

Nov. 13, 1956

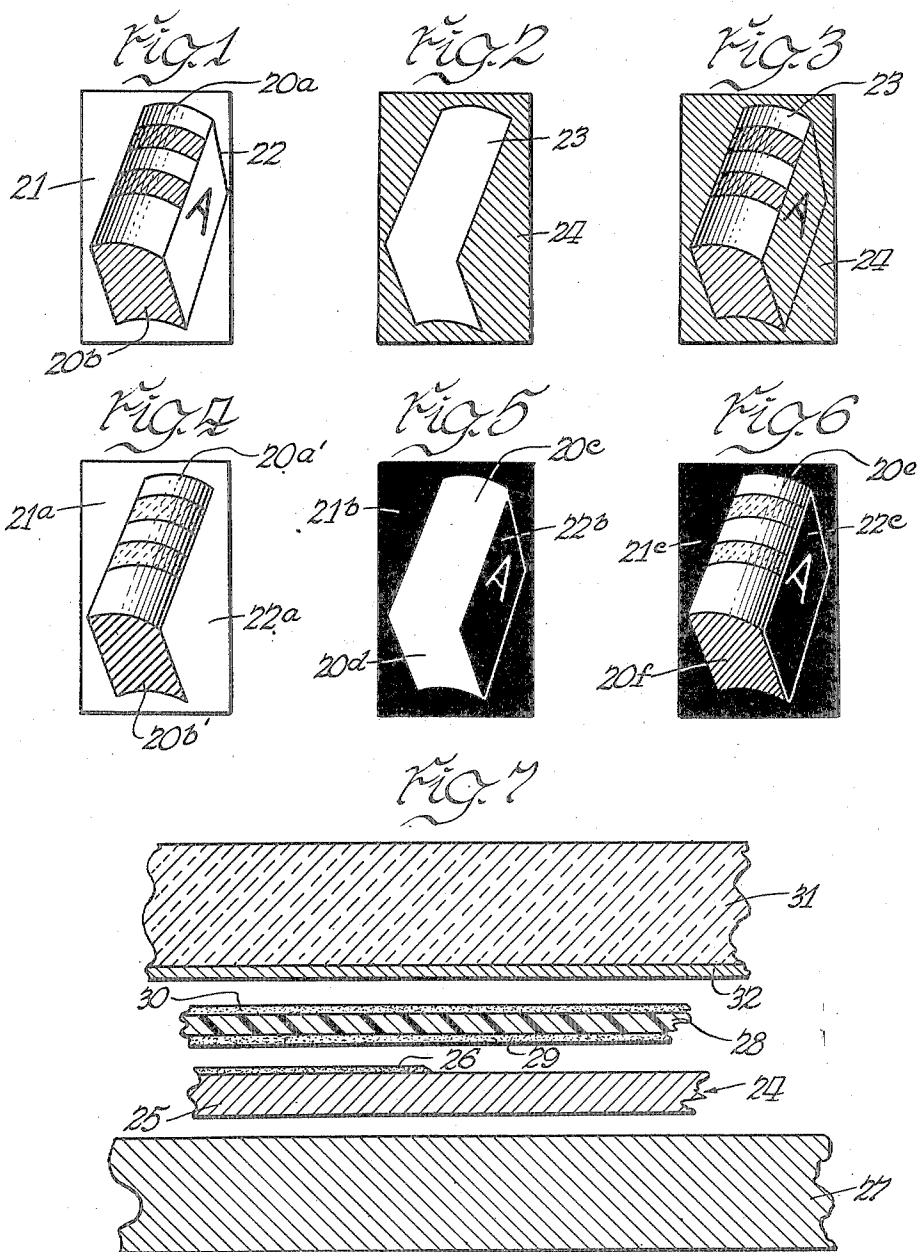
W. S. MARX, JR

2,770,534

METHOD AND MATERIAL FOR MAKING OVERLAY MASKS

Filed May 10, 1953

2 Sheets-Sheet 1



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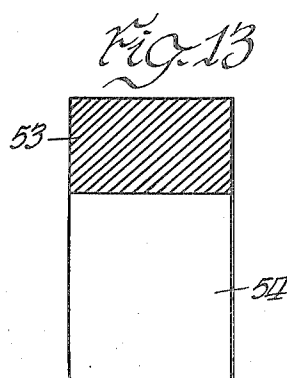
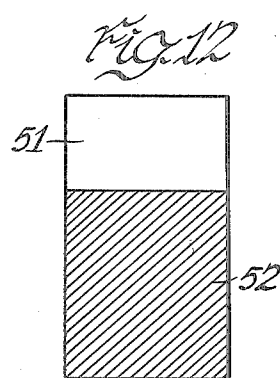
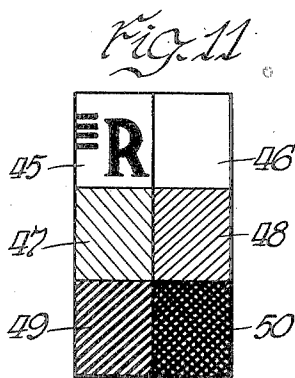
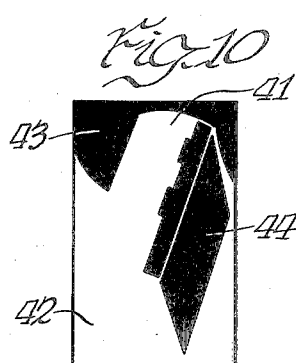
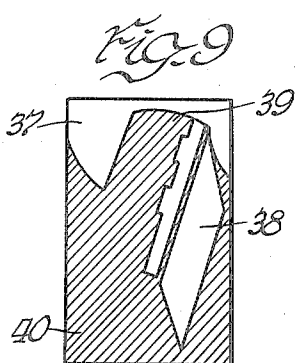
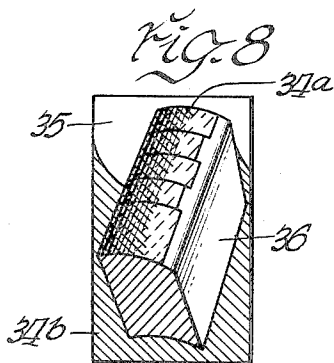
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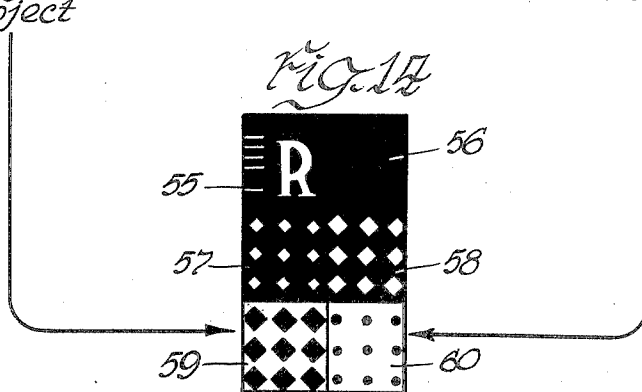
2 Sheets-Sheet 2



Original Subject

Matrix

Mask



Negative

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1

2,770,534

METHOD AND MATERIAL FOR MAKING OVERLAY MASKS

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Application May 10, 1953, Serial No. 356,285

9 Claims. (Cl. 41—41)

This invention relates to a method and material for making overlay masks adapted to use in the production of relief-printing and lithographic plates, and more particularly to a method and material for producing such masks without manual tracing, painting or cutting operations, or the like; it being understood that such masks have use in the establishment of highlight, line and solid areas free of pattern when the copy includes tone areas.

This application is related to my copending application, Serial No. 81,765, filed March 16, 1949, now U. S. Patent No. 2,687,949, for Method and Material for Making Overlay Masks and the Like. In many respects the ultimate results accomplished by the methods and materials of this and my aforementioned copending application are the same, but the method and materials of this application are considered to have certain differentiating characteristics and advantages which will be pointed out and described.

In one of its broader aspects, an object of this invention, like that disclosed in my aforementioned copending application, is to provide a method and material by which the making of overlay masks for use in producing combination line and halftone negatives or highlight halftone negatives, of the type utilized in the manufacture of relief-printing and lithographic and gravure plates, is rendered practically automatic.

More specifically, this invention has within its purview the provision of a method and materials for producing overlay masks directly from art copy by chemical action which occurs with only the normal moisture present in the art copy and materials, and with the aid of heat for accelerating the action for production purposes.

As another object, my invention comprehends the provision of a method and materials for producing overlay masks directly from art copy by chemical action and whereby visual observation affords an indication of the completion of the required action for the production of a mask of the required characteristics from given art copy.

My invention further has within its purview the provision of a method and materials for producing overlay masks directly from art copy by chemical action and which enables the artist producing the art copy to use the materials with which he is accustomed to working throughout all of such art copy, except for the highlights which are minor in relative area, and, being white, require no color-blending or similarly difficult application.

By this invention, I have provided a method and materials for making overlay masks from art copy by chemical action and which do not require special conditions for the storage of the materials, such as elevated humidity.

Further, this invention provides a method and materials for the production of overlay masks directly from art copy by chemical action and whereby more than one mask, if desired, may be made from the same art copy.

I have provided, by this invention, a method and materials for the production of overlay masks directly from art copy by chemical action and in a manner such that a color changing reaction is effected by rendering the color

2

change producing material active and mobile or transitive by the aid of mild heat, as by volatilization, vaporization or sublimation to produce a color-change producing material from inert substance initially incorporated in selected areas of the art copy and chemically reactive with substances contained in the mask material, said chemical reaction being accelerated by heat.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings in which similar characters of reference indicate similar parts throughout the several views.

In photomechanical reproduction of art copy, which includes tone areas as well as line and type areas, it has been customary to prepare negatives by one or a combination of the following four processes:

I. Negative stripping.—In this process two negatives were made, one halftone negative, screened throughout its entire area; and second, a line negative, unscreened throughout its entire area. These two negatives were temporarily superimposed one over the other, and a sharp blade used to cut imagewise through both in such a way as to permit the insertion of line sections and the removal of corresponding halftone sections in proper positions to make a composite negative. This method required hand work throughout, and was very time-consuming where complicated subjects were involved.

II. Double printing.—Two negatives were made as in the preceding instance. The line negative was painted opaque in these sections corresponding to the tone areas of the original, and then successively printed in register with the image from the halftone negative, similarly opaqued in its line areas, on one metal plate.

III. Masking method.—The original art subject was temporarily covered with a sheet of clear plastic. Upon that plastic sheet, and in correct position over the line areas of the subject, an opaque pigment was applied to obscure all those parts to be reproduced free of screen pattern. This was called a "line mask." Another "tone mask" was then made to similarly obscure all areas to be reproduced in half tone. It was necessary to make these masks very carefully to register exactly one with the other, and each with the original subject. In photography of the so masked original, one exposure was made with the line mask in register over the subject and a halftone screen in the camera so as to record those sections to be reproduced in tone or various shades of gray; a second exposure was made with the screen removed, the line mask removed, and the tone mask in register over the subject, to record the unscreened sections (lines, type, background, and highlights) on the same negative, in register with the tone image.

IV. Light differentiation method.—Combination line and halftone negatives by this method which comprises the subject matter of my U. S. Letters Patent No. 2,191,939, entitled "Photoengraving" and issued February 27, 1940, were made in a manner somewhat similar to that described in III, above, except that no tone mask was required. Original subjects prepared by light differentiation process are strongly absorptive of ultraviolet light in the tone areas. Thus when such subjects were photographed through a visually opaque ultraviolet-transmitting filter, all tone areas were photographically retarded just as though a mask had been hand-made to cover those areas. However, the line mask has still to be made by hand.

As distinguished from the processes which have been briefly referred to, this invention provides for the production of both the tone and line masks automatically, so that all hand work is eliminated. Thus, through this process both line mask and tone mask are now available for the printing and lithographic and gravure processes at an enormous saving in time, and with the increased

3

accuracy provided by mechanical means over manual means. For the purpose of this description, I refer throughout to:

"Color" or to "Coloring Matter" as having the commonly accepted meaning as considered in the physical sciences, with the spectrum as a basis, and without the limitations imposed by physiological or visual concepts, whereby discernible spectral energy absorption characteristics and changes occurring between wavelengths of 300 and 1200 millimicrons are included in the concepts concerned with this invention.

"Tone" or "Tone Areas," as those areas of a drawing, illustration, or picture, having a value other than white, and in contradistinction to white areas containing lines or type. Or, more specifically, as those areas of a subject or of an image of that subject, which, in current general printing practice, are reproduced in halftone screen pattern.

"Line" or "Line Areas," as those areas of a drawing, illustration, or picture, having one or a series of relatively small solidly-colored configurations such as type characters, pen, pencil or other lines or points upon an area or background effectually white in value. Or, more specifically, as those areas of a subject or of an image of that subject, which, in current general printing practice, are reproduced free of half tone screen pattern.

"Mask," a transparent or translucent covering for a subject to be reproduced, or for a facsimile of that subject, such covering having some photographically opaque area, or area capable of modification to or from photographic opacity, so as to divide the image of that subject into two or more separately recordable regions.

The method of this invention comprises the transfer of a reactive material from an image-defining part of an original subject (such as a wash-drawing, commonly used as art copy in newspaper display advertising) to a masking sheet which is to be superimposed over that subject during the photographic step incident to manufacture of a printing plate. The material, thus transferred, reacts with color in the masking sheet so as to alter that color in a corresponding image-defining area, to form an outline facsimile of the original subject. Substance to yield such reactive material may be imparted to a previously completed original drawing or subject by hand in an additional operation, but it is ordinarily preferable, in order to avoid such a step, to include that material in and as part of the pigment used initially to render the drawing.

A translucent layer of, for example, a triphenylmethane type dye is coated on one face of a transparent plastic sheet. That layer is then placed in close contact with an original subject which bears one or more compounds which in whole or in part are rendered mobile or transitive when heated, as for example compounds which decompose when heated to form a reducing agent, or a readily vaporizable, volatilizable or sublimable reducing agent in its tone areas only. Upon being heated to accelerate the reaction, the reducing agent is produced by decomposition on the surface of that subject, or is volatilized, vaporized or sublimed and thus transferred in an active gaseous state to the dye layer during contact with that dye layer, and immediately reduces the dye to its colorless leuco form, discharging all color from the reacted sections (tone areas) of the layer. The dye remains in its colored, unreduced, form throughout unreacted sections of the layer corresponding to the line areas of the original subject.

Thus, when a mask so made is photographed in register with the original, unhindered photography of the tone areas is permitted through the corresponding clear areas of the mask, while photography in the non-tone areas is retarded by unreduced triphenylmethane dye in the mask.

A drawing to be reproduced is made on ordinary illustration board or paper using conventional pigments;

4

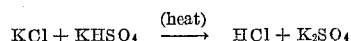
or, optionally, a photograph is retouched using ordinary retouching pigments which are usually opaque water-colors. In either instance, the technique is the same. Those areas of the drawing or photograph wherein all screen pattern is to be removed in a subsequently made halftone printing plate, are then covered with a specially mixed pigment containing, for example, ortho-chlorobenzoic acid in a concentration of about ten to twenty percent by weight, depending upon the porosity of the pigment binder.

As a vehicle for the color of the masking sheet of this invention, it is preferable to use a colloid, such as gelatin or agar. Other non-hydrophilic vehicles may also be used so long as the coloring matter embodied therein retains its susceptibility to change by chemical or other means. For instance, it may be advantageous to disperse color through a layer of Pyralin cellulose nitrate which gelatinizes in acetone. An effective inert generator of volatilizable, vaporizable or sublimable color-altering compound would then be incorporated in the color layer by contact, in a manner similar to the method used for the other described systems.

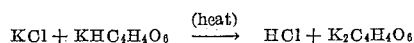
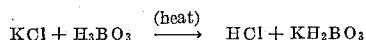
For convenience, the layer of color and vehicle may be coated upon a support film or sheet, and stored in rolls. The masking sheet may be kept from curling by coating its back surface with a layer of material of which the reactions with respect to thermal or atmospheric changes are similar to those of the color-and-vehicle layer.

Heat-activated color changes, of the type contemplated by this invention, can be produced in acid-base "indicator" type compounds by aromatic carboxylic acids and their derivatives, such as benzoic acid, the chlorobenzoic acids, toluic acids, and the like. Also useful are oxalic acid, and acidic compounds which, when heated, combine to yield acids. The basis of the latter acid generating process is the reaction between a salt of a volatile acid and a solid acid of lower volatility. Such a reaction occurs at an appreciable rate only by the application of heat.

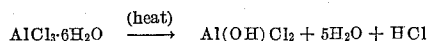
For example, potassium chloride is the salt of the volatile acid, hydrogen chloride. Potassium bisulphate is the solid acid derived from the less volatile sulphuric acid. A mixture of the substances is stable for an indefinite period at normal room temperature. Upon application of heat, however, hydrogen chloride is liberated, as indicated by the equation:



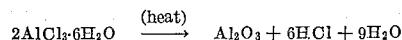
Boric acid or sodium bitartrate may be substituted for the potassium bisulphate in the stated reaction, and will yield hydrogen chloride, as follows:



Another mechanism for the production of a volatile acid, such as hydrogen chloride, is the thermal decomposition of a hydrate salt of such an acid which is capable of hydrolysis. Aluminum chloride hexahydrate is such a salt. Upon heating it undergoes a reaction which, in the first step, is probably:



This process passes through successive similar reactions which together yield the following overall equation:



The aforementioned materials, or others having a similar acidic reaction when heated, are suitable to the purposes of this invention when used according to the following examples of a preferred embodiment.

The numerous variations for using the method and materials of this invention fall generally into three pri-

mary alternatives, to which further variations are considered to be either corollary or secondary. For the purposes of summarizing, the variations are simplified by considering the tone areas of a subject or its image as one phase of the photo-mechanical function, and the line areas, similarly, as another phase. With this concept in mind, the photographic isolation of each phase is established by using one of the following:

(1) A mask to retard photography of one phase, and the original subject itself to retard photography of the other phase:

For this purpose I utilize, as a preferred combination, copy which absorbs ultra-violet light in its tone areas, and also contains in those tone areas a reducing agent subject to activation by heat, such as beta methyl umbelliferone as the ultra-violet absorbent, and morpholine with sodium sulfite and/or sodium hydrosulfite which probably decompose to yield SO_2 as the reducing agent. Morpholine is the volatile base which keeps beta methyl umbelliferone in its basic and light-absorbing condition and assists volatilization of the afore-mentioned SO_2 from the sulfite salts. In this instance, the overlay mask contains fuchsine as the color changeable compound. Fuchsine becomes colorless, as do triphenylmethane dyes, when reduced. During photography, a Wratten No. 12 (yellow) filter is used for the halftone exposure. An ultra-violet transmitting filter is used for the line exposure, at which time the fuchsine mask is preferably removed, but may remain in position since fuchsine transmits long-wave ultra-violet light quite readily.

(2) A mask to retard photography of both phases alternately:

For this purpose, I utilize an indicator dye, such as brom phenol blue in the overlay mask, as the color changeable compound. It becomes deep blue when basic (at pH 4.6 or above), and is bright yellow at pH 3.0 or below. The art copy, in this instance, contains an inert substance which is subject to activation by heat, such as ammonium oxalate, to produce a basic substance in gaseous form, namely ammonia, in its tone areas. In use, the overlay mask containing brom phenol blue in its acid condition is taped at one edge to the art copy and ammonium oxalate from the tone areas of the copy is activated by heat (at about $95^\circ\text{C}.$) to convert the normally acid mask (yellow) to the basic (blue) condition in those areas of the mask adjacent the tone areas of the art copy. Photography, in this instance, is accomplished with the use of a Wratten No. 34A (purple) filter during the halftone exposure, and a Wratten No. 12 (yellow) filter during the line exposure. The currently used high speed halftone stripping films are used with mercury vapor lights for illumination, and the mask is not removed during the photography.

(3) A mask to retard photography of one phase:

For this purpose, I utilize the following impregnating solution which is either mixed with the gelatin layer of the mask sheet before coating or applied to such gelatin layer after the support material is coated therewith:

	Percent by weight
5% sodium hydroxide in water	10.00
Beta methyl umbelliferone	1.40
Water	86.45
Brom thymol blue (indicator) (Dibromthymol sulfonphthalein)	0.15
Glycerine	2.00

In this formula, beta methyl umbelliferone provides the essential "color." The compound itself appears colorless, but since it is a strong absorber of ultra-violet light and near ultra-violet light in the wavelength range of 350 to 400 millimicrons, it serves, according to the stated definition of "color" as a true color for the purposes of this invention. The beta methyl umbelliferone, on the

other hand, does not appreciably absorb any wavelength of light when it is made acid. The sodium hydroxide, in the foregoing formula, keeps the beta methyl umbelliferone in its (alkaline) light-absorbing condition until that sodium hydroxide is neutralized. For this purpose, I utilize the aforementioned ortho chlorobenzoic acid in the pigment of the art copy. The color-changing reaction takes place when the art copy is heated to between $75^\circ\text{C}.$ and $100^\circ\text{C}.$ while the art copy and the mask sheet are in contact. Ortho chlorobenzoic acid, in addition to neutralizing the sodium hydroxide, reacts with the beta methyl umbelliferone to neutralize and acidify it to its non-light-absorbing or colorless form. Beta-methyl umbelliferone is hydroxy-methyl coumarin of which the $-\text{OH}$ group is subject to neutralizing reaction with alkaline agents, such as sodium hydroxide, to form the phenate salt. In changing from the free $-\text{OH}$ group to the salt form thereof, the response of the compound to light within certain wave lengths changes markedly, the salt formed being highly absorptive of certain ultraviolet wave lengths and hence fluorescent, while the free phenolic form of said compound is substantially colorless and non-fluorescent at said same wave lengths. As a result, any layer containing the beta-methyl umbelliferone may be made to change its light absorption and its light-transmittancy by changing the pH in a manner to effect the $-\text{OH}$ group, or its salt form, or a mixture of the two in the layer.

In the foregoing formula, the brom thymol blue indicator is added merely as a visual tracer to show visually when, in the course of the heating, the beta methyl umbelliferone has been entirely acidified, so that the desired conversion of the mask has been completed. The brom thymol blue and beta methyl umbelliferone both change color at approximately the same value on the pH scale. That is, at a pH value higher than 7.6, the beta methyl umbelliferone becomes absorptive of ultra-violet light, and brom thymol blue has a visual appearance of being blue in color. At pH values lower than 6.0, beta methyl umbelliferone becomes non-absorptive of ultra-violet light and effectively colorless and will not fluoresce when subjected to ultra-violet or near ultra-violet light, while brom thymol blue appears visually to be yellow.

The visible blue and yellow colors in an overlay mask made by the foregoing formula are quite weak. Thus, the mask need not be removed from the drawing or retouched photograph comprising the art copy when the halftone negative is made. Halftone exposures, slightly increased in time, may be made through the mask. Screen pattern is removed from areas of the reproduction by removing the halftone screen from the camera, inserting a filter (at the lens or at any other convenient place between the light source and negative), which filter is opaque to visible light and transparent to ultra-violet light in the wavelength range from 350 to 400 millimicrons. During this exposure, the negative is not affected by any parts of the image except those wherein the ortho chlorobenzoic acid had been applied to the art copy. The basic or unconverted sodium salt of the beta methyl umbelliferone absorbs all of the light passed by the ultra-violet transmitting filter. The parts of the image on the overlay mask sheet having the acidic or converted form of the beta-methyl umbelliferone are no longer absorptive of ultra-violet light. Thus, ultra-violet light from the illuminating source freely penetrates converted areas of the overlay mask and is reflected into the camera by the pigment of art copy immediately beneath those converted areas.

It is to be understood in connection with the foregoing examples that selectively usable actinic light bands have been chosen, and that others may be used without departing from my invention.

In each of the foregoing illustrative and preferred examples, the overlay mask sheet, made as specified, is, by preference, taped face down over the entire area of draw-

ing to be reproduced. This "sandwich" combination of the art copy and overlay mask sheet is then placed with the drawing facing upwardly on a flat supporting surface. When thus disposed, the "sandwich" combination is covered by a surface distributed and substantially flat heating element having its temperature regulated to about 75° C. to 100° C., and preferably 90° C. to 95° C. Light contact between the art copy and the superimposed sheet is sufficient to allow the vaporized, volatilized or sublimed material from the art copy to produce a clearly defined image where color conversion is to be made in the treated layer of the mask sheet. Such conversion, by the method and with materials herein disclosed, is completed in a period of from fifteen seconds to three or four minutes.

It is quite obvious that the use of other color-changing mechanisms, when utilized for the herein described purpose, are clearly within the scope of the invention. For example, when an acid-base "indicator" type of compound, such as brom phenol blue, is used in the overlay mask in an acid condition, then alkaline materials, such as ammonium carbonate, triisopropanolamine, ammonium oxalate and other compounds which, when heated, sublime, vaporize or decompose to yield alkaline gas capable of converting such acid-base indicators to the alkaline color or condition, may be employed.

Similarly, colored substances which are affected by reducing agents produce a color change which falls clearly within the scope of this invention when utilized for the purposes herein described. For example, the aforementioned triphenylmethane dyes are reduced when combination of morpholine and sodium sulfite or combination of morpholine and sodium hydrosulfite applied to the art copy is heated to approximately 95° C. By similar processes, leuco or colorless triphenylmethanes are oxidized by chlorine produced by the application of heat to a mixture of potassium bromate and sodium chloride, acidified to a pH between 2.5 and 4.0 with a weak organic acid such as potassium acid phthalate or primary potassium citrate. At a pH higher than that range the oxidation potential of the bromate is insufficient to produce chlorine from the chloride. At a pH lower than that range the oxidation potential is so great as to liberate chlorine without the application of heat.

Although the preferred manner of producing my mask is by direct contact of the mask sheet with the art copy for locally discoloring or changing the color in areas of the color layer on the mask sheet the results may, if desired, be accomplished through the use of a separate matrix sheet to transport the color-altering material from the original subject to the color layer. For instance, the original subject, bearing a vaporizable, decomposable or sublimable substance (e. g., benzoic acid) in its tone areas, is brought into contact with a porous matrix layer (e. g., paper) and heated so that a sufficient quantity of the substance is decomposed, vaporized, sublimed, or otherwise forced into that absorbent layer. The layer so treated may then be considered as a transfer matrix which is in turn brought into contact with a color layer (e. g., an acid-base indicator dye in gelatin) of a mask sheet and heated in such a way that the acid is permitted to react with the color as described. By this procedure, the color layer is never in contact with the original subject, thereby avoiding any risk of possible migration of color to the subject itself.

A variation on this separate matrix procedure has also been found advantageous. After an acid is condensed, adsorbed upon, or otherwise forced into the porous matrix, color or dye is applied directly to that matrix by painting, spraying, or by transfer of dye from another source or layer, or by other convenient means. When dye is applied to such a matrix correctly, it becomes discharged or altered wherever the acid is present. Thus, if the matrix includes a clear support sheet, and if the paper gelatin, or agar, or other carrier layer is effectually trans-

parent, the matrix, after dyeing, will serve as a completed mask in itself.

For the purpose of this invention, it is practical in some instances to impregnate areas of the original copy with color instead of color-discharge compounds, reversing the entire procedure so that the compounds in a matrix layer (or in a layer of the eventual masking sheet) are altered by contact with the original so as to produce an effective line mask or tone mask.

For instance, tone areas of the original subject may contain 4,6-dinitro-o-cresol in its acid, colorless, condition. When heated, a facsimile of the 4,6-dinitro-o-cresol tone image is transferred to a layer containing a sodium hydroxide or an equivalent base with pH adjusted to convert that compound to its yellow condition. When that conversion is complete, the yellow tone areas retard subsequent photography (through a blue filter) so as to permit partial or complete recording of line or background areas without affecting the tone areas. Thus, if the line or background areas are photographed through a blue filter while the half-tone screen is not in position, and separate halftone exposures made without a filter, with mask removed, a highlight halftone negative is produced.

In carrying out the method and utilizing the materials herein disclosed, there is little if any tendency for adhesion of surface pigment on the art copy to the overlay layer of the mask sheet, even though the ordinary and usual water soluble pigment materials are used by the artist in the preparation of the copy. Both the normally low moisture content of the materials utilized and the moderate heat required for effecting the vaporization, decomposition or sublimation of the color-changing reactive material (75° C. to 100° C.) do not materially soften the pigment in the time required for completing the required reaction (usually from 15 seconds to a maximum of 3 or 4 minutes). However, if the material is unusually moist, because of high humidity, or if the art copy is on heavy board, or if there are heavy applications of pigment in the art work, then steps may be taken to avoid the possibility of any adhesion between the art copy and mask sheet which may displace pigment particles from the art copy. For example, if the possibility of adhesion between the art copy and mask sheet is a contemplated factor, it may be avoided by: (a) applying either a mold-release compound or water-repellent silicone to the contact surface of the overlay layer of the mask sheet, or by use of an intervening slip sheet between the drawing and overlay layer which is a vapor-permeable paper or similar material.

It will be readily apparent from the description thus far provided that a large number of variations in both the method and materials are possible. The fundamental necessity is to produce a clean-cut transfer of either color or color altering compounds from the original subject to the mask made therefrom, either directly or indirectly, so that the mask produced aids photography of tone areas and/or line areas, each independently of the other.

It may be further considered as obvious that acid-base "indication," and oxidation-reduction are examples of, and equivalent to, many other types of reactions which can be made to convert color in an overlay mask for the purpose of discriminating between or segregating those areas of art copy which are to be reproduced in halftone from those which are to be reproduced without screen pattern. For example, such reactions as an acid to acid-ion change, liberation of elements, changes of valence or solvation, photochemical and metathetical reactions, and the like, will serve the same purpose, and are considered to be entirely comprehended by the other mechanisms or processes herein described in greater detail.

Referring to the two sheets of drawings:

Fig. 1 is a representation of an original art copy which is to be reproduced and which includes a combination of tone, background, highlight and line areas;

Fig. 2 depicts a mask made by my preferred process from the art copy of Fig. 1;

Fig. 3 illustrates the superimposition of the mask of Fig. 2 upon the art copy of Fig. 1;

Fig. 4 is a representation of a halftone negative made photographically from the superimposed mask and art copy of Fig. 3;

Fig. 5 is an illustration of a line negative made photographically from the superimposed mask and art copy of Fig. 3;

Fig. 6 is a negative made by the superimposed combination of the negatives of Figs. 4 and 5, which negative is suitable for use in the production of halftone printing plates;

Fig. 7 is a fragmentary and sectional exploded view depicting the order and arrangement of stacking materials during the application of heat in carrying out one step of my disclosed process in a preferred manner;

Fig. 8 is an illustration of an original art copy subject to be reproduced and which includes highlight, background and tone areas;

Fig. 9 is an illustration of a mask made by my preferred method from the original art copy of Fig. 8;

Fig. 10 is a negative reproduction made photographically from the superposed mask and art copy of Figs. 8 and 9; and

Figs. 11 to 14 inclusive provide a flow chart indicating the steps of my method, in which chart, Fig. 11 is illustrative of an original art copy, Fig. 12 depicts a matrix and Fig. 13 illustrates a mask made from the matrix, while Fig. 14 is a negative made photographically from the superposed mask, matrix and original art copy of Figs. 13, 12 and 11 respectively.

Fig. 1 is illustrative of an exemplary art copy including a line-and-halftone combination subject wherein shaded portions 20a and 20b depict tone areas, subsequently to be reproduced by halftone screen pattern. Area 21 is typical of a background section which, with my preferred method and material, is reproduced free of screen pattern. Portion 22, on the other hand, exemplifies a line-and-type area, which is also to be reproduced free of screen pattern.

In preparing the subject of Fig. 1, by one of the herein disclosed aspects of my invention, an absorbent of ultraviolet light, such as quinine bisulphate, referred to in my aforementioned Patent No. 2,191,939, is included in the wash with which the tone areas are rendered. As previously described, morpholine, water, sodium sulfite, sodium hydrosulfite and beta methyl umbelliferone may be used instead of that ultraviolet absorbing medium, workable concentrations being in the neighborhood of 5%, 89%, 4%, 0.5%, and 1.5% respectively. There is, of course, no ultraviolet absorbing compound in the line-and-type area 22, nor in the background areas 21.

Fig. 2 represents a transparent sheet which, according to one of the disclosed aspects of my invention, bears on one surface a colloidal layer containing fuchsine, a red-purple triphenylmethane dye, very susceptible to reduction. That fuchsine layer has been put into intimate contact with the art copy subject of Fig. 1 and heated for a limited period to about 95° C., so that some of the sodium sulfite and sodium hydrosulfite from tone areas 20a and 20b in Fig. 1 decompose to sulfur dioxide which has been transferred to the fuchsine layer on the sheet of Fig. 2. Having been produced by the application of heat, the sulfur dioxide has reacted with the fuchsine to convert it by reduction to its colorless leuco form, thus discharging color from a reacted area 23. Unreduced fuchsine remains in its original color condition throughout the balance of the layer and comprises a colored area 24.

Fig. 3 represents the approximate appearance of the art copy subject of Fig. 1, after the locally-discharged sheet or mask of Fig. 2 is superimposed over it, in register, and shows the correct arrangement for photography.

Fig. 4 depicts a halftone negative made by photographing the masked art copy of Fig. 3, when the photograph is taken through a yellow Wratten No. 12 filter which blocks out the red-purple color of the fuchsine in area 24 of Fig. 3. Area 23 of Fig. 3 being effectually transparent when the yellow filter is used, allows practically unhindered photography so that a proper halftone image, areas 20a' and 20b' of Fig. 4, is recorded from areas 20a and 20b of Fig. 1. The negative of Fig. 4 has not been affected in background, or line-and-type areas 21a and 22a respectively, because of the combined mask and filter action.

Fig. 5 illustrates the appearance of an unscreened (line) negative made directly from the masked art copy of Fig. 3 when photographed through a visually opaque filter which is efficiently transparent in the near ultraviolet range between wavelengths of about 360 to 400 millimicrons. The fuchsine layer, being highly transparent to the ultraviolet light used to form this image, does not effectually obstruct the photography of the masked area 24; with the result that negative areas 21b and 22b are produced along with clear areas 20c and 20d corresponding to art copy areas 20a and 20b, respectively. Since the tone areas of the art copy contain the material which is absorbent of ultraviolet light (of the same wavelength range as that freely transmitted by the filter and fuchsine layer), as described, the areas 20c and 20d receive no light which is actinic under the conditions, and consequently remain clear on the negative (Fig. 5).

Instead of making the negatives of Figs. 4 and 5 separately, they are usually combined, in actuality upon one negative element. This negative, when processed according to general halftone practice, provides a reproduction essentially as shown in Fig. 6, having halftone areas 20e and 20f, while background area 21c, as well as line-and-type area 22c, are devoid of screen pattern.

Irrespective of whether a single masking sheet or a supplementary matrix is used for effecting the transfer, intimate contact of either with the original subject may be accomplished by the use of apparatus, such as that fragmentarily shown in Fig. 7.

Art copy 24 comprising a base sheet 25, having thereon a pigment layer 26 containing a reactive material of the type disclosed herein, is placed upon a flat support or base 27. A transparent mask or matrix sheet 28, having gelatin coatings 29 and 30 on its opposite sides to prevent curling, is placed against the pigment layer 26 of the art copy with the gelatin layer 29 which carries the color-changeable material next to the pigment layer. The heating element of my disclosed apparatus embodies a clear heat-resistant glass plate 31 which has on its lower surface an electrical heating element 32 and is preferably hinged relative to the support or base 27. In my preferred construction, the heating element 32 is either in the form of an open-work grid having openings therein through which the progress of the color change of the mask sheet may be observed, or a translucent layer of a plastic, or the like, carrying resistance material for heat producing purposes. The temperature of the heating element is, of course, controlled, and by preference maintains a temperature of about 90° C. to 95° C.

By this or a similar means, reactive compounds are transferred from the original art copy subject surface 26 to either a matrix layer 29 of gelatin on a matrix sheet 28 or directly to the gelatin layer on the surface of the final masking sheet previously impregnated with a color-changeable material.

The method herein disclosed is also useful for the production of highlight halftones. An exemplary illustration of a highlight halftone original subject for reproduction is depicted in Fig. 8, wherein areas 34a and 34b are in various values of tone, area 35 represents a background section which, for purposes of halftone reproduction, is considered as having the same value as a highlight section, typified by area 36, and receives the same treatment

by the method of this invention. The tone areas 34a and 34b, in addition to the pigments with which they are rendered, may also contain a latent basic compound which is one of the types herein disclosed and which is subject to vaporization, volatilization or sublimation or is produced by decomposition of another compound when mildly heated. By direct contact and the application of heat, a matrix layer transfers such basic compound to a similar layer in the subsequently used masking sheet which may contain an indicator dye. If the masking layer contains throughout 2,4-dinitrophenol in its colorless acid condition, then transfer of the basic compound converts 2,4-dinitrophenol to its yellow condition in image-defining areas. Such a masking layer is illustrated in Fig. 9, wherein areas 37 and 38 are colorless, unconverted and acidified 2,4-dinitrophenol, and areas 39 and 40 are converted basic 2,4-dinitrophenol, having a deep yellow color.

Fig. 10 represents a line negative made from a combination of the mask of Fig. 9 with the original art copy subject of Fig. 8. For making the negative of Fig. 10, the mask was, of course, superimposed in register over the original subject. The negative of Fig. 10 was also made, in this instance, while using a blue filter interposed between light source and negative elements, so that the yellow areas 39 and 40 of the mask (Fig. 9), being absorptive of blue light, prevented photographic action on corresponding areas 41 and 42 of the negative shown in Fig. 10. The remaining highlight and background areas reflect (blue) light, and record substantially as shown by areas 43 and 44 of Fig. 10. It may be readily understood that if a halftone image of the art copy is photographed in register with the line image of Fig. 10, which art copy halftone image occupies areas 41 and 42, a highlight halftone negative is produced. That halftone image may be made either by removing the mask, or by leaving it in place and making the photograph while using a yellow filter interposed between the light source and the negative element.

A diagrammatic flow chart, including Figs. 11 to 14, is provided to clarify the steps comprising a preferred embodiment of this method. Fig. 11 represents art copy or the like including an area 45 comprising a line and type section, 46 a highlight or background section, 47, 48, 49 and 50 present four tone values of gray increasing from light to dark. Fig. 12 depicts an intermediate matrix made by contact with the original subject of Fig. 11, wherein area 51 (corresponding to areas 45 and 46 of Fig. 11) includes the line, type, background, and highlight sections, and has not been affected by contact with the original subject. Area 52 (corresponding to areas 47, 48, 49 and 50 of Fig. 11) bears a transfer of the color or color-altering compound in the tone sections. Fig. 13 shows the subsequent masking sheet made from the matrix of Fig. 12 and of which area 53 represents an unaltered color, and area 54 has been altered by the compound in area 52 of the matrix (Fig. 12).

Fig. 14 is a representation of a combination line-and-halftone negative made from the original subject of Fig. 11 through either the mask of Fig. 13, or the matrix of Fig. 12, or the combination of matrix and mask (Figs. 12 and 13 respectively) superimposed in register each with the other and with the original subject; the designations of the halftone pattern being somewhat exaggerated.

In the negative of Fig. 14, as made, unscreened area 55 is a continuous unscreened photographic record of line and type area 45 in Fig. 11. Area 56 is a continuous unscreened photographic record of highlight and/or background area 46 of Fig. 11. Areas 57, 58, 59 and 60 represent, by greatly enlarged halftone screen pattern, the approximate appearance of a halftone negative made through the mask from the areas 47, 48, 49 and 50 of Fig. 11, respectively.

Although my invention has been described in connection with specific details of the embodiments thereof, it

must be understood that it is not intended to be limited thereto except in so far as set forth in the accompanying claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of making an overlay mask on a base sheet of transparent or translucent material and of a type adapted for use in the production of relief halftone and lithographic plates from art copy having tone and other areas, which method comprises the steps of applying to the base sheet a surface exposed layer of a color-changeable substance, distinguishing between the tone and other areas of the art copy by the inclusion in one of said areas of a normally inert substance which is stationary at normal room temperature and so sensitive to mild heat at an elevated temperature that a gaseous reagent is generated from said substance, which reagent is chemically reactive in its gaseous form with said color-changeable substance to effect a change of the color thereof, placing the base sheet upon the art copy with the color-changeable substance in contact with said areas thereof, and heating the contacting surfaces from its normal room temperature to a reagent-generating temperature for said inert substance for a limited period of time to effect the color change of the color-changeable substance.

2. The method of making a photographic overlay mask for dry art copy which comprises forming a light-transmitting overlay sheet having uniformly distributed over a face thereof at an area comprehending the area of the art copy reactive substance subject to change by chemical reaction to alter the light-transmittancy of the sheet, said substance being normally inert and stationary in isolation of said overlay sheet at normal room temperature and dryness, placing said sheet in a normally dry state with said face in intimate contact with a normally dry face of another body having a predetermined area thereof containing normally solid heat-sensitive substance which is normally stationary and inert at normal dryness and normal room temperature, said substance being sensitive to heat at an elevated temperature and thereby activatable to generate a gaseous reagent reactive with said reactive substance of the sheet to change the light-transmittancy of the sheet, and applying heat to elevate the temperature at the interface of the body and the sheet whereby to generate said gaseous reagent and effect said reaction by transfer of the gas across the interface from the body to the sheet.

3. The method of claim 2 wherein the reactive substance at the face of the overlay sheet is a salt of beta-methyl umbelliferone, and wherein the normally solid substance on heating effects volatilization of acid.

4. The method of claim 2 wherein the reactive substance at the face of the overlay sheet is a salt of beta-methyl umbelliferone, and wherein the normally solid substance is a volatilizable organic acid.

5. The method of claim 4 wherein the normally solid substance is ortho-chlorobenzoic acid.

6. The method which comprises placing over normally dry art copy for photographic reproduction a normally dry covering sheet in intimate face-to-face relationship such as to permit flow of gas from one to the other only across the interface, said art copy containing in at least one selected area thereof normally solid substance which is normally stationary and inert in said area at normal dryness and normal room temperature, which substance is so sensitive to mild heat at an elevated temperature that a gaseous reagent is generated therefrom, which gaseous reagent is chemically active in its gaseous form with other normally solid reagent substance by a reaction producing new substance having light-transmittancy different from that of said solid reagent substance, said normally dry sheet being receptive of said gaseous reagent, heating the dry art copy and the sheet in intimate contact therewith to an elevated temperature which effects

13

generation of said gas, whereby said reagent gas is generated and is transferred to said sheet receptive thereof only at the area thereof over said selected area of the art copy and as located in said sheet is available for said reaction.

7. The method of claim 6 wherein the said covering sheet is that for a light-transmitting overlay mask and contains uniformly over an area comprehending the area of the art copy said solid reagent substance reactive with said gaseous reagent, whereby on said heating said new substance is formed and a change in light-transmittancy of the sheet is produced in the area of said sheet corresponding to the selected area of the art copy.

8. The method of claim 6 wherein the said sheet is an absorbent sheet wherein on heating the gaseous reagent is received and retained therein at the receiving area thereof.

9. The method of claim 6 wherein the said sheet is an absorbent sheet wherein on heating the gaseous reagent is received and retained therein at the receiving area thereof, followed by placing said sheet in contact with a light-transmitting sheet for an overlay mask which con-

14

tains uniformly over an area comprehending the area of the art copy said solid reagent substance reactive with said gaseous reagent, and transferring said gaseous reagent from said absorbent sheet to said mask sheet by heating the two sheets in intimate facial contact at an elevated temperature at which said reagent in the absorbent sheet is gaseous, whereby said new substance is formed in said mask sheet and the light-transmittancy of said mask sheet is altered in area corresponding to the selected area of the art copy.

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