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METHOD OF PHOTOGRAPHIC DODGING

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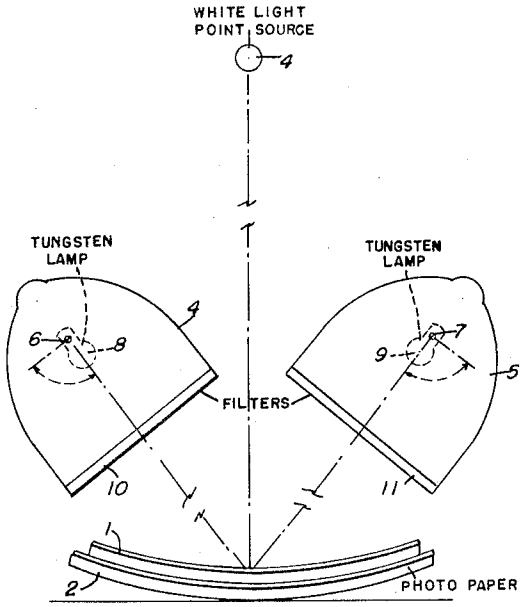


FIG. 1

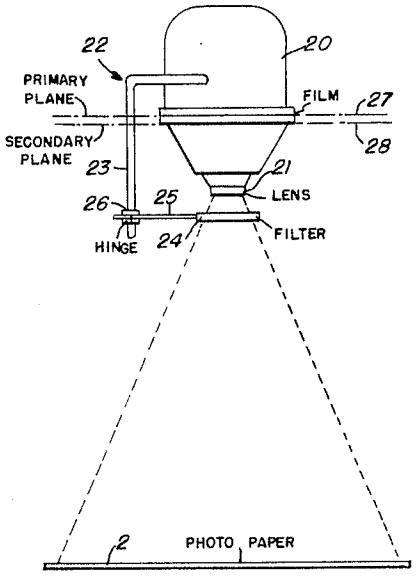
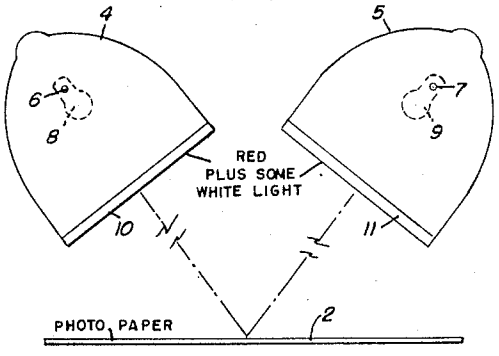


FIG. 2

FIG. 3



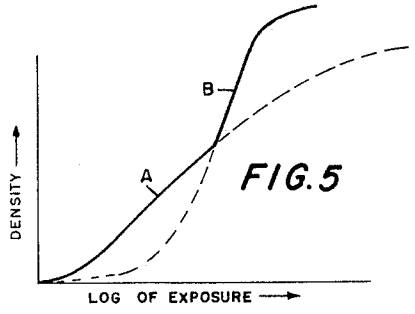
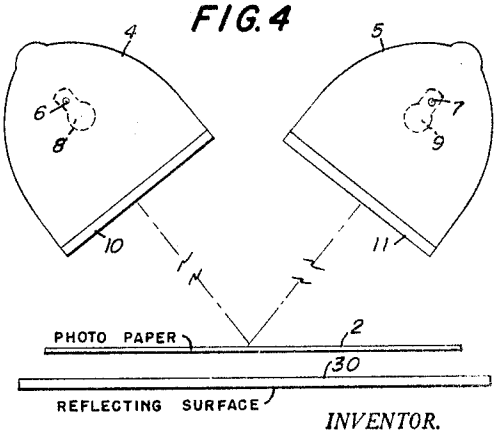


FIG. 5

FIG. 4



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METHOD OF PHOTOGRAPHIC DODGING

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The present invention relates generally to photography, and more particularly to methods and apparatus for producing high definition prints from negatives obtained under adverse lighting conditions, applying the Herschel effect to improve the prints.

The problem presented in producing photographs having good definition, where the negatives are taken under adverse lighting conditions, such as may obtain in aerial and news photographs, has received considerable attention in the photographic art. In some cases a single negative contains areas which range from substantially complete opacity to complete transparency, and the average density (where optical density is defined as the common logarithm of opacity $D=\log_{10} O$) may vary widely. The production of prints from negatives of this type has been accomplished by means of a method known in the art as "dodging."

The two most common methods utilized in the art of photography to accomplish dodging are (1) the "Unsharp Mask" technique, and (2) the "Electronic Dodging" technique. The "Unsharp Mask" technique relies for successful practice on the skill of the photographic technician. In practicing the method of this technique a positive transparency is made upon duplicating material from the negative to be printed. This transparency is made so that it is unsharp or out of focus, and is processed, washed and dried. The transparency is then placed in register but slightly out of contact with the negative film during the final print exposure, and is used to modulate the printing light intensity. In fact, the mask holds back part of the light passing through the thin or more transparent parts of the negative film, so that a uniformly exposed print results.

"Electronic Dodging" techniques are accomplished by using the flying spot cathode ray tube as a device for randomly scanning during the printing process. A photomultiplier tube is used to sense the light after it passes through, or as it is reflected by, the film. The photomultiplier tube generates an electronic signal which can be amplified and fed back to the grid of the cathode ray tube in an inverse sense, so as to dim (either reduce the intensity or increase the velocity of) the scanning or flying spot if the latter is too bright, and so as to increase the intensity (or reduce the velocity) if it is too dim. Thus the printing light utilized is modulated electronically on a continuous basis, and in response to constant sensing of all points of the film, in sequence.

The disadvantage of the "Unsharp Mask" technique is that it requires a great deal of time and considerable operator skill, and the results obtainable are directly a function of skill, different operators providing quite different results. The "Electronic Dodging" method requires little skill, but requires an expensive piece of equipment, which is subject to skilled maintenance.

It has become known that the resolution of photographs may be improved by utilizing the Herschel effect. The Herschel effect may be briefly characterized as the effect on a latent image in a print, of exposure to red or infrared light. The red light is found to provide a bleaching or erasing action on the image present on the print, before the latter is developed, thereby causing a reduction in the density range of the image. Erasing action is a function of the total red light intensity at each unit area of the still light sensitive print, as well as the number of

developable latent image centers within the unit area to be acted upon. The result of application of red or infrared light to a print image is therefore a reduction in the density range of the image. Thereby detail which would be invisible if printed at high density can become available to the eye.

In accordance with one method of utilizing the Herschel effect in photography, a short exposure to white light is made, with good contact between the photographic negative and the photographic printing paper. This produces a normal sharp image of the negative. Thereafter a suitable spacer is introduced between the negative and the paper, while maintaining registery between the image on the negative and the image on the paper, and a longer masking exposure to a broad red source of light is made. The reversing action of the red light causes a reduction in the density range of the image. The red light is sufficiently diffused by virtue of the fact that there is spacing between the negative and the print when the red light is applied, that details in the masking image are not resolved. Consequently, the contrast in the details printed by the white light is practically unchanged by the Herschel effect. Reduction of the density range provides higher contrast in the print, which makes detail easier to distinguish, and, furthermore, detail not visible at a lower contrast can then be seen.

The method as above described has severe disadvantages, in that it is necessary to make contact between the negative and the paper in the first step, and thereafter to produce a known separation therebetween while exposing to red or infra-red light. During the separation, moreover, registration between the images on the negative and on the printing paper must be maintained, and since both the paper and the negative are quite flexible, considerable skill is required in practicing this method, although excellent results can be obtained by a sufficiently skilled operator.

It is an object of the present invention to provide an improved system of photographic printing employing the Herschel effect.

It is another object of the invention to provide an improved method and apparatus for dodging a photographic contact print, utilizing the Herschel effect, which can be practiced by totally unskilled personnel, which requires a minimum of equipment, and of care in the utilization of the equipment.

It is still another object of the invention to provide a method of printing on photographic paper from a film negative, in which diverse portions of the negative are printed according to different characteristic curves pertaining to said photographic paper, said characteristic curves being plots of image density versus logarithm of exposure.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a schematic diagram in front elevation of an apparatus for practicing the present invention in making photographic prints.

FIGURE 2 is a modification of the system of FIGURE 1 utilized in making photographic enlargements.

FIGURE 3 is a view in front elevation of a modification of the system of FIGURE 1.

FIGURE 4 is a view in front elevation of a modification of the systems of FIGURES 1 and 3; and

FIGURE 5 is a plot of image density versus logarithm of exposure, associated with the system of FIGURE 1.

The methods and apparatus as herein described are simple, involve low initial cost to the user, and involve essentially maintenance free operation. There are no reg-

istration problems involved in setting up apparatus according to the invention or in utilizing or practicing the invention, and while the final positive print is made in two exposures, no movement of photographic materials and no processing of photographic materials are required until both exposures have been completed.

The invention finds particular application to the treatment of aerial photographs. Aerial photographs normally contain both highlight and shadow areas if indefinite size. Highlight areas are areas of high reflectivity and are imaged at the negative film as sections of high average density. Shadow areas are areas of low reflectivity yielding minute density differences at the film. Since highlight areas have been either properly exposed or over-exposed, the contrast between adjacent objects is normally too high, and these areas should be printed at normal to low contrast on the final photo-positive material to insure the yield of maximum definition and information. Shadows on the other hand, contain low contrast detail since this portion of the negative is invariably underexposed. This portion should be printed at high to normal contrast to amplify the image density differences. The methods described herein can be employed to produce the contrasts specified.

Referring now more particularly to the accompanying drawings, FIGURE 1 illustrates a contact printer employing the principle of the invention. A negative film 1 is separated from a sheet of photo-paper 2 by a constant distance of the order of 0.05 inch. A first exposure is made by turning on a white light source 4 which is of the point source type, and is located at the center of radius of curvature of the planes of film 1 and paper 2, the latter being located in concentric spherical surfaces. The first exposure is made for a time determined by the nature of the paper and the intensity of the light, and causes a sharp invisible latent image to be formed on the photographic paper, because the rays of light are directed essentially perpendicularly to both the film 1 and the paper 2. Reflectors 4 and 5 are mounted on hinge pins 6 and 7, the latter extending parallel to a plane perpendicular to a line drawn through the poles of the spherical planes of the negative 1 and photo-paper 2, so that reflectors 4 and 5 may be swung about the hinge pins 6 and 7 as axes. Located within the reflectors 4 and 5 are tungsten lamps 8 and 9, the openings of the reflectors 4 and 5 are provided with filters 10 and 11 which may be of the red type, i.e. filters which pass only red light from among all the wave lengths generated by the tungsten lamps 8 and 9. After the white light exposure has taken place, the reflectors 4 and 5 are swung about the hinge pins 6 and 7 so that the light from the tungsten lamps 8 and 9 are directed generally to approximately the center of the film 1, which implies that the rays of infra-red light impinging on the film 1 reach the film 1 at opposite angles of the order of 45°. Thereby the photographic paper is exposed to uniform red light via the negative 1, but because of the angles which the red rays make with respect to the plane of the paper, the exposure to red light is diffused, i.e. an unsharp red light image is generated on the photographic paper.

The red light causes latent image subtraction in proportion to the intensity of the latent image generated by the white light, in accordance with the Herschel effect, and the combination of the two exposures, one sharp and responsive to white light and the other diffuse and responsive to red light, yields a dodged positive print after processing of the paper 2 in the normal manner.

The total manipulation which is required by the operator is the rotation of the reflectors 4, 5 so that red light may impinge on the film negative 1, and the proper timing of the exposures to white light and to red light. The film and the photographic paper are not moved, or operated on in any respect other than by exposure. It is also apparent that the rotation of reflectors and proper timing of exposures to white and to red light may be automated.

Reference is made to FIGURE 2 of the accompanying drawings, which illustrates a device and method for producing photographic enlargements, wherein the Herschel effect is employed to improve the enlargement. In the system of FIGURE 2 an enlargement projector 20 is employed to project the image of a photographic negative onto photo-paper 2 via a lens 21. The photographic projector 20 may be completely conventional in character, and may utilize as a light source a tungsten lamp or any other lamp which provides both white light and infra-red (red and infra-red components), of considerable intensity. A right angle bracket 22 is secured to the projector 20, one arm 23 of the bracket 22 extending vertically downwardly from the projector 20. A red filter 24 is secured to a horizontal rod 25, terminating in a collar 26 providing a hinge for rotating the filter 24 about the arm 23 as an axis, and thereby into and out of registry with the lens 21. After the paper 2 has been exposed to normal white light via the lens 21, with the filter 24 out of registry, the filter 24 is moved into registry, and the paper 2 exposed to an enlarged film image by means of red light. At the same time that this is done the position of the enlarger 20 is slightly changed, i.e. from the primary plane 27 to the secondary plane 28, whereby the projection with red light is slightly out of focus, yet the red image is at the same relative magnification. Accordingly, the printing process involves a succession of steps, wherein initially a sharp latent image is generated on photographic paper 2 in response to white light passing through a photographic negative, and wherein a succeeding exposure of the paper 2 is made with red light to the same negative, but with defocussing, so that the red exposure is unsharp.

Referring to FIGURE 3 of the drawings, there is illustrated a modification of the system of FIGURE 1, which is applicable to enlargement printing of the type illustrated in FIGURE 2. In the system of FIGURE 3 the red light arriving from the tungsten lamps 8 and 9 via red filters 10 and 11 is applied directly to the photographic paper 2 rather than via a film negative. At the same time the filters are so selected that some actinic or white light passes through the filters in addition to the red light.

The small amount of actinic light passed by the filter will allow latent image build-up, where lack of image forming light during the primary exposure, in a conventional printing process, has failed to bring the latent image centers to a chemically developable state. The actinic light from the light source will not, on the other hand, appreciably affect the dense latent image formations in the emulsion of the photo-paper, such as exists for example in shadow areas. The red or erasing or image reversing light, on the other hand, will subtract from the latent image centers in areas that were overexposed during the initial exposure on the conventional printer, rendering detail in these areas more readily visible to the eye after chemical processing of the photo-paper. Subtraction by the erasing portion of the light will not occur in areas of the photo-paper aided by the actinic light from the light source. Since there are insufficient latent image centers, or insufficient targets in this area, the erasing light is ineffective in these portions of the undeveloped image. The result of the blend of wave lengths from the light sources is a build up of density in under exposed areas and a reduction density in over exposed areas of the photographic print, after chemical processing. The effect on the eye of the human observer is a yield of more total information than is otherwise available from conventional processing.

The system of FIGURE 3 can be materially improved by inserting a selective mirror or reflecting material 30 under the photo-paper, assuming the photo-paper is relatively translucent, so that the infra-red light passing through the latent images is used twice while the actinic light is not so reflected and reused, as is shown in FIGURE 4.

According to a modification of the invention of FIGURES 1 and 2, the negative may be exposed in a method

utilizing the apparatus of FIGURES 1 and 2, with the addition of yellow and blue filters during actinic exposure periods, the use of a variable contrast photographic emulsion as the printing material, and intimate contact between film and variable contrast photographic emulsion. The first exposure is made through a low contrast yellow filter, the light source in this case being either diffuse or a point light source. In consequence, after the first exposure, a latent image is present in the photographic paper. This image will be diffuse if the light source was diffuse or it will be precise if the light source was a point source. The second step is to erase through the negative by use of red light, employing the Herschel effect. Since shadow areas are already at a higher density level than highlights, more latent images are present here. The negative is at a minimum density over shadow areas, allowing most of the red light through. The negative is dense on the highlight areas, so that little erase is accomplished here, first because of the negative density and second because of the few latent image targets present. The result of the second exposure is thus seen to affect the shadow area primarily and the shadows are reduced considerably in density or in latent image centers. Thirdly an exposure is made through a blue filter yielding high contrast. This third and last exposure is very brief since its purpose is simply to expose through the thin or less dense portions of the negative at a high contrast. Since some information is contained by the paper after the erasing step in the shadow areas, only a short exposure to the blue high contrast light is required.

Referring to FIGURE 5 which represents graphically the process above described, the first exposure takes place on curve A, the second exposure erases information from the upper portion of curve A, while the third exposure is made on the upper portion of curve B. This makes the overall response of the variable contrast the photographic paper follow the discontinuous curve as shown by the solid lines in FIGURE 5.

While we have described and illustrated one specific embodiment of the present invention, it will become apparent that variations of the specific details of construction may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What we claim is:

1. A method of dodging in photography wherein a print is to be produced on printing paper from a negative, said paper being of variable contrast emulsion sensitive to wavelengths associated with all colors, a surface of said paper being located on a spherical surface, comprising placing the negative on a spherical surface concentric with the surface of the printing paper but spaced therefrom by approximately 0.05", forming an image on the paper by directing white light through said negative onto said paper from essentially a point source in a direction perpendicular to said surface while said paper and negative are located on said concentric surfaces, partially erasing said image by directing long wavelength diffuse light through said negative onto said paper in directions making an acute angle greater than zero with respect to said direction perpendicular to said surfaces.

2. The method according to claim 1 wherein said angle is on the order of 45°.

3. The method according to claim 1 wherein said white light and said long wavelength light are applied in succession.

4. A method of dodging in photographic printing from a negative to printing paper of variable contrast emulsion sensitive to wavelengths associated with all colors, which method employs a lens and a source of light including short and red wavelength components, comprising first, spacing said negative between said source of light and the lens, second, projecting white light from said source through said negative onto said paper to expose said paper, the spacing between said source of light and the lens and the characteristics of said lens being such as to provide a sharp image of said negative on said paper during said second step, third, changing said spacing upon insertion of a red wavelength filter between said lens and said paper, fourth, partially erasing said image by projecting light from said source through said negative, filter and lens onto said paper, said spacing being changed such that the image of said negative is defocused but is enlarged to the same extent as the image resulting from the second step.

5. The method of printing an image from a photographic negative on photographic print paper of variable contrast emulsion sensitive to wavelengths associated with all colors, comprising the steps of producing a latent image of low contrast by applying yellow light to said paper via said negative, partially erasing the image as produced by applying red light to said image through said negative, thereafter increasing the contrast of the erased image by applying blue light through said negative to the partially erased image.

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