitive element containing a silver image and a complementary image in sensitive silver salts that comprises the transformation of the silver image into an image of insensitive silver halide without rendering the sensitive salts insensitive, exposing the element to light and thus rendering the sensitive salts developable, developing the sensitive silver salts to form a silver image, and removing the insensitive silver salts.

5. A process of making a photographic image in a light sensitive element containing a silver image and a complementary image in sensitive silver salts that comprises the complete halogenization of the silver image, without affecting the first mentioned silver salts, exposing the element to light and thus rendering the first mentioned salts developable and developing the affected salts to form a silver image.

6. A process of making a photographic image in a light sensitive element containing a silver image and a complementary image in sensitive silver salts that comprises the complete halogenization of the silver image, without affecting the first mentioned silver salts, exposing the element to light and thus rendering the first mentioned salts developable, developing the affected salts to form a silver image and removing the undeveloped halogenized image.

7. The process that comprises the exposure to a light image of an element comprising a photographically sensitive gelatino-silver-halide emulsion, developing the affected salts in a bath that does not tan the gelatine, converting the developed image into an insensitive silver halide image in a bath that does not tan the gelatine or render the previously sensitive salts insensitive, exposing the element to light and developing the affected salts into a silver image that lies at the bottom of the emulsion, and removing the unaffected salts.

8. The process of making a photographic print that comprises the exposure to a light image of an element comprising a photographically sensitive gelatino-silver-halide emulsion, developing the affected salts in a bath that does not tan the gelatine, converting the developed image into an insensitive silver halide image in a bath that does not tan the gelatine or render the previously sensitive salts insensitive, exposing the element to light and developing the affected salts into a silver image lying at the bottom of the emulsion, and finishing the print by a method that includes the removal of the insensitive salts, one of the steps subsequent to the converting bath acting to tan the gelatine differentially.

9. The process of making a photographic print that comprises the exposure to a light image of an element comprising a photographically sensitive gelatino-silver-halide emulsion, developing the affected salts in a bath that does not tan the gelatine, converting the developed image into a different insensitive image in a bath that does not tan the gelatine, and treating the original unaffected salts to derive therefrom a permanent image by a process including the differential tanning of the gelatine.

10. The process of making a photographic print that comprises the exposure to a light image of an element comprising a photographically sensitive gelatino-silver-halide emulsion, developing the affected salts into a silver image by a bath that does not tan the gelatine, converting the silver image into a different insensitive image in a bath that does not tan the gelatine nor render the unaffected salts insensitive, exposing the element to light and developing the affected salts into a silver image lying at the bottom of the emulsion, and finishing the print by a method that includes the removal of the insensitive image, one of the steps subsequent to the converting bath acting to tan the gelatine differentially and a subsequent step utilizing the tanned image.

11. The photographic process that comprises the exposure to a light image of an element comprising a light sensitive gelatino-silver-halide emulsion, submitting the element to a bath that develops the affected salts into a silver image without tanning the

gelatine, submitting the element to a bath that converts the silver image into an image of silver halide insensitive to light, without tanning the gelatine, exposing the element to light and thus rendering the sensitive salts developable, submitting the element to a bath that develops the affected silver salts into a silver image without tanning the gelatine, submitting the element to a bath that converts the silver into a soluble salt and tans the gelatine differentially, submitting the element to a bath that removes all the salts, and then to a dye that is adsorbed to the differentially hardened gelatine.

Signed at Rochester, New York, this 9th day of November, 1923.

JOHN G. CAPSTAFF.