Patented Sept. 8, 1925. 1,552,791

UNITED STATES PATENT OFFICE.

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CONTROLLED REVERSAL PROCESS.

No Drawing. Application filed July 5, 1923. Serial No. 649,728.

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 Controlled Reversal Processes, of which the following is a full, clear, and exact specification.

My invention relates to the making of positive exposures upon the same support and in the same sensitive layer that is exposed in the camera, and more particularly is an improvement in the method known as "reversal", in which a negative silver image is made by exposure and development, this silver image being removed from the undeveloped silver salts which are then converted into a positive image.

As usually practiced heretofore, this method had the disadvantage that very exact exposure and development of the first image was required, so that there would be left, after the removal of the negative silver image, an image in the undeveloped salt that would reproduce correctly the tones of the original subject. As it is generally expressed, there is no latitude in the exposure. Moreover, slight inequalities in the emulsion or variations of the emulsion as a whole from the standard produce objectionably nonuniform positives.

My invention relates to a method of controlling the final image to compensate for differences in the original exposure, and consists in the step, after the first development, of removing such an amount of the remaining undeveloped silver salt as will yield, after the second development, a final image having the desired characteristics.

I will now outline the production of a print by a reversal process including my invention.

Step 1.—The sensitive plate, film or paper, hereafter referred to as a film, is first exposed in the usual way in photographic apparatus and developed fully in a developer, preferably producing high contrast, such as a "process" developer, a typical one being the following:

A.—Sodium bisulphite, 25 gms.; hydroquinone, 25 gms.; potassium bromide, 25 gms.; water to 1 liter.

B.—sodium hydroxide, 50 gms.; water to 1 liter. Mix equal parts of A and B.

Step 2.—The film, after a thorough washing, such as ten minutes in running water, is submitted to the reversing bath. This may be the following:

Potassium permanganate, 4% sol., 1 part; sulphuric acid (20%), 1 part; water, 20 parts.

An alternative reversing bath is, potassium bichromate, 2 grams; sulfuric acid, concentrated, 2 cc.; water to 1 liter. This step and all the succeeding ones may be performed in ordinary light and this fact adds to the convenience of the process.

Step 3.—The film is then submitted to a clearing bath capable of removing from the film the compounds or products formed in the reversing bath.

If the first mentioned reversing bath was used, the following clearing bath is satisfactory: Sodium bisulfite, 20 gm.; water to 1 liter.

If the second mentioned reversing bath was used, the following clearing bath is preferable: Sodium sulfite, 100 gm.; water to 1 liter.

Step 4.—The printing characteristics of the film are then determined. A skilled operator, working under standardized conditions, can judge the image with sufficient accuracy by viewing it by substantially parallel light transmitted through it. Another method of testing the film, particularly if it is motion picture film, is to redevelop a small re-exposed strip and judge from that how much of the undeveloped salts should be removed.

Still another method, when working with motion picture film, is to cut off several small strips and to place them for different lengths of time in the hypo bath to be mentioned in Step 5, and then redevelop them and thus determine which gives the best image.

I have used the expression "printing value" here and in the claims as an apt term for the capability of the image to be reproduced. Ordinarily a negative is used in printing upon a separate element; and in reversal processes in general the density of the negative determines inversely the density of the positive printed therefrom in the same emulsion. This printing value may be considered as inherent in the negative silver image or in the residual sensitive salts since they are complementary.

Step 5.—This step is the most important individual one of the process and the one to which my invention particularly relates. The film is now submitted to a plain "hypo" bath, preferably quite dilute. In practice I use the following: sodium thiosulfate, 9 grams; water to 1 liter.

The concentration of this bath is not important and does not affect the result if the action is carried to the same point, but a weak bath being slower acting gives more exact control. The film is left in this bath which dissolves out the silver salt, usually bromide, until there is left the slightest visible traces of bromide in the highest lights of the picture. Since this step is performed in the open light, the operator has opportunity to judge carefully.

This judgment of the image is intended to supplement and verify the results of the test or judgment arrived at in Step 4. When working on a commercial scale, for instance with motion picture film in a continuous process, reliance may be placed entirely on the results of Step 4, but in working with small cut films or plates or short strips of film more opportunity for judging during Step 5 is presented.

When the dissolving of the silver salt image has been carried to a point, such that the remaining salt will yield a satisfactory print, the film is removed from the hypo bath and thoroughly washed.

Step 6.—The remaining silver salt is then developed or converted into the final image. This may be done in any of numerous ways, some of which will be mentioned.

If a sepia tone is desired, the bath comprises 1% aqueous solution of sodium sulphide. This converts the salts to silver sulphide.

A bath giving a blue black tone is, stannous chloride, 100 gms.; hydrochloric acid, sp. gr. 1.17, 10 cc.; water, 1000 cc. This is a powerful chemical reducer, converting the salts into silver.

Ordinary photographic developers may be used, such, for instance, as the following: monomethyl paramidophenol sulfate, 23 gms.; sodium sulfite, 500 gms.; hydroquinone, 92 gms.; sodium carbonate, 50 gms.; potassium bromide, 10 gms.; water, 10 liters.

The use of developer has the advantage that it gives a method of control of the contrast in the final image. It is obvious that numerous toning baths, chemical reducers, and developers can be used in this step and that the final image can be modified, tinted or treated by any of the many processes known to photographers.

After such final development, toning or other process, the film would be given such washing or other treatment as would be necessary or customary, and dried as usual, the details of this finishing step being in accordance with regular practice. It is to be understood that when, in the claims, I refer to developing an image at this stage, I intend to include any process by which a permanent visible image is obtained from the residual silver salts.

It is obvious that this method provides a simple way of controlling the density of the final image rendering possible considerable latitude in the original exposure. It is performed largely in ordinary light and the baths used are those that are already familiar to photographic workers. The process is particularly applicable to the treatment of motion picture films taken by amateurs, where there is liable to be considerable variation in the original exposure, since it is possible to produce final prints of reasonably uniform quality on the original film, thus lowering the cost to the user.

Numerous variations in the process are possible and I contemplate as within the scope of my invention all such modifications and equivalents as fall within the terms 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 photographic images by reversal in a light sensitive element containing silver salts, which process comprises the forming of a silver image in said element, the removal of the silver image leaving an image of silver salts, and the transformation of said silver salt image into a permanent visual image, the step of removing certain of said silver salts before the completion of the step of transformation.

2. In a process of making photographic images by reversal from a photographic element containing an image in light sensitive salts, the step of submitting the element to a bath that will affect the light sensitive salts to render them non-developable in the emulsion, the extent of such submission being controlled in accordance with the printing value of the element, and then developing an image in said element from the unaffected salts.

3. In a process of making photographic images by reversal from a photographic element containing an image in light sensitive salts, the step of submitting the element to a bath that will remove the light sensitive salt, the extent of such submission being controlled in accordance with the printing value of the element, and then developing an image from such salts as remain.

4. In a process of making photographic images by reversal from a photographic element containing an image in light sensitive silver salts, the step of submitting the element to a bath containing sodium thiosulfate

and capable of dissolving the silver salts, the extent of such submission being controlled in accordance with the printing value of the element and then developing an image from such salts as remain.

5. In a process of making photographic images by reversal from photographic silver images in a light sensitive element which process comprises the removal of the silver from the element and then the development of the element, the steps prior to the completion of development, of determining the printing value of the element and of rendering the light sensitive element capable of only incomplete development in accordance with such determination.

6. In a process of making photographic images by reversal from photographic silver images in an element containing developable silver salts, which process comprises the removal of the silver from the element and then the development of the salts, the steps prior to such development of determining the printing value of the element and of removing a portion of such salts in accordance with such determination.

7. In a process of making photographic images by reversal from photographic silver images in an element containing developable silver salts, which process comprises the removal of the silver from the element and then the development of the salts, the steps prior to such development of determining the printing value of the element and of submitting it to a bath of sodium thiosulfate in accordance with such determination.

Signed at Rochester, New York, this 29th day of June, 1923.

JOHN G. CAPSTAFF.