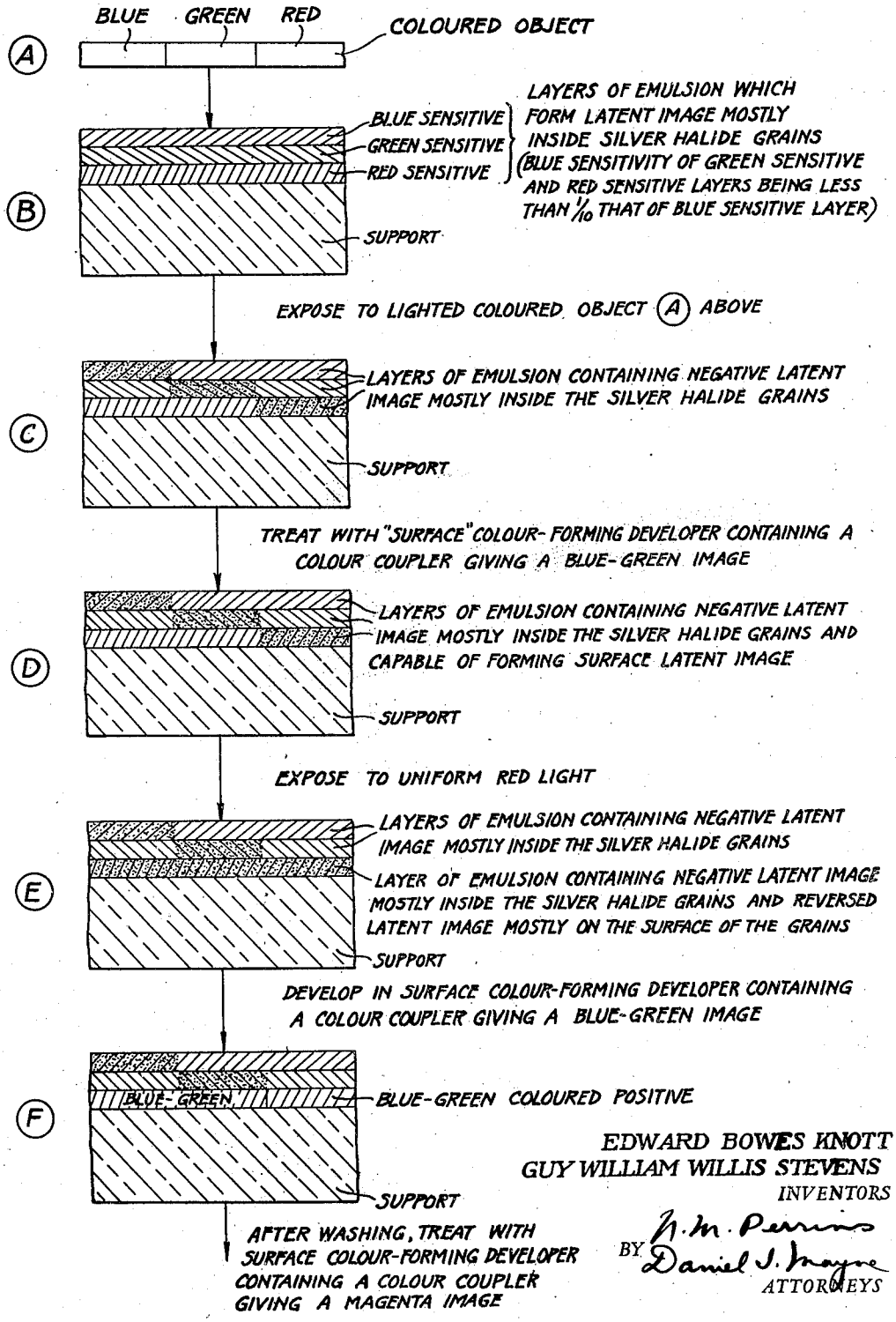
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PHOTOGRAPHIC REVERSAL PROCESSES

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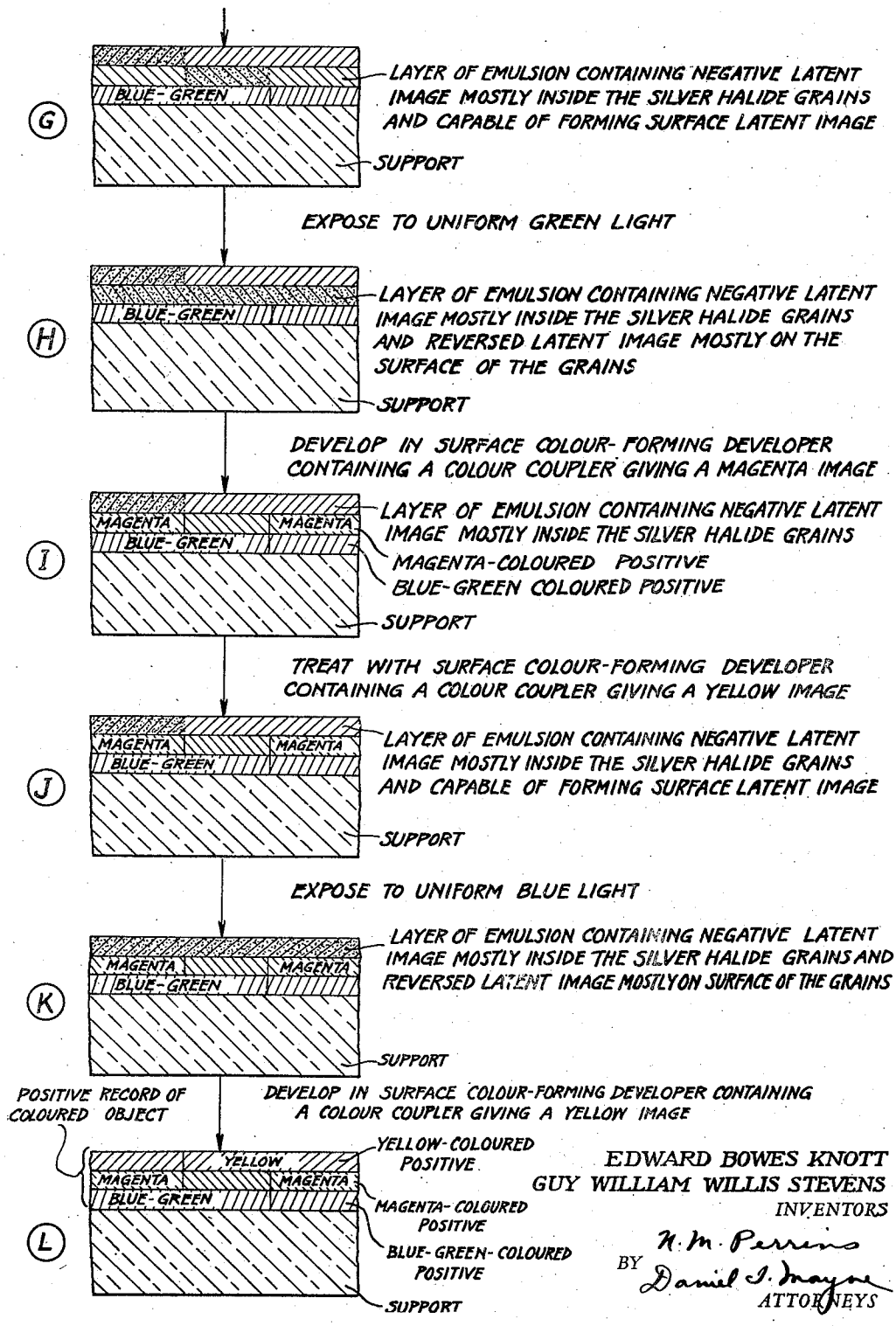
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PHOTOGRAPHIC REVERSAL PROCESSES

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Application August 1, 1947, Serial No. 765,633

8 Claims. (Cl. 95—5)

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This invention relates to photographic processes especially so-called reversal processes and materials therefor.

As is known the latent photographic image formed by the action of light on a photographic silver halide emulsion is not confined to the surface of the silver halide grains but it appears to be also distributed internally throughout those grains. It is possible to develop only the so-called surface latent image by means of developers which have little or no solvent action for silver halide. One of us has described in the literature given below that after removal of the surface latent image the internal latent image can be developed as simply and conveniently as can an ordinary surface latent image if this is done by employing a developer having a solvent action for silver halide; moreover the image so obtained indicated that the speed of the emulsion as measured by the internal image is often comparable with the speed as measured by the surface developed image. Such a developer is for convenience called an "internal" developer, and an example of such a developer is given on page 47 of the Pho. J., 1942, 82, 42.

There is a type of emulsion, which while known per se, is according to our recent investigations of such a nature that the latent image is formed mostly inside the silver halide grains and there is relatively little surface latent image formed; such emulsions have not found much commercial use, in fact they have for a long time been considered as practically useless. We have now found, however, that after such emulsions have been exposed to form an internal latent image therein, they can subsequently be treated to render them capable of forming surface latent image upon subsequent exposure, and that the extent of the surface latent image forming capability is greatest where the internal latent image was least and vice versa. An example of such type of emulsion is that known as Burton's emulsion given in Wall's "Photographic Emulsions," 1929, pp. 52–53. Moreover this type of emulsion may be prepared in other known manners, for instance by taking an ordinary silver bromide or silver iodobromide emulsion containing between 0.5 and 5% silver iodide (based on the total silver halide), and coating it as a layer and then after drying, treating it with the following bath:

Potassium bichromate	grams	12
Conc. sulphuric acid	ccs	12
Water	ccs	1000

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The time of treatment must be sufficient to inhibit surface latent image formation as can easily be ascertained by exposing (after washing) and then treating with developers of Formulae I and III, given below. Such an emulsion layer can then be used as it is or may be remelted and coated again as desired.

In our copending application Serial No. 765,632, filed August 1, 1947, we have applied the aforesaid discovery to give a reversed image in a sensitive layer of a silver salt emulsion.

In the present invention we apply the aforesaid discovery to give a new method or producing reversed photographic images in adjacent emulsions on a single support, as will hereinafter be described.

Various methods are known for producing positive images in adjacent silver halide emulsion layers which have been exposed so as to produce negative latent images therein; such reversal methods are employed in both black and white and in colour photography.

In the present invention such reversal images are obtained by employing for the emulsions the said type of emulsions in which the latent image is formed mostly or entirely internally in the grains; that is to say an emulsion only few or none of whose exposed grains are developable to silver by a developing solution which cannot act as a developer for latent image inside the grains—such a solution is Formula I (below). Whether an emulsion is of this type for the purpose of this invention can be ascertained by treating it (after exposure) in developers of the kind given in Formulae I, II (*a*) and II (*b*) and III below. It is of the type defined if it will develop in those of Formula II (*a*) or (*b*) but will not develop or will develop only slightly in Formula III and in Formula I.

The developer formulae above referred to are:

FORMULA I

"SURFACE" DEVELOPER

p-Hydroxyphenylglycine	grams	10
Sodium carbonate (cryst.)	do	100
Water to	ccs	1000

Development time 4 minutes at 20° C.

FORMULA II (*a*)

"INTERNAL" DEVELOPER

Hydroquinone	grams	15
N-methyl-p-aminophenol sulphate	do	15
Sodium sulphite, anhy.	do	50
Potassium bromide	do	10

Sodium hydroxide	grams	25
Sodium thiosulphate cryst.	do	20
Water to	ccs	1000

Development time 3 minutes at 20° C.

FORMULA II (*b*)

"INTERNAL" DEVELOPER

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite (cryst.)	do	90
Potassium bromide	do	4
Sodium carbonate (cryst.)	do	150
Sodium thiosulphate	do	20
Water to	ccs	1000

Development time 4 minutes at 20° C.

FORMULA III

COMMERCIAL DEVELOPER

This is the same as Formula II (*b*) but omitting the sodium thiosulphate.

Formula II (*a*) is a more energetic developer than Formula II (*b*) so that it usually gives a higher effective speed and a higher contrast than Formula II (*b*) but is often not so convenient, since it has a higher tendency to aerial oxidation and to give fog.

While in this specification we have described our invention partly in regard to a theory of internal and surface latent images, the correctness or otherwise of such theory, is not essential to the successful working of the invention, it being only necessary to choose the emulsions according to the tests hereinafter given.

The present invention employs the following types of emulsions:

TYPE I

These are the emulsions which will develop (after exposure) in internal developers of the kind given in at least one of Formulae II (*a*) and II (*b*), but will not develop or only slightly develop in Formula III or in Formula I.

(1) Normal range of exposure

As measured according to normal photographic testing technique, when a test layer of the emulsion is coated on a transparent support (e. g. glass) and the layer is exposed to a light intensity scale the whole of which is exposed for some fixed time between $\frac{1}{100}$th and 1 second and is developed in the internal developer II (*a*) the transmitted density obtained at any point along the $\log_{10}E$ axis over a range of 3.0 starting from the threshold of the curve (D=0.1 above fog) should be at least 5 times, and preferably at least 10 times, the transmitted density obtained when an identical test layer of the emulsion is developed with the surface developer of Formula I or III, the measurements of density being made at the corresponding (i. e. the same) points on the $\log_{10}E$ axis; as indicated, the best (i. e. preferred) emulsions are those giving the highest density ratios and the very best (i. e. most preferred) emulsions can be selected with greater certainty by substituting Formula II (*b*) for II (*a*).

(2) Small range of exposures

For this purpose the emulsion need not conform to such a rigid requirement, for instance for making a tone correcting mask, but it is sufficient if in the above test the upper limit of 3.1 is substituted by an upper limit of 1.0.

Since Formula III contains sodium sulphite and Formula I is free from sulphite, and sulphite is known to have some solvent action on silver chloride and bromide (although very little on silver iodide) it is apparent that when making any of the above measurements on an emulsion to obtain, with a high degree of precision, information on the amount of surface latent image given by such emulsion, it is important to use Formula I.

The reversal process of the present invention depends upon the fact that the type of emulsion defined above, namely one which upon exposure in the ordinary dry state forms the latent image mostly inside the grains, can be treated so as to render it capable of forming surface latent image on exposure. The treatment depends to some extent upon the particular emulsion. Examples of such treatment are as follows:

(1) All or nearly all emulsions of the type defined can be treated by soaking in any ordinary developing solution such as Formula I or III employing an organic developing agent and which has little or no solvent action on the silver halide.

(2) In the case of some emulsions of the type defined which are colour sensitised, the treatment can be with plain water alone.

The effect of any such treatment or any similar treatment for the same purpose can be ascertained by taking an unexposed layer of the emulsion and merely giving it the treatment and then subjecting it to an image-wise exposure and if this image can be developed in a developer or Formula I or III, the treatment can be employed in performing the present invention.

Hence, according to the present invention there is provided the method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising on a single support a plurality of photographic silver salt emulsions of the type herein-defined, then without developing up the latent images so formed in said emulsions, treating at least one of said exposed emulsions to render it capable of forming surface latent image, i. e. latent image developable by the developer of Formulae I or III, and then while continuing the treatment or after the treatment, uniformly exposing to light the so-treated emulsion to produce latent image some of which is developable by the aforesaid developer I or III, developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by developer I or III and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated (simultaneously with the first-mentioned emulsion or by a separate treatment) to render it capable of forming latent image developable by the aforesaid developer I or III to produce latent image some of which is developable by the aforesaid developer I or III, and developing the second uniformly fogged emulsion in a developer which develops the latent image which is developable by developer I or III and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion. The unused silver salt may then be dissolved out in the usual way. Of course, where it is desired to reverse two emulsions consecutively, they must be selectively re-exposed to a uniform exposure.

In one form of the invention there is provided the method of producing reversed photographic

images wherein a material comprising on a single support a plurality of silver salt emulsions of the type hereindefined, is exposed to an object or image, then without developing up the latent images so formed in such emulsions to visible images the exposed material is soaked in a photographic developing solution which is capable of developing a surface latent image but is incapable or only slightly capable of developing the "internal" latent images formed by the first exposure, and then the material is subjected to a uniform exposure which affects one of the emulsions and is of sufficient intensity and time to cause a reversed image to develop in the emulsion so exposed on continuing the treatment in the same or another surface developer, and subsequently the material is subjected to a further exposure which affects a further emulsion and is of sufficient intensity and time to cause a reversed image to develop in such further emulsion in continuing the treatment in the same or another surface developer. Such uniform exposures are of course each by light to which the emulsion to be reversed is sensitive and it is preferably of low intensity. The highest contrast in the reversed image is usually obtained by employing for the first image-forming exposure an over-exposure which can be ascertained by a test or series of tests giving different exposures and development of the latent image in a developer such as Formula II (*a*) or II (*b*) which gives an unreversed image.

In another form of the invention at least one of the emulsions is a colour sensitised emulsion and the treatment to render it capable of forming surface latent image consists in treating it with plain water.

The invention includes a sensitive photographic material comprising on a single support at least two sensitive silver salt emulsions both of which are of the type hereindefined, such emulsions being of such character or so arranged in the material that they can be selectively exposed.

When the uniform exposures of the material are made after immersion in a developer such exposures may be adjusted by making tests, so as to give the desired strength of reversed images and to some extent errors in the first image forming exposure can be compensated by so adjusting the uniform second exposure.

To obtain the best results when a reversal exposure is made during treatment of the emulsion after the first exposure, in a developing solution, it is very important that no appreciable development of the reversed image should occur before the completion of the reversal exposure since such development would cause screening of the emulsion grains where it occures and would lead to a reversal effect or to a reduction of the higher densities. To avoid this, one may employ, for instance, a developing solution which is very dilute or whose pH is so low that the surface developing activity is very small.

Examples of developing solutions having such a low pH are as follows:

A.

N-methyl-p-aminophenol sulphate	grams	10
Sodium sulphite, cryst.	do	100
Water to	ccs	1000

B.

Hydroquinone	grams	8
Sodium sulphite, cryst.	do	80
Sodium metaborate	do	16
Water to	ccs	1000

It should be noted that for satisfactory results in performing the present invention the emulsion layer, after receiving the first image-forming exposure, must be well soaked with the developing solution before being given the uniform second exposure to produce the reversed image.

An example of a sensitising dye for use in an emulsion with which may be employed the plain water treatment given above is 5-[2-ethyl-1(2)benzoxazolylidene)ethylidene] - 3-n-heptyl-1-phenyl-2-thiohydantoin. This is the dye described in Example 3 of United States Patent No. 2,282,116. This dye was used at the rate of 0.05 gram of dye for each amount of silver halide equivalent to 200 grams of silver nitrate. The dye was added during ripening (i. e. before washing); if the dye is added after washing then a greater quantity should be used.

An advantage of the method of the present invention of producing reversed images is that such type of emulsion can be made to have a higher effective speed combined with a lower graininess in the image than that of any known to us which is made for giving a reversed image upon direct development (such material is exemplified by that described and claimed in British Patent No. 524,087).

An advantage of the method according to the present invention over known methods in which reversed images are obtained by developing the first formed image to silver and then removing such silver followed by exposure and redevelopment or fogging redevelopment is that only one development is necessary for each image and for black and white work no silver removal bath is required.

In performing the present invention the sensitive material may consist of a plurality of silver salt emulsions of the type hereindefined on a single support which emulsions are of such character or are so arranged that they can be selectively exposed; then it is a simple matter to develop only one of them to give a reversed image in a first developer which is not possible in the known methods where there are employed only emulsions of the type where upon exposure surface latent images are formed on the grains. Further the other emulsion or emulsions can be successively treated in similar manner. The character or arrangement of the emulsions so that they can be selectively exposed can be determined in known manner, for example:

1. A not specially colour sensitised emulsion having a high blue sensitivity mixed with or superimposed on a green or red sensitised emulsion of relatively low blue sensitivity.

2. A green sensitised emulsion mixed with or superimposed on a red sensitised emulsion.

3. Two emulsions between which or in one of which is a material which filters out light to which on of them is sensitive, for instance two not specially colour sensitised emulsions with a blue absorbing filter layer between them or in one of them.

4. Two emulsions coated side by side (i. e. on different areas of the support).

It is obviously of great advantage to be able to develop a reversal image in a first developer since this very materially decreases the number of processing steps and gives a simpler process, especially in colour photography employing three of the kind of emulsion in question. This advantage can be seen by considering the case of two superimposed emulsion layers one being for example red sensitive and the other being for ex-

ample green sensitive. The steps required to produce reversed images if both emulsions are of the same type are as follows:

ORDINARY SURFACE LATENT IMAGE FORMING TYPE

A red sensitised emulsion of this type coated over a green sensitised emulsion of the same type.

After exposure the processing normally is:

1. Develop both layers.
2. Wash.
3. Expose the one layer uniformly to red light.
4. Colour develop the re-exposed layer.
5. Wash.
6. Expose the other layer uniformly to green light.
7. Colour develop this last re-exposed layer.
8. Wash.
9. Remove all silver.

INTERNAL LATENT IMAGE FORMING TYPE

A red sensitised emulsion of this type coated over a green sensitised emulsion of the same type.

After exposure the processing can be:

1. While immersed in one "surface" colour developer exposed uniformly to red light and allow the red record layer to develop.
2. Wash.
3. While immersed in another "surface" colour developer expose uniformly to green light through the back and allow the green record layer to develop.
4. Wash.
5. Remove all silver.
6. Wash.

Thus, when such emulsions are employed for example as mixed emulsions or superimposed emulsion layers in colour photography, the method of the present invention enables coloured positives to be obtained more expeditiously on a material containing a negative latent image of a coloured object or colour positive.

The present invention may be applied to a three-colour material consisting of three superimposed or mixed emulsions each of the said type sensitised to record respectively blue, green and red, in which the red and green sensitised emulsions have blue sensitivities which are very low, such as less than one tenth of the blue sensitivity of the blue-sensitive emulsion (see British Patent No. 540,444); the following procedure may be adopted to process such an exposed material. First immerse the material in a "surface" colour-forming developer containing a colour coupler giving a blue-green image and then expose the material to a uniform red light; the negative latent image in the lowest red sensitive layer will then develop as a blue-green coloured positive.

After washing, immerse the material in a colour-forming surface developer containing a colour coupler giving a magenta image and then expose the material to a green light; the negative latent image in the green sensitive emulsion will then develop as a magenta-coloured positive. Finally, immerse the material in a colour-forming surface developer containing a colour coupler giving a yellow image and then expose the material to blue light; the negative latent image in the blue sensitive layer will then develop as a yellow coloured positive. Colour forming developers given such blue-green magenta and yellow images (respectively) suitable for this purpose are those of the kind commonly employed in colour photography which have little or no

tendency to dissolve silver halide such as those in British Patent No. 507,841.

The accompanying drawings show a flow-diagram which depicts graphically the application of our invention to a three-colour material as described above. In the first sheet of drawings, at B is shown a three-colour sensitive material comprising coated on a support three superimposed silver halide emulsion layers which are red, green and blue sensitive reading from the support. The blue sensitivity of the red and green sensitive layers is very low compared to the blue sensitivity of the blue sensitive layer, viz. less than $\frac{1}{10}$ the blue sensitivity of the blue sensitive layer. Upon exposure of the three-colour sensitive material shown at B to the light coloured object shown at A, a negative latent image of the red part of the coloured object is formed mostly inside the silver halide grains of the red sensitive layer; a negative latent image of the green part of the coloured object is formed mostly inside the silver halide grains of the green sensitive layer; and a negative latent image of the blue part of the coloured object is formed mostly inside the silver halide grains of the blue sensitive layer, as shown at C. Upon treatment of this exposed three-colour material to render it capable of forming surface latent image by immersing it in a "surface" colour-forming developer containing a colour coupler giving a blue-green image, the red sensitive layer still contains the aforesaid negative latent image mostly inside the silver halide grains, but is now capable of forming surface latent image as shown at D. Upon exposing the material to a uniform red light, a reversed (or positive) latent image is formed mostly on the surface of the silver halide grains as shown at E. Upon development of the red-sensitive emulsion layer in the aforesaid "surface" colour-forming developer containing a colour coupler giving a blue-green image, a blue-green coloured positive develops in the red-sensitive layer as shown at F. After washing the material and upon immersing the washed material in a "surface" colour-forming developer containing a colour coupler giving a magenta image, the green sensitive layer still contains the aforesaid negative latent image mostly inside the silver halide grains, but is now capable of forming surface latent image as shown at G (second sheet of drawings). Upon exposing the material to uniform green light, a reversed (or positive) latent image is formed mostly on the silver halide grains as shown at H. Upon development of the green-sensitive layer in the aforesaid "surface" colour-forming developer containing a colour coupler giving a magenta image, a magenta coloured positive develops in the green-sensitive layer as shown at I. Upon immersing the material in a "surface" colour-forming developer containing a colour coupler giving a yellow image, the blue-sensitive layer still contains the aforesaid negative latent image mostly inside the silver halide grains, but is now capable of forming surface latent image as shown at J. Upon exposing the material to uniform blue light, a reversed (or positive) latent image is formed mostly on the surface of the silver halide grains as shown at K. Upon development of the blue-sensitive layer in the aforesaid "surface" colour-forming developer containing a colour coupler giving a yellow image, a yellow coloured positive develops in the blue-sensitive layer as shown at L, and a positive record of the coloured object is complete.

An alternative method of processing such a

three-colour material is illustrated by considering the case where the layers are in the following order:

Blue sensitive layer
Green sensitive layer
Red sensitive layer
Support.

For example, to process this material after exposure to a coloured object or image, first place it in an ordinary "surface," developer (e. g. Formula III) and then uniformly expose to red light whereupon a reversed image develops (in black silver only) in the red sensitive emulsion; then convert such silver to silver ferrocyanide by treatment with a solution of 2% potassium ferricyanide and then develop with a colour-forming developer containing a colour coupler giving a blue-green coloured image. The red sensitive layer which is nearest the support then contains a reversed image in red dye plus silver. Next place the material again in an ordinary surface developer (e. g. Formula III) and then uniformly expose to green light whereupon a reversed image develops (in black silver only) in the green sensitive emulsion; then by means of controlled diffusion convert such silver to silver ferrocyanide without converting the silver in the red sensitive layer; then develop such silver ferrocyanide with a magenta forming colour developer. The top layer is then treated similarly to the treatment just described for the green sensitive layer except that the uniform exposure must be by blue light and the colour developer should give a yellow image. Finally, all silver and unused silver salt is removed in the usual way. This example illustrates the processing of superimposed layers in sequence so that the reversed image formed in any one layer does not screen the subsequent re-exposure of another layer in which a reversed image is to be formed.

In performing the present invention, it is sometimes found that in the development of one of the reversed images there may be a tendency for some development of the first formed latent images therein to occur and this gives veiled whites. For instance, this is particularly likely to occur when the emulsion is dye-sensitised; to test for this in any particular case, one should first expose the emulsion layer behind a step wedge and develop in an "internal" developer (Formula II (*a*) or II (*b*)), then ascertain therefrom the exposure which gave the maximum density, next over-expose another portion of the emulsion layer (say, four times the amount which gave said maximum density) and now on development in a "surface" developer (Formula I) the density obtained should desirably be not above 0.05 above the fog density.

This undesirable tendency can be prevented by treating the emulsion (or the whole material) after the first image exposure (but before immersion in the developing solution) in a mild silver-oxidising bath such as for 1 minute at 20° C. in

Potassium ferricyanide	grams	1
Potassium bromide	do	0.5
Water	ccs.	1000

Such a bath does not seriously affect most sensitising dyes (if present in the emulsion) nor the "internal" latent image.

This application is a continuation-in-part of our copending application Serial No. 589,094, filed April 18, 1945.

What we claim as our invention and desire

to be secured by Letters Patent of the United States is:

1. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between 1/100th and 1 second and development for 3 minutes at 20° C. in the following developer (II*a*):

Hydroquinone	grams	15
N-methyl-p-aminophenol sulphate	do	15
Sodium sulphite, anhydrous	do	50
Potassium bromide	do	10
Sodium hydroxide	do	25
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog, at least 5 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said emulsions to visible images treating an exposed emulsion to render it capable of forming latent image developable by the following developer (III):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	150
Water to	ccs	1000

uniformly exposing to light the so-treated emulsion to produce latent image some of which is developable by the aforesaid developer (III), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by developer (III) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer III to produce latent image some of which is developable by the aforesaid developer (III), and developing the second uniformly fogged emulsion in a developer which develops the latent image which is developable by developer (III) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

2. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a trans-

parent glass support upon exposure to a light intensity scale for a fixed time between 1/100th and 1 second and development for 3 minutes at 20° C. in the following developer (IIa):

Hydroquinone	grams	15
N-methyl-p-aminophenol sulphate	do	15
Sodium sulphite, anhydrous	do	50
Potassium bromide	do	10
Sodium hydroxide	do	25
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog, at least 10 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20 C. in the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said emulsions to visible images treating an exposed emulsion to render it capable of forming latent image developable by the following developer (III):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	150
Water to	ccs	1000

uniformly exposing to light the so-treated emulsion to produce latent image some of which is developable by the aforesaid developer (III), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by developer (III) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer III to produce latent image some of which is developable by the aforesaid developer (III), and developing the second uniformly fogged emulsion in a developer which develops the latent image which is developable by developer (III) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

3. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between $\frac{1}{100}$ and 1 second and development for 4 minutes at 20° C. in the following developer (IIb):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium hydroxide	do	150

Sodium thiosulphate, crystals	grams	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog; at least 5 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said emulsions to visible images, treating an exposed emulsion to render it capable of forming latent image developable by the aforesaid developer (I), uniformly exposing to light the so-treated emulsion to form latent image some of which is developable by the aforesaid developer (I), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer (I) to produce latent image some of which is developable by the aforesaid developer (I), and developing the second uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

4. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between $\frac{1}{100}$ and 1 second and development for 4 minutes at 20° C. in the following developer (IIb):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium hydroxide	do	150
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog; at least 10 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said emulsions to visible images, treating an exposed

emulsion to render it capable of forming latent image developable by the aforesaid developer (I), uniformly exposing to light the so-treated emulsion to form latent image some of which is developable by the aforesaid developer (I), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer (I) to produce latent image some of which is developable by the aforesaid developer (I), and developing the second uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

5. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between $\frac{1}{100}$ and 1 second and development for 3 minutes at 20° C. in the following developer (II*a*):

Hydroquinone	grams	15
N-methyl-p-aminophenol sulphate	do	15
Sodium sulphite, anhydrous	do	50
Potassium bromide	do	10
Sodium hydroxide	do	25
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog, at least 5 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (III):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	150
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said exposed emulsions, treating an exposed emulsion to render it capable of forming latent image developable by the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

uniformly exposing to light the so-treated emulsion to form latent image some of which is developable by the aforesaid developer (I), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer (I) to produce latent image some of which is developable by the aforesaid developer (I), and developing the second uniformly exposed emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

6. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between $\frac{1}{100}$ and 1 second and development for 3 minutes at 20° C. in the following developer (II*a*):

Hydroquinone	grams	15
N-methyl-p-aminophenol sulphate	do	15
Sodium sulphite, anhydrous	do	50
Potassium bromide	do	10
Sodium hydroxide	do	25
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog, at least 10 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (III):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	150
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said exposed emulsions, treating an exposed emulsion to render it capable of forming latent image developable by the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

uniformly exposing to light the so-treated emulsion to form latent image some of which is developable by the aforesaid developer (I), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer (I) to produce latent image some of which

is developable by the aforesaid developer (I), and developing the second uniformly exposed emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

7. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between 1/100th and 1 second and development for 4 minutes at 20° C. in the following developer (IIb):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	150
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog, at least 5 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (III):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	20
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said exposed emulsions, treating an exposed emulsion to render it capable of forming latent image developable by the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

uniformly exposing to light the so-treated emulsion to form latent image some of which is developable by the aforesaid developer (I), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer (I) to produce latent image some of which is developable by the aforesaid developer (I), and developing the second uniformly exposed emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

8. The method of producing reversed photographic images comprising exposing to a lighted object or image a photographic material comprising inseparably combined and extending over the same area on a single support a plurality of photographic silver halide emulsions a test layer of any one of which emulsions coated on a transparent glass support upon exposure to a light intensity scale for a fixed time between 1/100th and 1 second and development for 4 minutes at 20° C. in the following developer (IIb):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	150
Sodium thiosulphate, crystals	do	20
Water to	ccs	1000

gives a transmitted density at any point along the $\log_{10}E$ axis, over a range of 3.0 starting from the threshold of the characteristic curve beginning at a density of 0.1 above fog, at least 10 times the transmitted density obtained when an identical test layer of the emulsion is developed for 4 minutes at 20° C. in the following developer (III):

Hydroquinone	grams	12
N-methyl-p-aminophenol sulphate	do	3
Sodium sulphite, crystals	do	90
Potassium bromide	do	4
Sodium carbonate, crystals	do	20
Water to	ccs	1000

the measurements of density being made at the same points on the $\log_{10}E$ axis, then without developing up the latent images so formed in said exposed emulsions, treating an exposed emulsion to render it capable of forming latent image developable by the following developer (I):

p-Hydroxyphenylglycine	grams	10
Sodium carbonate, crystals	do	100
Water to	ccs	1000

uniformly exposing to light the so-treated emulsion to form latent image some of which is developable by the aforesaid developer (I), developing the uniformly fogged emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed, then uniformly exposing to light another of said exposed emulsions which has also been treated to render it capable of forming latent image developable by the aforesaid developer (I) to produce latent image some of which is developable by the aforesaid developer (I), and developing the second uniformly exposed emulsion in a developer which develops the latent image which is developable by the aforesaid developer (I) and gives no more than a negligible development of the negative latent image formed by the original exposure compared with the positive image which is developed in said second emulsion.

EDWARD BOWES KNOTT.
GUY WILLIAM WILLIS STEVENS.

REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
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Wall, "Photographic Emulsions," published by American Phot. Publ. Co., Boston, 1929; pages 52, 53 and 135–137. (Copy in Div. 67.)

Certificate of Correction

Patent No. 2,456,954. December 21, 1948.

EDWARD BOWES KNOTT ET AL.

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 6, line 61, claim 3, for the words "which on" read *which one*; column 7, line 26, for "exposed" read *expose*; line 72, for "given" read *giving*; column 11, line 18, for "20 C." read *20° C.*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of April, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.