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DEVELOPING OF DIAZOTYPE IMAGES

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Fig. 1.



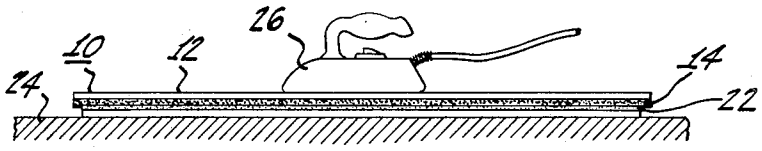


Fig. 2.

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DEVELOPING OF DIAZOTYPE IMAGES

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This invention relates to the developing of images produced by the diazotype process, and particularly to the so-called "dry" developing process.

The diazotype process of reproducing images has been extensively used in the past, and involves reacting a light-sensitive diazonium compound with at least one azo dye coupler to produce a deeply colored azo dye from substantially colorless or only very slightly colored starting materials. The sensitivity of the diazonium compound is such that when exposed to light of the proper wave length and of sufficient intensity, it is decomposed or chemically changed so that it is no longer capable of forming deeply colored material. Wave lengths between about 3,400 and about 4,100 Angstroms are generally the most effective. However, the dye formation is essentially an aqueous phase reaction and requires a definite pH or degree of alkalinity in the absence of which it will not take place.

It has been accordingly found suitable to provide on a support such as a paper sheet, a sensitized stratum containing a mixture of one or more diazonium compounds and one or more couplers, but not in the alkalinity or pH range required for color formation, then expose the stratum to an optical image to be reproduced, and develop the image by treating the exposed stratum to bring it to the conditions suitable for color formation. Those parts of the stratum which correspond to the light parts of the image become deactivated by the light so that little or no color is formed during the development, depending upon the light gradation. The darker parts of the image however, at least partially protect the correspondingly positioned stratum against deactivation by the light so that color is developed in accordance with the image.

If the development is effected by the application of an aqueous solution of alkaline material, it becomes necessary to provide special liquid treating apparatus and to also delay the final handling of the developed copy until the stratum and its carrier are again dried.

In an attempt to avoid the difficulties resulting from wetting a so-called "dry" process has been evolved with gaseous moist ammonia applied to the stratum as the developing agent. Any wetting of the stratum is thereby reduced to insignificance. There still remains the difficulty of providing special developing chambers as well as the moist ammonia gas which is extremely annoying in the event of its liberation outside the development chamber. Not only does the ammonia have

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a choking effect on people even in small quantities, but it may spoil stored diazotype copying sheets by causing premature color formation.

Attempts have been made in the past to incorporate developing agents in the sensitized stratum but in such condition that they do not cause development until heated or steamed. Although such techniques can be made to operate, they have been found unsatisfactory in that the useful storage life of the sensitized stratum is severely shortened, color formation taking place gradually even without the application of heat or steam. As a result it becomes necessary, if such processes are used, to make sure the sensitized material is relatively fresh, even a few weeks storage being too long in many cases.

It is accordingly a principal object of the invention to provide an improved diazotype image development technique which does not have the above and other disadvantages.

A further object of the invention is the provision of an improved development process, as well as development media and compositions, in which the development has the advantages of the so-called "dry" type as well as further advantages with respect to ease of treatment.

The above as well as other objects of the invention will be more readily understood from the following description of exemplifications thereof, reference being had to the accompanying drawings wherein:

Figure 1 is a perspective view of the improved color-developing material of the invention ready for use, and

Figure 2 is a side view of one technique for practicing the improved developing process of the invention.

According to the present invention the color-developing material is a hydrophilic wax-like material having a melting point between about 20 and 150 degrees centigrade and having the desired color-developing ability when molten. This composition can be carried in the form of a layer by a carrier support such as a sheet of paper and applied to an exposed sensitized diazotype copying stratum. By melting the color-developing layer, it becomes transferred to or wets the diazotype stratum by reason of its hydrophilic property and thereby causes development of the image. The development is simple and neat, and can even be effected with an ordinary household type flatiron.

As preferred examples of the novel color-developing material of the invention, wax-like hydrophilic materials have been found to be

extremely effective. By wax-like (or waxy) is meant an amorphous or microcrystalline structure and a melting point of between about 20 and 150 degrees centigrade. A hydrophilic character is defined as the property of having an affinity for water, usually accompanied by appreciable solubility in or miscibility with aqueous phases. Examples of suitable wax-like hydrophilic materials are the solid polyethylene glycols and solid alkali soaps of fatty acids, particularly those acids having from about 12 to 22 carbon atoms per molecule.

Polyethylene glycols are polymerization products of ethylene glycol. When the polymerization is extensive enough, the products are solid and quite similar to wax, being commercially known under the trade name "Carbowax." Such material by itself has no color-developing ability. However it will readily transfer to a sensitized diazotype layer when applied to it in molten condition, and when a color-developing agent is incorporated with it, will cause the development of color as desired. For best results the color-developing agent should be dissolved or dispersed in the polyethylene glycol. Sodium acetate is an effective agent for this purpose but its solubility and efficacy are increased by also including urea and water in the mixture. Urea alone is readily miscible with the polyethylene glycol when both are molten, but the color-developing ability is greatly improved by the presence of a salt of a base with a weak acid.

Without limiting the invention, one example of a highly satisfactory color developing material is as follows:

	Parts by weight
Polyethylene glycol having an average molecular weight of between about 3000 and 4000	20
Urea	15
Sodium acetate ($CH_3COONa \cdot 3H_2O$)	15
H_2O	10

The above ingredients are mixed and heated till the glycol melts and the urea and sodium acetate are completely dissolved. Upon cooling to room temperature, the mixture solidifies to a uniform wax-like product.

The mixture is exceedingly effective even when the urea and the sodium acetate content are each as low as 5 per cent by weight. The water content may be reduced to insignificance without appreciably affecting the operation. Concentration of urea and sodium acetate higher than those shown in the example may also be used, being limited only by the melting point range given above, and the loss of amorphous or wax-like characteristic. Other salts may be used in place of the sodium acetate. Thus any of the alkali metal acetates or alkali earth acetates are substantial equivalents. Other metal acetates are also suitable but not quite so effective. Instead of the acetate, the salt of a different weak acid such as oxalic, formic, propionic or other fatty acid is also effective.

When the color-developing mixture is molten, the salt of the weak acid appears to be sufficiently alkaline with or without the urea to provide vigorous development of color. This alkalinity is indicated by a pH of at least about 8 or higher, when molten. Although the development of color may be started at pH's as low as 5, the higher pH or alkalinity is needed to at least partially neutralize the excess acidity used to protect the diazotype from premature coloring.

As another example of color-developing material, the following composition has also been found to be highly satisfactory:

	Parts by weight
Sodium stearate soap	10
Urea	5

The two ingredients are melted together and stirred producing a completely miscible combination. Upon cooling, the melt solidifies to a wax-like product resembling the original soap. Where the soap is sufficiently alkaline by itself the urea may be omitted. Apparently at the elevated color-developing temperature, the urea hydrolyzes in the presence of the other materials to increase the alkalinity and the color-developing action. With other proportions of the ingredients, complete miscibility when molten may not result, but by thoroughly dispersing the two phases and then solidifying, a satisfactory color-developing material is produced. Suitable soaps are not limited to the stearates, but include all the fatty acids having between about 12 and 22 carbon atoms per molecule either saturated or unsaturated. Any alkali metal salt of such an acid is effective.

Figure 1 shows a color-developing member **10** exemplifying the invention. The member consists of a sheet **12** of porous material such as paper, and a layer **14** of wax-like hydrophilic material such as described in the examples carried by the sheet. Although shown as a coating layer, all or part of the layer **14** may be impregnated within the sheet **12**. The member is readily prepared by any standard paper-waxing or coating technique, the only changes necessary being to assure a liberal amount of the composition on the sheet. About 5 grams or more per square foot of carrier has been found very effective. The member of Figure 1 may also be made by merely dipping the sheet **12** in the molten color-developing composition, then withdrawing and cooling.

Figure 2 shows a convenient developing technique according to the invention. The sensitized and exposed diazotype paper with the diazotype coating, shown at **22**, is placed on a support **24**, the developing member **10** superimposed over it, and a hot pressing member **26** pressed down over the developing member **10**. The developing mixture rapidly melts and the color development is rapidly completed, so that the pressing member **26** can be rapidly shifted about into pressing engagement with the carrier **10** over all the portions of the image. Not more than a few seconds is needed. The developing sheet **10** may then be readily peeled away from contact with the diazotype **20** before or after cooling.

With the compositions of the invention no subsequent drying of the diazotype print is necessary. The developing material is not watery and does not have to be removed from the print even if present in substantial excess. The alkalinity at room temperature is low enough to not appreciably affect the diazotype color or the paper sheet **20**, even over prolonged periods. The polyethylene glycol-sodium acetate-urea-water mixture is especially inert.

The present invention can be used to develop diazotypes whether or not they have all the necessary coupler compounds incorporated with the sensitized stratum that is exposed to the image being copied. Thus in some types of commercial diazotypy, the sensitive stratum is prepared without couplers, and has only a light-sensitive diazonium compound such as p-diethylamino ben-

zene diazonium chloride usually in the form of a double salt with zinc chloride. A small amount of acidic material such as aluminum sulphate may also be incorporated. With such strata, the color developing compositions of the invention include one or more phenolic azo dye couplers such as phloroglucinol or resorcinol, which react with the diazonium compound when the pH is sufficiently raised, to form the intense dye color. About 1 to 5 percent of coupler compound by weight in the developer is sufficient.

Other diazonium compounds and couplers may also be used inasmuch as they can all be developed in accordance with the present invention.

A feature of the invention is the fact that the prepared developing members and mixes are quite stable and have an extremely long shelf life. Paper coated with any of the mixtures has been found to be fully as active after a year's storage, as when freshly prepared. Even developer mixes including coupler compounds are relatively stable notwithstanding some alkalinity, apparently not only because the alkalinity is low but also because the mixture is stored as a solid in which form its reactivity is low.

While several exemplifications of the invention have been indicated and described above, it will be apparent to those skilled in the art that other modifications may be made without departing from the scope of the invention, as set forth in the appended claims.

What is claimed is:

1. In a process of developing an image in a stratum by chemical reaction between a light-sensitive diazonium compound and an azo dye coupler, in an alkaline medium, the step of applying the alkali required for said developing process incorporated in a solid film of a hydrophilic, waxy material having a melting point between about 20° and about 150° C. and heating said material to cause said waxy material to melt and thereby to at least partially transfer said alkali to said stratum to react with the substances thereof to develop the image.

2. The combination as defined by claim 1 in which said waxy material is applied in the form of a coating carried by a carrier member.

3. The process as defined by claim 1 in which said alkali comprises a water-soluble salt of a strong base with a weak acid.

4. The process as defined by claim 1 in which said alkali is essentially a water-soluble alkali metal soap of a fatty acid.

5. The process as defined by claim 1 in which said alkali includes urea and a water-soluble salt of a strong base with a weak acid.

6. The process as defined by claim 1 in which the composition applied to said stratum comprises a mixture of a hydrophilic wax, water, and a water-soluble salt of a strong base and a weak acid.

7. The process as defined by claim 1 in which the composition applied to said stratum comprises a solid solution of water, a polyethylene glycol wax, urea and a water soluble salt of a strong base and a weak acid.

8. The process as defined by claim 1 in which the composition applied to said stratum comprises a solid solution of water, a polyethylene glycol wax, urea and sodium acetate.

9. In a process of developing an image in a stratum by chemical reaction between a light-sensitive diazonium compound and an azo dye coupler, in an alkaline medium, the steps of applying the alkali required for said process incorporated in a layer of a hydrophilic, waxy material having a melting point of about 20° to about 150° C., supported on a sheet of paper, and applying heat to said layer to cause it to melt and thereby to at least partially transfer said alkali to said stratum to react with the substances thereof to develop the image.

10. A process according to claim 9 in which said heat is applied by pressing said sheet of paper against said stratum with a hot member.

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