F. E. IVES.

PHOTOGRAPHIC PRINTING PROCESS.

APPLICATION FILED JULY 12, 1912.

1,121,187. Patented Dec. 15, 1914.

Fig. 2

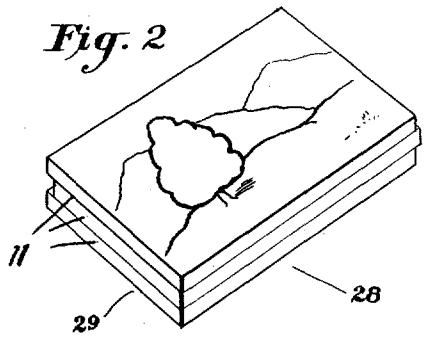


Fig. 1

Fig. 3

Fig. 4

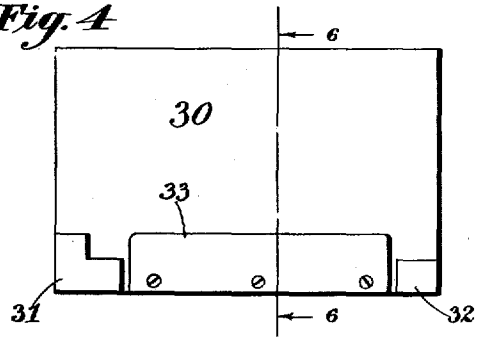
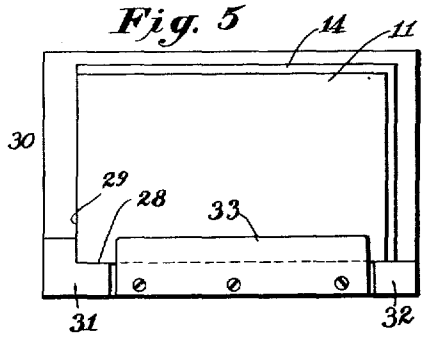


Fig. 5



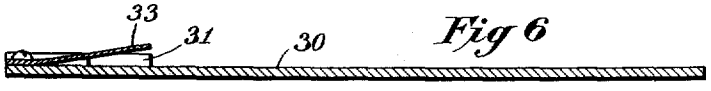
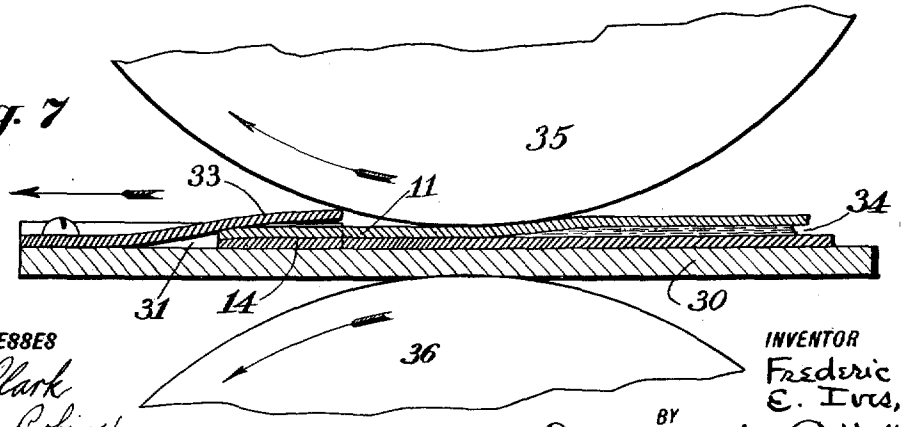


Fig 6

Fig. 7



WITNESSES

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PHOTOGRAPHIC-PRINTING PROCESS.

1,121,187. Specification of Letters Patent. Patented Dec. 15, 1914.

Application filed July 12, 1912. Serial No. 709,034.

To all whom it may concern:

Be it known that I, FREDERIC EUGENE IVES, a citizen of the United States, residing at Woodcliffe-on-Hudson, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in a Photographic-Printing Process, of which the following is a specification.

My invention relates to photographic imbibition printing and to the process thereof, hereinbelow described and set forth.

Generally speaking the objects of the present improvement are to improve known imbibition processes by improving the manner of dyeing or staining the vehicle or dye member from which the image is afterward to be imbibed into the print member, to afford a means of controlling the extent or depth of dyeing, to improve the manner of treating such dye member after applying the dye thereto, to assist and expedite the transfer of the image during imbibition and the fixing thereof in the print member, and to otherwise increase the practicability and superiority of the process of imbibition printing and the perfection and quality of the resulting print or product.

It is a further object of the present improvements to not only increase the desirability and availability of imbibition printing in photographic work generally, but also specifically color photography or the production of multi-color prints by the successive imbibitions upon a single print member of a plurality of dye images of different colors; and the present improvements, it is thought, will find their greatest utility in this latter field.

I will first describe a photographic imbibition printing process and product thereof, embodying my present improvements, and will then point out the novel features in the claims.

As a convenient starting point for a description of the present improvements, I will recite the imbibition process set forth in prior application filed by me March 9, 1912, Serial No. 682,774. According to that application a series of steps are successively performed, and they may here be recited in order as follows:

1. The dye member is first produced in any known manner that will enable it to selectively create dye images that afterward can be transferred by imbibition, for example the dye member may be made in bichromated gelatin by exposure thereof behind a photographic negative, followed by development or washing away of the unaffected gelatin in warm water. This will be capable of selective absorption because of and in proportion to the varying thickness of its gelatin surface, which is preferably in a very tenuous relief.

2. The dye member thus produced is next dyed or stained, for example by immersing it in a dye bath, after which it is dried by hanging up or otherwise.

3. A print member, as it may be called, will have been previously prepared, it being of such nature as to be capable of receiving the dye image by imbibition from the dye member, and the print member having a pervious back, for example of paper, which is preferred to be coated with a hardened and mordanted gelatin surface somewhat thicker than the gelatin of the dye member and insoluble in boiling water.

4. Then follows the assemblage of the dye member and print member face to face, they being in a dry condition, although one or both of them might be used moist in a manner explained in my aforesaid prior application. Plate pressure is to be applied to force the two members together, but means is also provided if the members are dry to permit the access of moisture thereto for the purpose of imbibition. Thus in said prior application a moist sheet or blotter wetted with non-alkaline water is placed behind the pervious backing of the print member with perhaps an interposed pervious retarding sheet so that upon the application of pressure the moisture will gradually pass through the print member into the dye member, thus opening the way to imbibition.

5. Thereupon the imbibition commences, after rather than before the application of the pressure, and the imbibition is maintained for a substantial period of pressure of several minutes.

6. The two members will then be disassembled and dried, being preferably dried before disassemblage to assist the transfer of dye, and then stripped apart.

7. If a multi-color print is to made the print member with the monochrome dye picture is then properly registered, face to face as before, with a second dye member containing a dye image of a different color,

and the imbibition process repeated. This would be kept up for as many colors as would be employed. For example, under the three color system, the successive dye images would preferably be of yellow, peacock-blue and magenta.

Having thus set forth the process of my prior application, I will proceed to detail the present improvements therein.

I will first describe that part of my improvements which, while insuring effective imbibition, precludes or practically eliminates the reverse flow of the dye from the print member, which is the final recipient of the image, either into another dye member or relief or elsewhere. This improvement may be said to be effected herein by the selection and use of dyes of a character having little or no specific affinity for gelatin, and in charging the gelatin coated print with an insoluble mordant for such selected dyes. By this improvement the dyes easily pass out of the gelatin relief member in the presence of the water used in imbibition, but entering the print are rendered insoluble by the mordant there contained.

Particularly in the making of multi-color prints by successive imbibitions, it was heretofore a difficulty that some of the dye of an image previously transferred would partly diffuse back into a subsequent dye member or relief so that the results were not perfectly definite. The degree of brilliancy of effect was apt to vary, and it sometimes became important or necessary to wash out each dye member or relief after imbibition before re-dyeing, in order to remove the absorbed dye of improper color. This latter objection added to the length and difficulty of the procedure and detracted from the reliability and constancy of the results.

By my present improvement as I prefer to carry it out, any dye which has once passed into the print member is converted into an insoluble color lake, so that none of it is likely to be absorbed by the gelatin of another dye member subsequently applied, or by anything else with which it may come in contact. It is also found that by the present improvement the transfer of color from each dyed relief to the print member is more complete, thereby rendering the results more permanent and definite.

As before stated my improvement is accomplished by employing dyes for which gelatin has little or no specific affinity, and print paper charged with an insoluble mordant for such dyes. By this improvement imbibition is expedited since the dyes readily pass out of the relief into the print. The transfer of dye may be rendered most complete by allowing the relief and the print to dry out in contact before separating them; the celluloid or collodion support of the relief being impervious to water, the evaporation must take place through the print, and this serves to carry almost the last trace of dye with the evaporating water from the relief into the surface of the print. Upon arriving at the print the dye comes in contact with the insoluble mordant and combines with it to make an insoluble color lake.

In carrying out this improvement I prefer to use certain alizarin dyes for the reason that they have no specific affinity for gelatin, but on the contrary are capable of forming insoluble lake with proper mordants, and they are moreover among the most permanent colors known. The dyes referred to will scarcely color gelatin at all in simple aqueous solutions, but by slightly acidulating the solution the dye is adequately absorbed by the gelatin relief and is thereafter readily given up in the presence of the water used in imbibition. In regard to the mordant contained in the gelatin of the print paper, this preferably should not be a soluble mordant, for example certain soluble aluminum or chrome salts, for then some of the mordant would be carried into the relief and operate to fix the color there instead of permitting its complete transfer to the print; on the contrary an insoluble mordant should be used, such for example as certain insoluble alumina and chrome mordants.

The particular dyes which I prefer to use for the production of trichromatic prints by the process of this improvement, are as follows. For peacock blue, Bayer's alizarin blue A S, 1 gram to one quart of water, with 1 gram of citric acid and 1 to 3 grams of citrate of potash. For magenta pink, equal parts of Bayer's alizarin rubinol R and rubinol 3 G, with 1 gram of citric acid and 1 to 3 grams of citrate of potash. For yellow, Bayer's sulphon yellow R, with 1 gram of citric acid and 1 to 3 grams of citrate of potash. The hardened gelatin coated print paper may be mordanted by soaking in a solution consisting of hyposulphate (thiosulphate) of soda 4 ounces, and common alum ¼ ounce, in one quart of water, freshly mixed, and the solution gradually heated up while the paper is soaking in it until it throws down a copious precipitate. The paper is then washed in several changes of water, drained and dried.

I will next describe that part of my improvements which has for its object the control of the depth of dyeing of the dye members or reliefs. This object may be said to be accomplished herein by the employment in the dye bath of a restraining agent, particularly one which may be quantitatively added to determine how much color shall be taken up by the dye member. By thus definitely controlling the depth of coloring of the dye members, I am enabled, especially in the production of trichromatic prints, to

obtain correct balance of the printing colors, and uniformity of results.

Broadly speaking the dye control of this improvement is applicable not only to an imbibition printing process as herein described, but also to the coloring of photographic reliefs for superposition, such for example as referred to in my U. S. Patent No. 980,962, patented Jan. 10, 1911. Whatever printing process may be employed, and in the case of multi-color printing whatever mode of superposition is adopted, it is true that reliability and precision depend upon dyeing to a uniform and predetermined depth of color as to each of the colors employed, so that the final or composite prints shall be correct in hue and "key" without need of recourse to subsequent re-dyeing, reduction or re-touching, which have heretofore been commonly more or less depended upon.

The particular dyes which are preferably used in order that their state of solubility may be maintained until fixed in the final transfer, will suitably color up the tenuous reliefs only when used in acid solution, and I therefore add to the dye baths a moderate amount of acetic, citric or other suitable acid. It is impossible, however, to satisfactorily regulate the amount of dye taken up by the reliefs through the quantitative alteration of the strength or acidity of the simple acidified dye solution. It is found, for example, that any considerable reduction in the acidity or strength of the solution merely renders the dyeing process very much slower without substantial change in the final result. In the course of my experiments I found that it was necessary to provide by chemical means for a quantitative balance of the attraction which the dye solvent on the one hand, and the gelatin relief on the other hand possess for the dye. I also determined that it was highly desirable that each dye bath should contain such a large amount of dissolved dye as not to become materially exhausted by continued use; otherwise frequent additions of dye would disturb the adjustment or equilibrium of the solution. I have met these conditions and problems by employing for a dye bath a quite strong dye solution sufficiently acidified to render it easily absorbable by the gelatin relief, and then quantitatively controlling the amount of dye which may be taken up in each relief by adding to the bath a controlling agent in the form of a neutral dye-solublizing salt such as citrate of potash. This enables the color strength of the dye relief to be quantitatively controlled by definite quantitative admixture of citrate of potash in the bath solution. It has even been found possible by adding sufficient quantity of dye solublizing salt to render an acid dye bath incapable of yielding to the relief more than a mere trace of the dye. To solublize a dye, as I adopt the expression, indicates to assist or maintain solution or to retard deposition thereof.

The manner of regulating the dye baths may be slightly modified within the principles above stated by putting into each dye bath a definite amount of the dye-solublizing salt and then varying quantitatively the amount of acid; for I have discovered that in the presence of the solublizing salt the acid will act to afford quantitative control in an effective way, that was not the case in the absence of the salt.

In order to insure the retention in the relief print of the correct amount of dye quantitatively introduced as above explained, each relief print upon removal from the dye bath is preferably run through an elastic roller press so as to remove the surplus or loose dye, or in lieu thereof passed through a dilute solution of acetic acid, for example a 10% solution of No. 8 acid, which removes dye adhering to the surface without dissolving out that contained in the gelatin. The former operation may be carried out by running the dyed relief fresh from the dye bath slowly through an ordinary wringer comprising opposed rubber rolls. This step is advantageous if the relief is subsequently to be contacted dry with the print member and imbibition instituted under pressure in accordance with my prior application No. 682,774, for I find that the relief comes out of the wringer "surface dry" and that it dries completely in a small fraction of the time otherwise required. I also found that during imbibition the color transfers more rapidly owing to the absence of acetic acid.

Alizarin dye baths which may be employed and controlled successfully by the mode of control above set forth have already been hereinabove referred to. Other dye baths more rapid in action but resulting in prints not so proof from fading by sunlight may be constituted as follows: For peacock-blue prints a solution of Neptune green 23 grains to one quart of water. For magenta prints, fast red D extra 15 grains and acid Rozazeine B extra 8 grains to one quart of water. For yellow prints, brilliant yellow 23 grains to one quart of water. With these dyes, in order to quantitatively control the amount of dye taken up, additions are made to the dye baths of such chemicals as acetic, citric, tartaric or oxalic acids on the one hand for increasing the depth of the color in the reliefs, or on the other hand such chemicals as ferrocyanid of potassium, acetate of soda, citrate of potash or bicarbonate of soda, to reduce the absorption of color by the relief. The colors named are acid colors and will ordinarily put too much color into the reliefs, even for use as transparencies if

the dyeing is done in simple acid baths, but this as before stated is corrected by the proper addition of a neutral salt such as neutral citrate of potash which acts to solublize the dye, and thereby reduce its action. For example a bath of Neptune green may be made slightly, but definitely acid, and then have citrate of potash added until the exact required depth of dyeing is attained, which can be regulated quantitatively within wide limits according to the percentage of the salt introduced. In this way a small introduction of citrate of potash will give the required depth for transparencies, whereas by adding a larger amount much weaker coloring is obtained suitable for viewing or superposition upon an opaque white ground. Hereinabove approximate practical proportions of the citrate are designated. In the case of a dye like brilliant yellow, which is not so susceptible to the influence of citrate of potash, bicarbonate of soda may be used as a controlling agent for increasing the weakness of prints.

The procedure thus far described for control of dyeing is found to be entirely precise and satisfactory. In the case of deterioration of the dye solutions, they of course as in the case of any other photographic solution, become unreliable owing to variations in the working strength resulting from partial exhaustion by repeated use or by evaporation if long left uncovered in open trays or otherwise. This unreliability may introduce inaccuracies in the use of the deteriorated baths. I have conceived a procedure which enables the use of the stale solutions and practically eliminates the dangers referred to as affecting ultimate results. This procedure consists in a further control afforded by the use of certain definitely constituted washing baths preferably of dilute acetic acid and of strengths calculated with reference to the required depth of dyeing. In applying this principle I have found that a 5% No. 8 acetic acid bath might slightly reduce a print of transparency strength soaked in it, but the reduction is terminated at a definite point depending exactly upon the degree of acidity of the bath. On the other hand a very much weaker acetic acid bath will cause much greater but equally definite reduction of color. My preferred plan is to dye the reliefs in dye baths which give possibly a slight excess of color followed by the use of the dilute acetic acid baths which simultaneously wash away surplus dye as described, and also reduce the depth of color slightly to the definite standard required.

This portion of my improvement is of broad applicability and susceptible of indefinite variations in its several features. It might be employed for example with basic dyes instead of acid dyes, in which case a different set of chemical salts will be required to perform the functions indicated or their equivalents.

I will next describe that part of my improvements which has for its object to assist accuracy of transfer of a dye image from a dye member to the print and preclude uneven straining of the later. This object may be said to be accomplished herein by causing a temporary separating means to be between the dye and print members during their superposition, to be thereafter removed when true contact occurs and imbibition commences. This temporary separator might consist of a variety of substances, but I prefer to employ a layer of acidulated water between the dyed relief and the print during their superposition, which is forced or caused to depart preferably by the pressure of rollers, so that the imbibition may be then begun. A solid separator such as a thin non-absorbent film of collodion might be usefully employed preferably in connection with the acidulated water and means of forcing out the water as the solid separator is mechanically extracted. Without this improvement and unless the parts are assembled dry as in my application No. 682,774, the dye in the relief print is during the act of assemblage liable to run into the water employed in the imbibition, and thereby unevenly spread upon or stain the receiving coating of the print, and is liable also to rob the relief print of some of its color before the necessary intimate contact of surfaces is obtained. This is particularly true of the extremely tenuous, and consequently comparatively strongly dyed, reliefs which it is necessary to use in order to secure continuous intimate contact upon hard gelatin print paper.

The use of acidulated water accomplishes the object specified because constituting a layer which distinctly separates the two surfaces and because of the acid character of the liquid which deters the dye from flowing. Other liquid separators would be available as equivalents, and many viscous liquids such as a syrup of dissolved sugar, which will serve to keep the surfaces sufficiently separated to avoid premature or displaced transfer. I prefer, however, the acidulated water. After the assemblage or superposition of the two members it becomes necessary to remove the acidified water layer and to secure intimate contact of the two surfaces, both of which may be done by the application of strong pressure, preferably applied by passing the contacting members between stiff elastic rollers which are forcibly pressed toward each other. The degree of pressure should be very high, and I find that for the best results the pressure should be very much greater than the ordinary pressure secured by squeegeeing. As an in-

dication or measure of the degree of pressure required, it should be such that if the gelatin of the print were unhardened and moistened, the pressure would cause it to adhere or become glued to the relief print, or if unhardened and wet to the extent of being considerably swelled, the pressure would crush and disintegrate it. My employment of hard gelatin for the surface of the print besides its other advantages overcomes these consequences of heavy pressure, and thus the procedure is entirely practical. It is a part of my improvements and of importance in the respects mentioned that the receiving gelatin for the final print is so much harder as to bear without injury a pressure of the high degree just defined. This feature is available for gelatin prints either on glass or paper. It makes a practical procedure for duplicating lantern slides without positive necessity of any mordant in the gelatin coating on the glass if it is made sufficiently thick and hard. The film on the glass is preferably to be hardened by soaking it in formalin solution and then drying it without washing. Such formalin-hardened gelatin tends to prevent undue diffusion of dye into its substance and thereby keeps the prints almost as sharp as they would be upon gelatin which is both hardened and loaded with insoluble mordant, and owing to impervious glass or celluloid being used as a backing for lantern slides, none of the dye can spread into the support as in the case of unmordanted gelatin used on a paper support. This fact indicates a possible advantage in some cases in having an impervious film of amyl acetate collodion between the gelatin coating and paper, but in practice the porosity of the paper support offers advantages in connection with the mordanted hard gelatin coating. It should be stated also that while pretty sharp prints can be made upon unmordanted hard gelatin, nevertheless the successive wetting operations necessary to secure multiple color impresisons tend to spread the contained dye perceptibly, whereby the composite images are not precisely as sharp as when the gelatin contains a suitable mordant. As a temporary liquid separator I prefer to use a 10% solution of No. 8 (that is 30%) acetic acid which possesses the necessary character.

I will next describe that part of my improvements which has for its object to assist and expedite the registration of dye members or reliefs, especially in multi-color photography, with the print member or paper, and to properly attain such registration before the actual contacting of the members. This object may be said to be accomplished herein by trimming the respective dye members in exact registry and applying them in succession to a print member laid upon a surface having gages or raised stops, against which the print and the successive reliefs will be contacted without need of attention to the images thereof. This serves to secure exact registration before there is any true contact at any part of the surface of the relief and print, and therefore no dye is allowed to pass to the receiving surface until at that later point of time when intimate contact is produced. Referring further in detail to this portion of my improvement, the preferred procedure is to first superpose the respective dyed reliefs upon each other in exact registry and then trim one or more or all, preferably two adjacent edges, in exact correspondence so that they may at any time be brought to the same register relatively to each other by placing them against a gage or raised stop upon a given surface. Having prepared such a surface, preferably flat, with raised stops for example at an end and a side, the print or paper which may be wet is laid face up against the stops. A temporary separator is then placed upon the print, and as before stated I prefer a layer of acidified water which will be flooded over the surface of the print. Then upon the top of the print a dyed relief is to be placed face down in contact with the gages or stops, care being taken not to prematurely cause pressure or intimate contact or disturbance of either member. The members will then preferably be clamped at the registered edge or edges or the corner, and the entire assemblage including plate, print and relief promptly run through the high pressure roller press, thus immediately securing intimate contact without smearing of color, and at the same time forcibly removing the temporary separator. After from three to ten minutes, the contacting members may be separated and the dye image will be found to be very perfectly transferred to, and fixed in, the coating of the print paper. The time of contact necessarily will vary according to the characters of relief and dyes used.

If it is desired to render the transfer more rapid, this may be accomplished by employing print paper which is impregnated with a dye-solublizing salt such as citrate of potash. I find that with some dyes this additional procedure is always advantageous. It even permits sometimes of the use of dyes for which the gelatin of the relief may have some substantial degree of specific affinity, though less than that of the hardened and mordanted gelatin of the print paper. The solublizing salt overcomes the tendency of such dyes to cling in the relief print.

Reference has been made to clamping the print and relief in registry, and for this purpose I prefer a spring clamp attached to the supporting plate in such manner that

upon engaging between the elastic rollers the clamp is pressed down, thus automatically clamping the edges at the instant of the commencement of the rollers' pressure upon the superposed print and relief.

The above described novel method of registration besides other obvious advantages possessed, is very much quicker and is more convenient and reliable than the visual registration heretofore practised.

I will next describe that part of my improvements which has for its object to fix the dye image in the print even more completely against subsequent wetting or soaking in water than is secured by the unaided action of the mordant contained in the coating of the print paper. In addition to the dye actually fixed by the mordant in the print paper, there is usually some dye which is held mechanically by the gelatin or which is only loosely mordanted. In order to accomplish the object of more completely fixing this dye, I prefer to transfer the print, after imbibition, to a fixing bath containing one or more, and preferably all, of the following ingredients, namely tannic acid, acetic acid, alum and acetate of calcium. After this treatment it can be hung up to dry or otherwise dried. A suitable fixing bath for the purposes hereof can be made with the following proportions, namely, water 30 ounces, No. 8 acetate acid 1 ounce, tannic acid 15 grains, alum 75 grains, acetate of calcium 10 grains. Approximate results can be obtained by omitting one or more of the ingredients mentioned, but the composition named is of great advantage and utility in that it contains all that is necessary to completely fix a great variety of dyes which have proved useful in carrying out photographic imbibition printing processes.

Another method of fixing the dye prints against the action of water consists in varnishing them with an amyl-acetate collodion varnish. This method is convenient, efficient, and offers certain advantages. Thus, prints made on a smooth mat surfaced paper can be well protected with this kind of a varnish coating so thin that it scarcely alters the appearance of the surface, or a thicker coating may be applied with the effect of producing what is technically known as a velour surface, or a still thicker coating may be used to give a high gloss surface. The same paper may thus be used to produce prints having either kind of surface that may be desired.

While I have above described a complete photographic printing process in detail, in fact in several different details, it will be understood that in general the same object is aimed at in all, and that the different parts of the present improvement constitute in effect a single process. It will also be understood that while so many details are given, the same may nevertheless be indefinitely departed from in many respects, while so followed in other respects as to retain the advantages of the latter. Therefore no limitation is intended upon the improvement hereof except as may be specified in the appended claims respectively.

While generally speaking it may be said that some of the improvements herein would have utility in the arts generally, the same have been developed in the photographic art and especially pertain thereto. Moreover, it may be said the improvements have been largely the result of endeavors to make practical and perfect a process for producing multi-color photographs, and in this aspect alone the present improvements bear an exceedingly great importance in view of the failure heretofore of other inventors to afford an available photographic process for producing multi-color prints.

A part of the hereinabove description refers to particular materials and apparatus capable of illustration. Drawings, therefore, are appended hereto in which for convenience thin dimensions are exaggerated.

In said drawings, which are merely illustrative of materials and apparatus that may be employed in carrying out the present invention, Figure 1 is an enlarged section of a carrier bearing an image in relief. Fig. 2 shows three dyed relief members trimmed at two edges. Fig. 3 is a section of the print member. Fig. 4 shows the registry plate. Fig. 5 shows the print and one relief member placed on the registry plate with liquid separator between them. Fig. 6 shows a section of the registry plate on the plane 6, 6, of Fig. 4. Fig. 7 shows the registry plate, print member and dye carrier passing through the rolls.

The dye carrier 11 has the relief 12 at its face, and the transparent backing 13. The color image is constituted by the dye absorbed into the relief 12, which varies in thickness. The print 14 consists of the colloid coating 15 on the paper backing 16.

The procedure involves first properly preparing the three dye carriers 11 to be successively registered. They may be trimmed for this purpose at the adjacent side 28 and end 29. This enables them to successively be brought to corresponding positions upon the aluminum registry plate 30, which has a gage 31 for the trimmed corner of each carrier 11, and the gage 32 for the trimmed side. The plate also has a clamp 33 beneath which may be placed the print 14, and on top of that, one of the carriers 11 with a separating layer of liquid 34, between. On now passing the plate 30 through the elastic rolls 35, 36, as shown, the clamp 33 clamps together the members 11 and 14. The action of the rolls then squeezes

out the liquid separator 34, and simultaneously brings the two members into intimate contact, so that imbibition may proceed.

Whatever method is adopted, it is understood that the three color images from the three dye carriers 11, 11, 11, are successively imbibed into the gelatin coating of the print 14, whereupon the entire picture, complete in all its colors, is reproduced.

The novel product or color-photograph print whose characteristics have been pointed out in the hereinabove description is not made the subject of claim herein but is claimed in co-pending application, Serial No. 849,007, filed July 3rd, 1914.

What I claim and desire to secure by Letters Patent is:

Character of dye and mordant.

1. The process of photographic imbibition printing comprising the dyeing of a dye member with dye of a character having substantially no specific affinity for gelatin and thereafter transferring the dye image so formed by imbibition to a gelatin coated print member charged with an insoluble mordant for such dye.

2. The process of photographic imbibition printing comprising the dyeing of a dye member with dye of a character having substantially no specific affinity for gelatin and thereafter transferring the dye image so formed by imbibition to a gelatin coated print member charged with a mordant of a character capable of converting such dye into an insoluble color lake.

3. The process of photographic imbibition printing comprising the dyeing of a dye member with an acid dye and thereafter transferring the dye image so formed by imbibition to a gelatin coated print member charged with a mordant of a character capable of converting such dye into an insoluble color lake.

4. The process of photographic imbibition printing comprising the dyeing of a dye member with an acid dye of a character having substantially no specific affinity for gelatin and thereafter transferring the dye image so formed by imbibition to a gelatin coated print member charged with a mordant of a character capable of converting such dye into an insoluble color lake.

5. The process of photographic imbibition printing comprising the dyeing of a dye member with a dye of a character having substantially no specific affinity for gelatin and thereafter transferring the dye image so formed by imbibition to a gelatin coated print member having a pervious back and charged with an insoluble mordant for such dye, and permitting the two members to substantially dry out while in mutual contact.

6. The imbibition process of making multi-color photographic prints comprising the dyeing each of a plurality of the dye members with dye of a character having substantially no specific affinity for gelatin, and thereafter successively and in registry transferring the respective dye images so formed by imbibition to a gelatin coated print member charged with an insoluble mordant for the dyes used.

7. The imbibition process of making multi-color photographic prints comprising the dyeing each of a plurality of dye members with an acid dye, and thereafter successively and in registry transferring the respective dye images so formed by imbibition to a gelatin coated print member charged with an insoluble mordant for the dyes used.

8. The method of making photographic prints from colloid photograph reliefs consisting in dyeing such reliefs with dyes of such character as to be capable of rapidly washing out of the relief in plain water, and then transferring the soluble dye image by imbibition into a print surface of gelatin so mordanted as to insolubly fix the dye as it receives it.

9. The method of making multi-color photographic prints from colloid photograph reliefs consisting in dyeing such reliefs with dyes of such character as to be capable of rapidly washing out of the relief in plain water, and then transferring the soluble dye images successively by imbibition into a print surface of gelatin so mordanted as to insolubly fix each successive dye image as it receives it.

Control of dye.

10. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in a color bath, controlling the action of such color bath by a dye controlling agent incorporated in the bath, and subsequently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

11. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in a color bath, controlling the action of such color bath by a dye solublizing agent quantitatively incorporated in the bath, and subsequently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

12. In the art of color photography the

method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in an acid or acidified color bath, controlling the action of such color bath by a dye solublizing agent quantitatively incorporated in the bath, and subsequently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

13. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in a color bath, controlling the action of such color bath by a dye solublizing agent quantitatively incorporated in the bath, removing surface dye by washing the dyed member in a dilute acid solution and subsequently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

14. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in a color bath, controlling the action of such color bath by a neutral dye solublizing agent quantitatively incorporated in the bath, together with a quantitative addition of a deposition assisting agent or acid, and subsequently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

15. The process of making photographic prints comprising the dyeing op a photographically prepared colloid member in a dye bath controlled definitely in action by means of a dye solublizing agent quantitatively added thereto, and subsequently washing the member in dilute acid to remove surface dye.

16. The process of making photographic prints comprising the dyeing of a photographically prepared colloid member in a dye bath controlled in action by means of a dye solubilizing agent added thereto, and subsequently washing in a bath in which quantitative presence of acid definitely controls the ultimate depth of color.

17. The process of making photographic prints comprising the dyeing of a photographically prepared colloid member in a dye bath controlled in action by means of a neutral dye solublizing agent added thereto, together with a quantitative addition of acid.

18. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in a color bath strong with dye and slightly acidified, controlling the action of such color bath by a dye solublizing agent incorporated in definite amount in the bath, and subsequently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

19. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing a positive colloid member from one of such negatives, dyeing the same in a color bath strong with dye and slightly acidified, controlling the action of such color bath by a neutral dye solublizing agent such as citrate of potash incorporated in definite amount in the bath, and subseqently combining the color image selectively so produced with a color image of another color produced from another of such negatives.

20. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing a positive colloid member from such negative, dyeing such positive in a color bath, and controlling the action of such color bath by a dye solublizing agent incorporated quantitatively in the bath.

21. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing from one of such negatives a positive colloid relief to serve as a temporary dye carrier, immersing said carrier in a color bath whereby a dye image is produced by selective absorption, controlling the action of such color bath by a suitable dye controlling agent incorporated in the bath, and subsequently transferring the color image by imbibition to the final print and combining it with an image of another color produced from another of such negatives.

22. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photograhpically preparing from each of a plurality of such negatives a positive colloid relief to serve as a temporary dye carrier, immersing said carriers in color baths of different colors whereby dye images are produced by selective absorption, controlling the action of each color bath by a suitable dye controlling agent incorporated in the bath, and sub-

sequently transferring the several color images by imbibition to a single gelatin-coated opaque-black print.

23. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing from one of such negatives a positive colloid relief to serve as a temporary dye carrier, immersing said carrier in a color bath whereby a dye image is produced by selective absorption, controlling the action of such color bath by a suitable dye solublizing agent quantitatively incorporated in the bath, and subsequently transferring the color image by imbibition to the final print and combining it with an image of another color produced from another of such negatives.

24. In the art of color photography the method of making multi-color prints from a set of color-selection negatives comprising the following steps: photographically preparing from one of such negatives a positive colloid relief to serve as a temporary dye carrier, immersing said carrier in an acid color bath whereby a dye image is produced by selective absorption, controlling the action of such color bath by a suitable neutral dye solublizing agent, quantitatively incorporated in the bath, and subsequently transferring the color image by imbibition to the final print and combining it with an image of another color produced from another of such negatives.

Temporary separator.

25. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing a dye member from such negative, dyeing the same in a color bath to produce a color image, introducing a temporary imbibition-preventing separating means between said dye member and a print member, applying said members to each other while imbibition is so prevented, and thereafter causing the removal of said temporary means, and the imbibition of the dye image from the dye member into the print member, while preventing relative movement between the two members.

26. In the art of color photography the method of making a multi-color print from a plurality of color selection negatives comprising the following steps: preparing a print in one of the colors by one of said negatives, photographically preparing a dye member from another negative, dyeing said dye member in a color bath to produce a color image, introducing a temporary imbibition-preventing separating means between said dye member and said print member, applying said members to each other and registering them while imbibition is so prevented, and thereafter causing the removal of said temporary means and the imbibition of the dye image from the dye member into the print member, while preventing relative movement between the two members, whereby a plurality of color images are combined in a single print.

27. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing a dye member from such negative, dyeing the same in a color bath to produce a color image, introducing a layer of imbibition-preventing liquid between said dye member and a print member, applying said members to each other while imbibition is so prevented, and thereafter causing the removal of said liquid layer, and the imbibition of the dye image from the dye member into the print member, while preventing relative movement between the two members.

28. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing a dye member from such negative, dyeing the same in a color bath to produce a color image, introducing a layer of imbibition-preventing liquid comprising acidulated water between said dye member and a print member, applying said members to each other while imbibition is so prevented, and thereafter causing the removal of said liquid layer, and the imbibition of the dye image from the dye member into the print member, while preventing relative movement between the two members.

29. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing a dye member from such negative, dyeing the same in a color bath to produce a color image, introducing a layer of imbibition-preventing liquid between said dye member and a print member, applying said members to each other while imbibition is so prevented, and thereafter causing the removal of said liquid layer, by an advancing or rolling pressure, which secures intimate contact and thereby starts the imbibition.

30. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing a dye member from such negative, dyeing the same in a color bath to produce a color image, introducing a layer of imbibition-preventing liquid between said dye member and a print member having a hardened gelatin surface, applying said members to each other while

imbibition is so prevented, and thereafter causing the removal of said liquid layer, by an advancing or rolling pressure, which secures intimate contact and thereby starts the imbibition, such pressure being of such high degree as would disintegrate the gelatin of the print member if unhardened.

Relation of gelatin to pressure.

31. In the art of photography the method of making color prints from photographic negatives comprising the following steps: photographically preparing from such negative a positive colloid relief adapted to serve as a dye carrier, immersing the same in a color bath whereby it absorbs color selectively to form a dye image, introducing a temporary imbibition-preventing separating means between the said dye carrier member and a suitable print member, applying said members to each other while imbibition is prevented by said separating means, and thereafter causing the removal of said separating means and the imbibition of the dye image from the dye carrier into the print member while preventing relative movement between the two members.

32. In the art of color photography the method of making a multi-color print from a plurality of color-selection photographic negatives, comprising the following steps: photographically preparing from each of a plurality of such negatives a positive colloid relief adapted to serve as a dye carrier, immersing each relief member in a color bath whereby it absorbs color selectively to form a dye image, introducing a temporary imbibition-preventing separating means between the said dye carrier member and a gelatin coated print member, registering said members while imbibition is prevented by said separating means, and thereafter causing the removal of said separating means and the imbibition of the dye image from the dye carrier into the print member while preventing relative movement between the two members, whereby a plurality of color images are combined in a single print.

33. In the art of color photography the method of making a multi-color print from a plurality of color-selection photographic negatives, comprising the following steps: photographically preparing from each of a plurality of such negatives a positive colloid relief adapted to serve as a dye carrier, immersing each relief member in a color bath whereby it absorbs color selectively to form a dye image, introducing a temporary imbibition-preventing liquid layer between the said dye carrier member and a gelatin coated print member, registering said members while imbibition is prevented by said liquid layer, and thereafter causing the removal of said liquid layer and the imbibition of the dye image from the dye carrier into the print member while preventing relative movement between the two members, whereby a plurality of color images are combined in a single print.

Mode of registry.

34. In the art of color photography the method of making a multi-color print from a set of color-selection negatives comprising the following steps: photographically preparing a plurality of dye-members from said negatives, dyeing said dye members to produce color images by selective absorption, trimming said dye members in exact registry, applying the dyed members successively face to face against a print member with a temporary imbibition preventing separator between the members, gaging the position of each dye member by means of the trimmed part thereof, causing said separator to be removed, and causing imbibition to proceed; whereby the several color images are transferred in registry to the common print member.

35. In the art of color photography the method of making a multi-color print from a set of color-selection negatives comprising the following steps: photographically preparing a plurality of dye-members from said negatives, dyeing said dye members to produce color images by selective absorption, trimming said dye members in exact registry, applying the dyed members successively face to face against a print member with an imbibition-preventing liquid as acidulated water between the members, gaging the position of each dye member by means of the trimmed part thereof, and causing the removal of such liquid by an advancing or rolling pressure which secures intimate contact thereby causing imbibition to proceed; whereby the several color images are transferred in registry to the common print member.

Facilitating imbibition.

36. In the art of photography the method of making color prints from photographically prepared dye members comprising the application face to face in the presence of moisture of a dye member and a print member whose receiving surface is impregnated with a dye solubilizing agent such as citrate of potash together with a mordant, and maintaining said two members in intimate face contact during the imbibition of dye from the dye member to the print member.

Color fixation.

37. In the art of photography the method of making a color print, from a photographically prepared dye member comprising the

transfer by imbibition of a dye image from the dye member, or dye images from different dye members, to a print member, followed by fixation of the imbibed images in the print member to protect the color against displacement or removal, by finally applying a coating of amyl-acetate collodion.

In testimony whereof I affix my signature in presence of two witnesses.

FREDERIC EUGENE IVES.

Witnesses:
EDWARD LEMBERGER,
ELIZABETH B. KING.

Corrections in Letters Patent No. 1,121,187.

It is hereby certified that in Letters Patent No. 1,121,187, granted December 15, 1914, upon the application of Frederic Eugene Ives, of Woodcliffe-on-Hudson, New Jersey, for an improvement in "Photographic-Printing Processes," errors appear in the printed specification requiring correction as follows: Page 2, line 77, for the word "lake" read *lakes;* page 4, line 73, for the words "straining of the later" read *staining of the latter;* same page, line 116, for the word "displaced" read *misplaced;* page 5, line 47, for the word "impresisons" read *impressions;* same page, line 112, for the word "relief" read *reliefs;* page 7, line 68, before the word "dye" strike out the article "the"; page 10, strike out line 8; 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 9th day of March, A. D., 1915.

[SEAL.]

J. T. NEWTON,

Acting Commissioner of Patents.