June 7, 1966 E. R. BLOUT ETAL 3,255,001
PHOTOGRAPHIC PRODUCTS, PROCESSES AND COMPOSITIONS UTILIZING
INSULATED AZO DYE DEVELOPERS
Filed Feb. 3, 1955

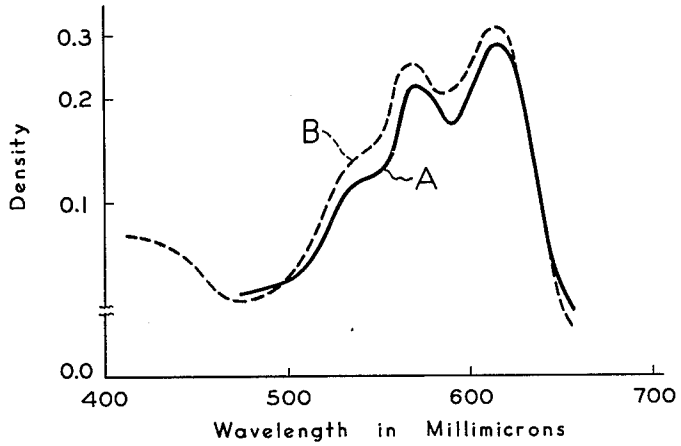

FIG. 1

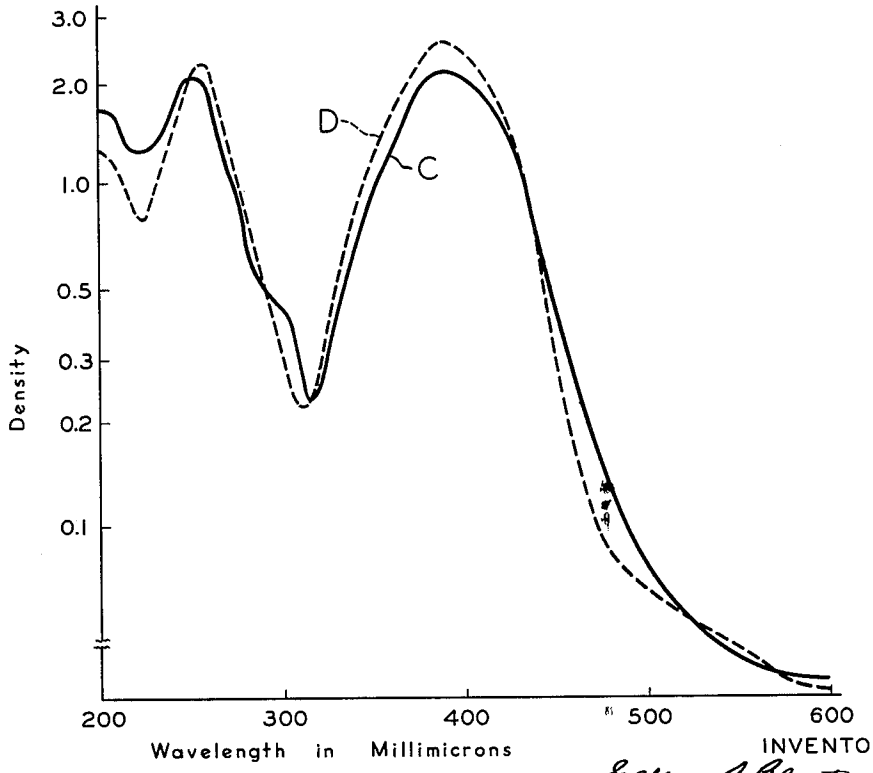

FIG. 2

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United States Patent Office

3,255,001
Patented June 7, 1966

3,255,001

PHOTOGRAPHIC PRODUCTS, PROCESSES AND COMPOSITIONS UTILIZING INSULATED AZO DYE DEVELOPERS

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Filed Feb. 3, 1955, Ser. No. 485,840
11 Claims. (Cl. 96—29)

This invention relates to photography and more particularly to products, processes and compositions for the development of photosensitive silver halide elements.

It is one object of the present invention to provide novel compositions and processes for the development of silver halide emulsions, in which colored developing agents are used to develop a latent photographic image.

Another object is to provide novel compositions and processes for the the development of silver halide emulsions, in which colored developing agents develop a photographic latent image and impart a reversed or positive colored image of said latent image to a superposed image-receiving element.

A further object is to provide novel processes to provide colored developing agents capable of developing a photographic latent image and imparting a reversed or positive colored image of said latent image to a superposed image-receiving element.

A further object is to provide novel products, compositions and procesess for preparing monochromatic and multichromatic photographic images, and to provide colored developing agents suitable for use in said processes, products and compositions.

Other objects of this invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the processes involving the several steps and the relation and order of one or more of such steps with respect to each of the others, and the products and compositions possessing the features, properties and the relation of elements which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a graph illustrating the light-absorbing properties of a dye which may be used in accomplishing the objects of this invention, and also the light-absorbing properties of one embodiment of the invention employing this dye; and

FIG. 2 is a graph illustrating the light-absorbing properties of another dye which may be used in accomplishing the objects of this invention, and also the light-absorbing properties of another embodiment of this invention embodying this dye.

U.S. Letters Patent Nos. 2,559,643 and 2,647,049 to Edwin H. Land disclose examples of diffusion transfer-reversal processes wherein a photographic material, such as a photosensitive element comprising an exposed silver halide emulsion layer containing a latent image, is processed to impart to an image-carrying or image-receiving element a reversed or positive dye image of said latent image by permeating into said emulsion a layer of suitable liquid processing composition and bringing said photosensitive element into superposed relationship with an appropriate image-receiving element, prior to, during or after application of the liquid processing composition. In these processes, the desired colors are obtained by a coupling reaction involving oxidized developing agent to form a dye. In such processes, two reactions are required to form the desired dye: (1) oxidation of the developing agent followed by (2) a coupling reaction of the oxidized developing agent to form the dye.

The copending application of Howard G. Rogers, Serial No. 415,073, filed March 9, 1954 (now abandoned, the subject matter thereof having been incorporated in continuation-in-part application Serial No. 748,721, filed July 15, 1958, which application in turn is now U.S. Patent No. 2,983,606, issued May 9, 1961) discloses and claims an improvement in the method of obtaining positive dye images by diffusion transfer-reversal processes such as described in the above-mentioned patents to Edwin H. Land; this improvement comprises the use of so-called dye developers, i.e., a silver halide developing agent which is also a dye. In this process, the unoxidized dye developer is utilized to provide a dye image on the image-receiving element; thus, only one reaction is required.

As noted in the above-mentioned application of Howard G. Rogers, the photographic art is aware, in a general sense, of the existence of compounds which may be considered as dye developers. For example, U.S. Patent No. 2,543,691, issued to Joseph S. Friedman on February 27, 1951, makes reference to 4-phenylazo-1,2-naphthalenediol as a dye developer. This patent also refers to certain azo acyl esters as dye developers.

It will be apparent that the available number of complete dyes which are capable of developing silver halide emulsions is quite small, and therefore one working in this aspect of color photography has been afforded little choice in selecting dye developers.

It has been discovered that it is possible to prepare dye developers possessing the desired color by uniting a dye of a desired, predetermined color with a group possessing a silver halide developing function to obtain a dye developer having substantially the same color as the chosen dye and substantially the same developing power as the chosen developer. Use of the techniques of this invention thus permits one to obtain dye developers of predetermined color characteristics and thus this invention greatly broadens the field of choice afforded to workers in color photography.

Dye developers of the type contemplated by this invention may be represented as:

(I) D—X—D'

wherein D represents a dye unit and comprises the chromophoric system of a dye, D' represents a developer unit, i.e., an organic group which possesses substituents imparting thereto a silver halide developing function, and X represents an achromophoric bond joining said dye unit D to said developer unit D'.

As used in this specification and in the claims, the term "achromophoric bond" refers to a chemical linkage joining the dye unit D to the developer unit D'. The achromophoric bond does not contribute a color-producing group to the dye developer molecule but acts to prevent

or interrupt any system of conjugation or resonance extending from the dye unit D to the developer unit D'. Thus, any influence of the developer unit on the color characteristics of the dye unit is substantially excluded, as it is insulated from the chromophoric system of the dye unit D, and the color of the resulting dye developer is determined substantially entirely by the chromophoric or resonance system of the dye unit D. It may be said that the shape of the visible spectral absorption curve and the absorption peaks of the dye developer do not differ substantially from those of the parent dye from which the dye unit D is obtained; this is illustrated in the accompanying drawing, which will be referred to hereinafter. In general, the absorption peak of the dye developer will vary no more than about 15 millimicrons ($m\mu$) from that of the dye from which it is derived.

The achromophoric bond may be a single covalent bond, as where a dye unit D is directly joined to a developer unit D' by a shared pair of electrons, or it may be a bivalent, organic group, i.e., an organic group having two free valences attached to different atoms and joined to a dye unit D and a developer unit D' by such single covalent bonds.

As examples of suitable achromophoric bonds which may be used to form dye developers from separate, complete dyes and developers within the scope of this invention, mention may be made of the following:

—(a shared pair of electrons)
—CO—
—CZ_2—, wherein Z may be hydrogen, alkyl or aryl
—SO_2—
—NZ—
—R—, wherein R is a bivalent hydrocarbon residue, e.g., alkylene or arylene
—NZ—R—
—SO_2—R—SO_2—
—CO—R—
—CO—R—CO—, i.e., a bivalent residue of a dibasic organic acid, acid anhydride or acid halide
—alkylene-NH—NH-alkylene—
—R—O—
—O—P(OH)—O—
—O—R—O—
—SO_3—R—NH—
—Q—, wherein Q is the bivalent residue of a heterocyclic group, which may be a hydroaromatic group, e.g., a cyclohexyl ring, or which may contain atoms other than carbon in the ring, such as nitrogen or oxygen, e.g., a triazine ring.

The alkyl, aryl, alkylene, arylene, hydrocarbon and heterocyclic groups referred to above are intended to include corresponding substituted groups also.

The following specific examples are intended merely to illustrate the application of the principle and technique of this invention, and are not intended to be limiting.

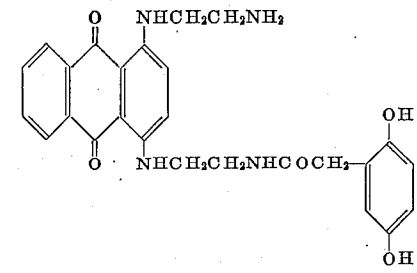
Example 1

2 - hydroquinoneamino - 4 - hydroxy-6-(4-phenylazoanilino)-s-triazine may be prepared from aminohydroquinone, cyanuric chloride and p-aminoazobenzene, as described and claimed in the copending application of Richard S. Corley, Serial No. 445,171, filed July 22, 1954 (now abandoned). In this illustration, the achromophoric bond is a triazine radical having two free valences. This dye developer gives a yellow positive image when used in a diffusion transfer reversal process such as described herein and in the cited application.

It will be noted that the s-triazinyl radical which constitutes the achromophoric bond may be further substituted by a second dye unit or developer unit whereby the developing potential or the color properties of the dye developer may be adjusted to meet a particular need.

Example 2

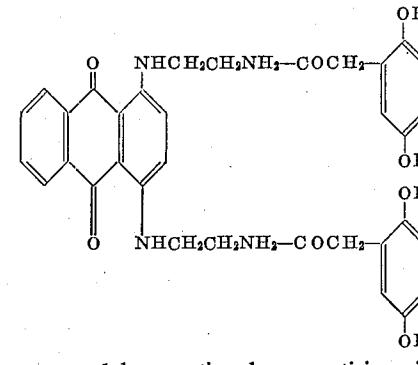
(II)



may be prepared from 1,4-bis-(beta-aminoethylamino)-anthraquinone and homogentisic lactone or homogentisic acid chloride, as described and claimed in the copending application of Elkan R. Blout et al., Serial No. 471,542, filed November 26, 1954 (now abandoned, the subject matter thereof having been incorporated in continuation-in-part applications Serial No. 1,443 and Serial No. 1,442, filed January 11, 1960, said last-mentioned application in turn having been abandoned, the subject matter thereof having been incorporated in continuation-in-part application Serial No. 401,714, filed October 5, 1964). Use of this dye developer in a diffusion transfer-reversal process such as described herein and in the cited application provides a greyish-blue positive image.

Another cyan dye developer having the formula:

(III)



may be prepared by reacting homogentisic acid lactone with ethylene diamine and reacting this product with leucoquinizarin, or in a manner similar to that by which the dye developer of Formula II is prepared.

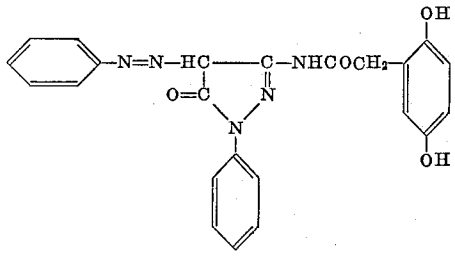
Similarly, yellow dye developers may be prepared by reaction of homogentisic acid chloride dibenzoate with 1-phenyl-3-amino-4-phenylazo-5-pyrazolone (see Formula IV, infra) or 1-phenyl-3-amino-4-(2',5'-dichlorophenylazo)-5-pyrazolone. In dye developers of the type described in this example, the achromophoric bond is the bivalent —CO—$(CH_2)_n$— group, wherein n may be zero or a positive integer and preferably is an integer from 1 to 5; in the case of the above dye developers, n is 1.

Curves A and B reproduced in FIG. 1 of the accompanying drawing represent, respectively, the visible absorption curves of the dye, 1,4-bis-(beta-aminoethylamino)-anthraquinone, and the dye developer of Formula II prepared from this dye and homogentisic acid lactone. It will be noted that the characteristics of these curves are very similar. At a concentration of 1.315×10^{-5} moles/liter of pyridine, the dye (Curve A) exhibits peaks at 425 $m\mu$, molecular extinction coefficient ϵ=4.750; 572 $m\mu$, ϵ=15,600; and 616 $m\mu$, ϵ=20,400. The dye developer (Curve B) under the same conditions exhibits peaks at 425 $m\mu$, ϵ=6,000; 570 $m\mu$, ϵ=17,150; and 613 $m\mu$, ϵ=21,100. When dissolved in ethanol at a concentration of 10^{-4} moles/liter, this dye exhibits peaks at approximately 430 $m\mu$, 557 $m\mu$ and 599 $m\mu$. The dye developer dissolved in ethanol at a concentration of $<10^{-4}$ moles/liter exhibits peaks at approximately 420–440 $m\mu$, 557 $m\mu$ and 600 $m\mu$.

Curves C and D reproduced in FIG. 2 of the accompanying drawing represent, respectively, the absorption

curves of the dye 1-phenyl-3-amino-4-phenylazo-5-pyrazolone, and the dye developer

(IV)

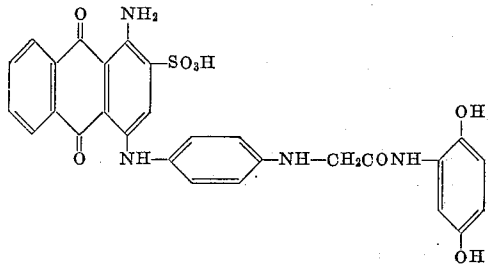


prepared from this dye and homogentisic acid chloride dibenzoate. At a concentration of 10^{-4} moles/liter of ethanol, the dye (Curve C) exhibits a peak at 385 mμ, ϵ=27,000. The dye developer of Formula IV (Curve D) under the same conditions exhibits a peak at 390 mμ, ϵ=21,300.

These curves were obtained using a Cary Recording Spectrophotometer, Model 11M. The density scale represents the log $(1/T)$, non-linear.

Example 3

(V)



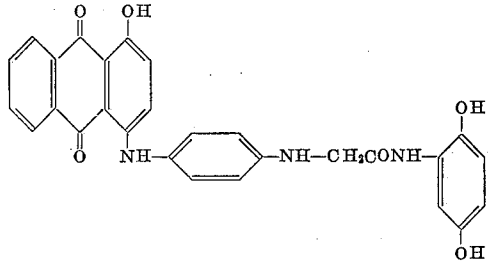
may be prepared from chloroacetamidohydroquinone and 1-amino-4-(p-aminoanilino)-anthraquinone - 2 - sulfonic acid, as described and claimed in the copending application of Elkan R. Blout et al., Serial No. 459,198, filed September 29, 1954 (now abandoned, the subject matter thereof having been incorporated in continuation-in-part applications Serial No. 771,718 (now abandoned) and Serial No. 771,719, filed November 4, 1958, said last-mentioned application in turn having been abandoned, the subject matter thereof having been incorporated in continuation-in-part application Serial No. 193,320, filed May 8, 1962). In this instance, the achromophoric bond through which the developer, hydroquinone, is joined to a reactive, terminal amino group on the dye, is a

$$—CH_2CONH—$$

group. It will be noted that while an amido group in some cases may be considered to be a color contributing group, the presence here of the methylene group between the amido group of the achromophoric bond and the terminal —NH— of the dye effectively insulates the amido group from the chromophoric system of the dye unit. This dye developer, when employed in a diffusion transfer reversal process such as described herein and in the cited application, provides a cyan positive image.

Another example of a dye developer utilizing this achromophoric bond is

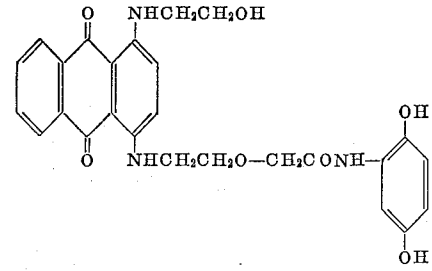
(VI)



prepared from chloroacetamidohydroquinone and 1-hydroxy-4-(p-aminoanilino)-anthraquinone. This dye developer gives a cyan positive image when used in a diffusion transfer reversal process.

The same achromophoric bond may be used to join a developer group to a dye by reaction with a reactive, terminal hydroxyl group on the dye. For example,

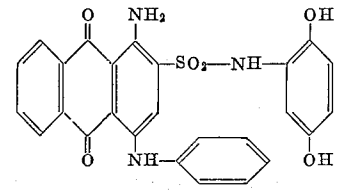
(VII)



may be prepared from 1,4-bis-(beta-hydroxyethylamino)-anthraquinone and chloroacetamidohydroquinone, as described and claimed in cited application Serial No. 459,198.

Example 4

(VIII)



may be prepared by the reaction of aminohydroquinone with 1-amino-2-chlorosulfonyl-4-anilino - anthraquinone. In this instance, the achromophoric bond is a single covalent bond between the sulfonyl group (—SO_2—) of the dye and the amino group (—NH—) of the developer.

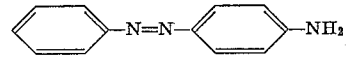
It will be readily apparent from the above examples and description that the nature and size of the bivalent organic group which functions as the achromophoric bond may vary considerably. The particular group employed is chosen with a view to obtaining a dye developer which is capable of being solubilized by the liquid processing composition, and whose oxidation product is capable of being immobilized substantially in situ with the developed latent image, as described hereinafter. In the preferred embodiment, the achromophoric bond comprises no more than ten carbons.

The achromophoric bond which unites the dye unit with the developer unit may be initially present in one of the starting materials or it may be introduced by various methods as illustrated above. Thus, the dye developer may be "built up" from complete dyes and developers, as by attaching the organic group comprising the achromophoric bond to the developer or a suitable derivative thereof and this intermediate then reacted with the desired dye. Conversely, the organic group comprising the achromophoric bond may be attached first to the dye and this intermediate then reacted with the developer. It is not necessary to prepare the dye first as the developer unit may be introduced during the preparation of the dye. Note, as an illustration of this technique, the dye developer of Formula III (Example 2) wherein the developer group was attached to a dye intermediate (ethylene diamine) prior to the reaction of such intermediate with another dye intermediate (leucoquinizarin) to obtain the desired dye. In general, the method of preparation involves reaction with a terminal, reactive group such as amino, hydroxyl, —SO_2Cl, etc. As will be apparent, the terminal, reactive group to which the achromophoric bond is attached should not be a part of the conjugated achromophoric system of the dye. It will be apparent that a particular achromophoric bond may be introduced by suitable reaction with different terminal groups. An illustration of this flexibility is given in Example 3 wherein a —CH_2CONH— group is introduced by reaction with terminal amino or hydroxyl

groups on the dye. Similarly, an achromophoric bond comprising the —NH—R— group may be introduced by reacting the corresponding primary amine with a reactive, terminal sulfo (—SO_3H) or carboxyl (—COOH) group on a dye.

In certain instances, a dye may possess several terminal, reactive groups through which the —X—D′ group may be attached to the dye unit D; in such instances, reaction may be brought about at one or more of such reactive groups and one or more —X—D′ groups caused to be attached to the dye unit D. The designation D is intended to include such additional —X—D′ groups as part of the dye unit where appropriate. As noted in Example 1, it may be possible to attach additional dye units or developer units to a particular achromophoric bond.

"D" has been defined as a dye unit which comprises the chromophoric system of a dye. It will be apparent from the above examples that the dye unit D has the same structure as the dye from which it has been derived, except for the portion of the reactive, terminal group displaced in the reaction. Thus, the dye unit D as derived from the dye



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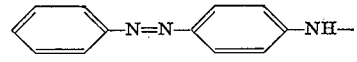
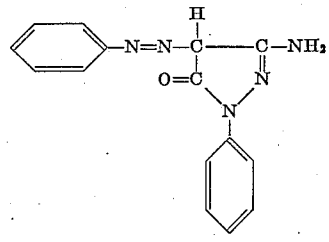


while the dye unit D as derived from the dye



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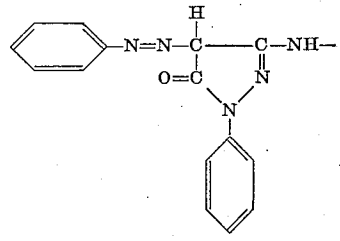
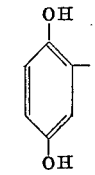


It will be apparent that the field from which the dye used to provide the dye unit D may be selected is extremely large, encompassing all types of dye structures, and is primarily limited only by the color which it is desired to have in the dye developer product. Where the solubility of the dye is not satisfactory, it may be usually modified by the addition or removal of solubilizing substituents or insolubilizing substituents. The solubility characteristics of the dye are preferably such that the dye developer product is capable of being solubilized in the liquid processing composition, and the oxidation product of the dye developer rendered insoluble or otherwise immobilized in situ with the developed silver image.

Dyes utilized to provide the dye unit D of the dye developers of this invention preferably should not, as for example, sulfide dyes, possess constituents which are harmful to photographic materials such as silver halide. In the event the dye unit D of the dye developer is of a nature which tends to desensitize silver halide, suitable precautions, such as those mentioned in the copending application of Howard G. Rogers, Serial No. 358,011, filed May 28, 1953 (now abandoned, the subject matter thereof having been incorporated in continuation-in-part application Serial No. 577,711, filed April 12, 1956, now U.S. Patent No. 3,019,124, issued January 30, 1962), should be utilized for controlling this undesirable condition.

D′ has been defined as a developer unit, i.e., an organic group containing substituents imparting thereto a silver halide developing function. In some of the above illustrations, the developer unit D′ may be considered as being derived from hydroquinone, i.e., D′ comprises the group



It is intended that this example of a developer unit is merely illustrative and other substituents may be used to supply the silver halide developing function. In a preferred embodiment, D′ contains an aryl nucleus, such as a benzene or naphthalene nucleus. Thus, where D′ contains a benzene nucleus, the silver halide developing function may be supplied by amino, alkylamino and/or hydroxyl groups substituted in the ortho or para positions, with respect to each other. Reference is made to The Theory of the Photographic Process, C. E. K. Mees (1st ed. 1942), the Macmillan Co., New York, N.Y., p. 342 et seq., for a discussion of the chemical constitution of silver halide developing groups. It is to be noted also that D′ may contain substituents other than those which supply the silver halide developing function so long as such substituents do not destroy the silver halide developing ability; examples of such substituents include alkyl, hydroxyl, amino, halogen, etc.

In carrying out a diffusion transfer reversal process employing the dye developers described herein, a photosensitive element containing a silver halide emulsion is exposed and a liquid processing composition applied thereto, as by immersing, coating, spraying, flowing, etc., in the dark. In a preferred embodiment, the photosensitive element contains a layer of the dye developer, and the liquid processing composition is applied to the photosensitive element in a uniform layer as this element is brought into superposed position with an image-receiving element. The liquid processing composition permeates the emulsion and provides a solution of dye developer substantially uniformly distributed therein. As the solubilized dye developer develops the latent negative image to silver, its oxidation product is immobilized or precipitated in situ with said silver. This immobilization is apparently due, at least in part, to a change in the solubility characteristics of the dye developer upon oxidation, and especially as regards its solubility in alkaline solutions. It may also be due, in part, to a tanning effect on the emulsion by the oxidized dye developer. The unoxidized dye developer retains its solubility in the liquid processing composition, thereby providing an imagewise distribution of unoxidized dye developer, at least part of which is transferred, by imbibition, to a superposed image-receiving element, said transfer substantially excluding silver or oxidized dye developer. The latter element receives a depthwise diffusion, from the emulsion, of at least part of the unoxidized dye developer without appreciably disturbing its imagewise distribution, thereby giving a reversed or positive, colored image of the developed images. The image-receiving element may contain agents adapted to mordant or otherwise fix the diffused, unoxidized dye developer. Imbibition periods of approximately one minute have been found to give good results, but this contact period may be adjusted where necessary to compensate for variations in temperature or other conditions. The desired positive image is revealed by stripping the image-receiving element from the photosensitive element at the end of the imbibition period.

The novel dye developers disclosed herein may be

utilized in the liquid processing composition, in the image-receiving element, or in the photosensitive element, as for example, in, on or behind the silver halide emulsion layer. When employed in either element, the dye developer becomes solubilized by the liquid processing composition as it permeates the element. In a preferred embodiment, a coating or layer of the dye developer is placed behind the silver halide emulsion layer, i.e., on the side of the emulsion layer adapted to be located most distant from the photographed subject when the photosensitive element is exposed. This coating of the dye developer is preferably also located on the side of the emulsion layer adapted to be most distant from the image-receiving element when in superposed relationship therewith. Placing the dye developer behind the emulsion layer, as in the preferred embodiment, has the advantage of providing increased contrast in the positive image, and also minimizes any light-filtering action by the colored dye developer. In this preferred embodiment, the layer of dye developer may be applied by using coating solutions containing about 0.5% to 8%, by weight, of the dye developer.

An example of a suitable coating solution for applying the dye developer, set forth for purposes of illustration only, is:

Dye developer (e.g., the compound of Formula II, above) ---------- g--	3
Cellulose acetate hydrogen phthalate ---------- g--	4
Acetone ---------- cc--	80
Methanol ---------- cc--	20

The liquid processing composition referred to above comprises at least an aqueous solution of an alkaline material, such as diethylamine, sodium hydroxide or sodium carbonate. In some instances, it may contain a minor amount of a conventional developing agent. If the liquid processing composition is to be applied to the emulsion by being spread thereon, preferably in a relatively thin, uniform layer, it may also include a viscosity-increasing compound constituting a film-forming material of the type which, when spread over a water-absorbent base, will form a relatively firm and relatively stable film. A preferred film-forming material is a high molecular weight polymer such as a polymeric, water-soluble ether which is inert to an alkaline solution, as for example, a hydroxyethyl cellulose or sodium carboxymethyl cellulose. Other film-forming materials or thickening agents may be employed whose ability to increase viscosity is substantially unaffected when left in solution for a long period of time.

An example of a suitable liquid processing composition, set forth for purposes of illustration only, is:

Water ---------- cc--	100
Sodium carboxymethyl cellulose ---------- g--	4.0
Sodium hydroxide ---------- g--	2.0

As previously noted, the dye developer, if desired, may be incorporated in the liquid processing composition; concentrations of 0.5 to 8%, by weight, of the dye developer are satisfactory. A typical concentration of dye developer in the liquid processing composition is 1 to 2%, by weight.

The liquid processing composition may contain a minor amount of a conventional developer, such as Metol. The amount of this conventional developer used is insufficient to give appreciable negative density by itself, for example, 0.1 to 0.2%, and merely serves to accelerate and possibly initiate the action of the dye developer.

It should be noted that certain dyes used to provide the dye unit D of dye developers within the scope of this invention may be subject to color changes as a result of pH changes; thus a highly alkaline pH in the portion of the image-receiving element to which the unoxidized dye developer is diffused may affect the color of the positive image. Since the dye developer is rendered effective by solution in an aqueous alkaline liquid processing composition, it accordingly is necessary to assure that the environment in which the transferred and unreacted dye developer is deposited has, or is capable of attaining, the requisite pH value according the desired color to the diffused dye developer. This may be accomplished by use of a volatile basic compound, such as diethylamine, in the liquid processing composition. If sodium hydroxide is utilized in the processing liquid, it becomes carbonated after processing and by contact with the air, and this is effective to provide the desired pH change. Further control of the pH of the transferred and unreacted dye developer may be had by utilizing an image-receiving element which is difficultly penetrable by alkali, for example an appropriate nylon such as N-methoxymethyl polyhexamethylene adipamide, or by the use of an image-receiving element in which an acid or an acid-forming compound, for example oleic acid, has been incorporated.

The novel dye developers herein disclosed may be used also in conventional photographic processes, such as tray or tank development of conventional photosensitive films, plates or papers to obtain black-and-white, monochromatic or toned prints or negatives. By way of example, a developer composition suitable for such use may comprise an aqueous solution of 1–2% of the dye developer, 1% sodium hydroxide, 2% sodium sulfite and 0.05% potassium bromide. After development is completed, any unreacted dye developer is washed out, preferably with an alkaline or other washing medium in which the unoxidized dye developer is soluble. The expression "toned" is used to designate photographic images wherein the silver is retained with the precipitated dye, whereas "monochromatic" is intended to designate dye images free of silver.

It will be apparent that by appropriate selection of the image-receiving element from among suitable known opaque and transparent materials, it is possible to obtain either a colored positive reflection print or a colored positive transparency. Likewise, the inventive concepts herein set forth are adaptable for multicolor work by the use of special photographic materials, for example, film materials of the type containing two or more photosensitized elements associated with a suitable number of image-receiving elements and adapted to be treated with one or more liquid processing compositions, appropriate dye developers suitable to impart the desired subtractive colors being incorporated in the photosensitized elements or in the liquid processing compositions. Examples of such photographic materials are disclosed in the previously mentioned U.S. Patent No. 2,647,049.

The inventive concepts herein set forth are also adaptable for the formation of colored images in accordance with the photographic products and processes described and claimed in the copending application of Howard G. Rogers, Serial No. 415,073, filed March 9, 1954 (now abandoned, the subject matter thereof having been incorporated in continuation-in-part application Serial No. 748,421, filed July 14, 1958, which application in turn is now U.S. Patent No. 2,983,606, issued May 9, 1961), and also those set forth in the copending application of Edwin H. Land, Serial No. 448,441, filed August 9, 1954, now U.S. Patent No. 2,968,554, issued January 17, 1961.

In the preceding portions of the specification the expression "color" has been frequently used. This expression is intended to include the use of a plurality of colors to obtain black, as well as the use of a single black dye developer.

Since certain changes may be made in the above products, compositions and processes without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A photographic product comprising a support carrying on one side thereof a plurality of layers, at least one of said layers containing a silver halide emulsion, and at least one of said layers containing a dye developer, said dye develper being a compound of the formula:

D—D'

wherein D is the dye radical of an azo dye D—H containing a conjugated ring system capable of resonance and including at least one ring of 5 to 6 members, inclusive, selected from the group consisting of heterocyclic and aromatic rings, and also including chromophoric groups, whereby said dye D—H exhibits appreciable light absorption in the range of the visible spectrum; D'— is a monovalent developer radical containing an aromatic nucleus so substituted by at least two members of the group consisting of hydroxy, amino and alkylamino groups as to be capable of developing exposed silver halide, the valence of said radical D'— being directly attached to said aromatic nucleus of D'—; said D'— being attached through a divalent organic insulating group including an intralinear acyclic atom of D to a ring of D selected from the group consisting of an aromatic ring and a heterocyclic ring, so that the conjugated bond system of said developer radical D'— is unconjugated with respect to any conjugated bond system of said dye radical D whereby the color characteristics of said dye developer are determined substantially entirely by the chromophoric-resonance system of said dye radical D.

2. A photographic product as defined in claim 1, wherein the absoprtion peak of the visible spectral absorption curve of said dye developer does not vary by more than about 15 millimicrons from that of said dye D—H from which said radical D is derived.

3. A photographic product as defined in claim 1, wherein said developer radical D' is a hydroquinonyl radical.

4. In a process of forming diffusion transfer images in color, the steps which comprise developing an exposed silver halide emulsion with an alkaline solution containing a dye developer, said dye developer being a compound of the formula:

D—D'

wherein D is the dye radical of an azo dye D—H containing a conjugated ring system capable of resonance and including at least one ring of 5 to 6 members, inclusive, selected from the group consisting of heterocyclic and aromatic rings, and also including chromophoric groups, whereby said dye D—H exhibits appreciable light absorption in the range of the visible spectrum; D'— is a monovalent developer radical containing an aromatic nucleus so substituted by at least two members of the group consisting of hydroxy, amino and alkylamino groups as to be capable of developing exposed silver halide, the valence of said radical D'— being directly attached to said aromatic nucleus of D'—; said D'— being attached through a divalent organic insulating group including an intralinear acyclic atom of D to a ring of D selected from the group consisting of an aromatic ring and a heterocyclic ring, so that the conjugated bond system of said developer radical D'— is unconjugated with respect to any conjugated bond system of said dye radical D whereby the color characteristics of said dye developer are determined substantially entirely by the chromophoric-resonance system of said dye radical D, oxidizing said dye developer as a function of the point-to-point degree of development, forming in undeveloped areas of said silver halide emulsion an imagewise distribution of unoxidized dye developer and transferring at least part of said imagewise distribution of unoxidized dye developer, by imbibition, from said emulsion to an image-receiving layer in superposed relationship with said emulsion to impart a dye transfer image to said image-receiving layer.

5. The process as defined in claim 4, wherein said dye developer is dispersed prior to exposure in a photosensitive element comprising said silver halide emulsion, and including the step of permeating said photosensitive element with an aqueous alkaline liquid capable of solubilizing said dye developer.

6. The process as defined in claim 5, wherein said liquid is introduced by being spread in a substantially uniform layer between said photosensitive element and an image-receiving element comprising said image-receiving layer as said elements are brought into superposed relationship.

7. The process as defined in claim 6, wherein said liquid contains a thickener for increasing viscosity and for facilitating the spreading thereof between said photosensitive element and said image-receiving element.

8. The process as defined in claim 4, wherein said dye developer is dissolved in an aqueous alkaline solution prior to application of said solution to said exposed emulsion.

9. The process as defined in claim 4, wherein the absorption peak of the visible spectral absorption curve of said dye developer does not vary by more than about 15 millimicrons from that of said dye D—H from which said radical D is derived.

10. The process as defined in claim 4, wherein said developer radical D' is a hydroquinonyl radical.

11. The process as defined in claim 4, wherein said alkaline solution includes a silver halide developing agent which is substantially colorless in at least its unoxidized form.

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