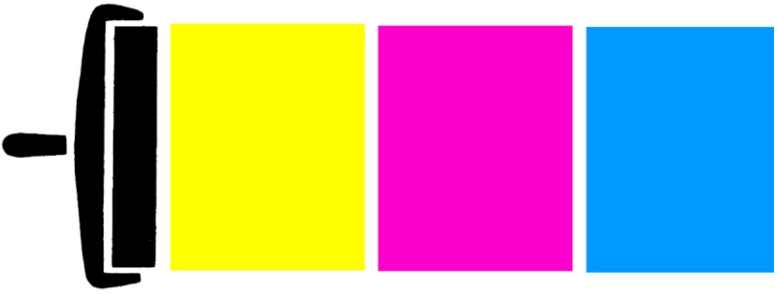


KODAK DYE TRANSFER PROCESS

CONTENTS

NEW! As this booklet goes to press, a special KODAK Dye Transfer Film is becoming available under the designation SO.351. The new film makes possible "day-night" prints, suitable for viewing either by transmitted or reflected light. As of the time of writing, the technique of using the film is the some in all respects as described in this booklet for paper prints, including the use of KODAK Dye Transfer Paper Conditioner.

The KODAK Dye Transfer Process is a method of making full color photographic prints on paper from dyed relief images, known as matrices. The matrices can be made from color separation negatives, a color negative, or an internegative

Although more direct methods of making color prints have become available, the Dye Transfer Process continues to have important advantages in many professional applications. It offers unique possibilities for the control of color balance and contrast, together with unexcelled photographic quality.

If the starting point is a positive color transparency, color separation negatives are made on a suitable panchromatic film, such as KODAK SUPER-XX Panchromatic Sheet Film, by exposures from the transparency through red, green, and blue filters. Then three matrices on KODAK Matrix Film (ESTAR Thick Base) are made from the separation negatives by white-light exposures.

An original color negative or a color internegative is, in effect, a set of color separation negatives on one sheet of film. The three matrices, therefore, can be exposed directly from the negative through tri-color filters. Here, KODAK Pan Matrix Film (ESTAR Thick Base) is used.

Regardless of the starting point, the actual Dye Transfer printing procedure is substantially the same. After exposure through the base side, the matrix films are developed, fixed, washed in hot water to remove the gelatin in the unexposed areas, and dried. The images that remain are gelatin reliefs in which the thickness varies with the degree of exposure. The matrices - which are, in effect, red, green, and blue color- separation positives - are soaked in solutions of cyan, magenta, and yellow dye, respectively. Each matrix takes up dye in proportion to the thickness of the gelatin. When the three dye images are transferred in register to a sheet of KODAK Dye Transfer Paper, a color print is produced.

MAKING SEPARATION NEGATIVES FROM A COLOR TRANSPARENCY

Masking

A color transparency is an approximation, although generally a satisfactory and pleasing one, of the original subject. When the transparency is reproduced, the result becomes an approximation of an approximation.

This is sometimes neither satisfactory nor pleasing. A more accurate reproduction of the subject can be obtained by making some correction for the deficiencies of the photographic dyes. This correction procedure, known as "masking," constitutes an additional step in the reproduction process, but the resulting improvements usually more than justify the extra effort involved.

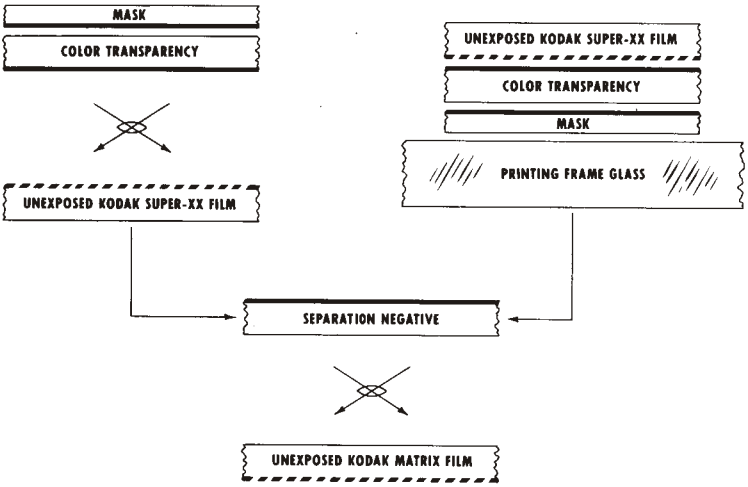
A single mask corrects relative brightness and saturation errors. With most color transparencies, one mask gives acceptable results. To correct hue-shift errors, two masks are necessary. In addition to such a principal mask or masks, a highlight mask is sometimes necessary to retain important highlight detail. If a highlight mask is needed, it is made first and used with the transparency during exposure of the principal mask or masks. Prepare the highlight mask on KODAK Professional Line Copy Film according to the instructions packaged with the film. The principal mask or masks should be made on KODAK Pan Masking Film as described in the film instructions.

Registering the Mask

If one principal mask is used, it remains on the transparency during the exposure of all three separation negatives. If two principal masks are used, the red-filter mask is taped in register with the transparency and left there while the red and green-filter negatives are being exposed. It is then replaced by the green-filter mask during the exposure of the blue-filter negative.

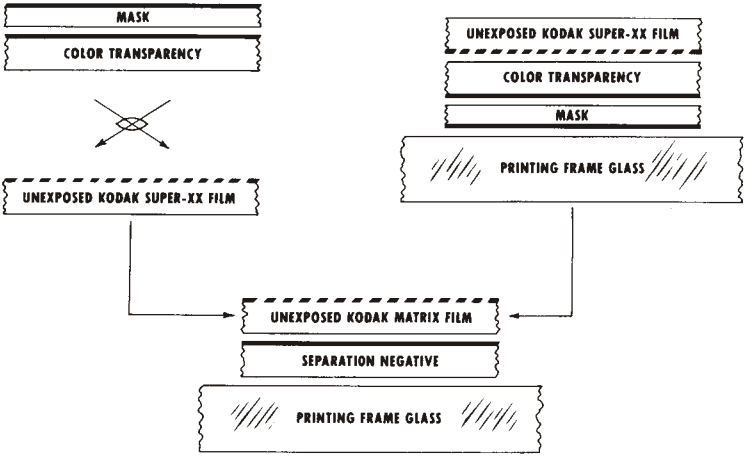
If the matrices are to be exposed by enlarging the separation negatives, register the mask on the base side of the transparency. Then place the emulsion side of the transparency so that it faces the emulsion side of the separation- negative material, and print either by contact or enlarging. See Figure 1.

If the matrices are to be exposed by contact, register the mask on the emulsion side of the transparency. Then place the transparency so that its base side faces the emulsion side of the separation- negative material and so that the emulsion sides of the mask, transparency, and negative material all face the light source. See Figure 2. The separation negatives can be exposed either by contact printing or by enlarging.



Orientation of color transparency and principal mask in either contact-printing frame or negative carrier of enlarger when matrices are to be made by projection. These procedures furnish the sharpest separation negatives and prints.

Figure 1



Orientation of color transparency and principal mask in either contact-printing frame or negative carrier of enlarger when matrices are to be made by contact. Prints made by these procedures are not as sharp as those made using the procedures shown in figure 1.

Figure 2

Use of Register Punch. The KODAK Register Punch is very useful in registering color- separation negatives, masks, and matrices. If separation negatives and masks are to be made by contact from a sheet-film transparency, simply attach a strip of punched film to the original. The image can then be positioned exactly relative to the pins on a register board or in a KODAK Register Printing Frame. If a sheet of masking film is punched and placed on the register pins before exposure, it can be registered with the transparency at any time. Thus, during the exposure of a set of separation negatives, one color-correction mask can be substituted for another quickly and with assurance of good register. The masking film should, of course, be large enough so that it can be punched along one edge without interfering with the picture.

It is also advisable to punch the separation- negative film before exposure so that the image placement will be the same on each. If the negatives are printed by contact on matrix film that also has been punched, the three images will register automatically. If the negatives are printed by projection, however, the matrices must be registered after they have been processed and dyed, unless, of course, the negative carrier has register pins. If it has, the matrices can be prepunched and exposed on a vacuum register board.

Exposing the Separation Negatives

Preliminary Steps. Proper identification of the separation negatives is necessary to avoid confusion. One way is to trim the corners with scissors. Usually, the red-filter negative is left untrimmed, one corner is trimmed from the green, and two corners are trimmed from the blue,

Attach a KODAK Photographic Step Tablet to the transparency. If the separation negatives are to be made by enlargement, prepare a mask from black interleaving paper; cut an opening of the proper dimensions to accommodate the transparency and the step tablet.

Orient the transparency and separation- negative film as described under" Registering the Mask," page 4, and as shown in Figures 1 and 2.

Newton's Rings. The close contact between transparency and printing-frame glass sometimes produces Newton's rings. One remedy is to use a fine powder in a small polyethylene squeeze bottle with a short tube projecting from it. The end of the tube should have an opening only a few thousandths of an inch in Diameter. In the

bottle, place about ½ inch of Oxy-Dry Offset Powder (made by Oxy-Dry Sprayer Corporation, 331 Park Avenue South, New York, N.Y. 10010) or a similar powder used for preventing offset on the delivery end of printing presses. First, shake the bottle and tilt it so that the nozzle points upward; then squeeze to apply the powder. The resulting spray should be hardly visible and should be applied to only one of the surfaces involved.

Exposure. Use a suitable panchromatic film, such as KODAK SUPER-XX Panchromatic Sheet Film, to make the separation negatives; expose the film as described in the instructions packaged with it.

Processing. Follow the development times and tray-agitation technique presented in the film instructions.

Interpretation of Gray Scales

A color-balanced set of separation negatives should have the same contrast, as well as approximately equal densities, in corresponding steps of the grayscale. In order to evaluate the results, the densities of the steps in the three gray scales should be read and plotted.

After the desired densities and contrasts have been obtained consistently in exposing and processing tests, the plotting of each step can then be dispensed with. Instead, the density ranges should be determined from corresponding steps in the three negatives that most closely match those of the diffuse highlight and shadow densities in the red-filter negative.

Plotting Step- Tablet Densities. The densities in the reproduction of the KODAK Photographic Step Tablet, which was placed alongside the transparency when the negatives were exposed, should be plotted against the densities in the step tablet itself. The three curves so obtained provide a measure of the contrast, as well as the relative balance, of the negatives.

The step-tablet densities should be noted along the bottom, or horizontal, scale of a sheet of rectangular coordinate graph paper. On an electronic or visual densitometer without any filter in place, read the densities of the steps in the red-filter negative. Plot the densities as follows: From the point where the original step-tablet density is indicated on the "Density of Original" scale at the bottom of the paper (see Figure 3),

move upward along a vertical line and locate the point opposite the appropriate value on the vertical "Density" scale. The plotting points for each step of the separation- negative scales are fixed by the intersection of two lines, the one extended vertically upward from the point indicated for each density in the original step tablet, the other extended horizontally from the corresponding density read on the separation negative.

Lay a straightedge along the points, and with a red pencil draw a solid, straight line through them. Use appropriately colored pencils for the other two curves. The points should fall on the line or very close to it, if the densities have been carefully read and plotted. The densities at either end of the scale probably will not lie on the straight line connecting the intermediate points but will form slight curves. These curved lines correspond to the highlight and shadow areas of the transparency.

Interpreting the Curves. The curves for a perfectly balanced set of separation negatives are not only alike in shape and slope, but also are superimposed. If the curves are parallel but do not coincide, the developing times were correct but the three exposure times were not properly balanced. If the density range of the transparency recorded in each of the separation negative is the same, compensation for a slight lack of coincidence can be made by adjustment of the matrix exposures.

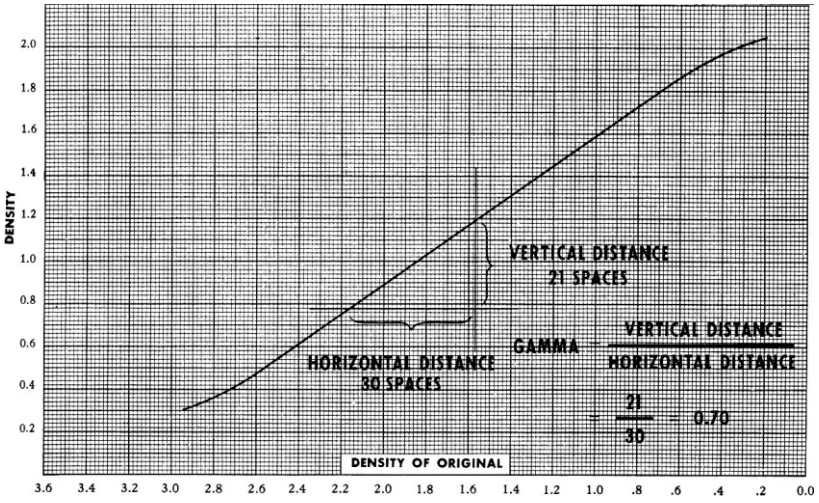


Figure 3

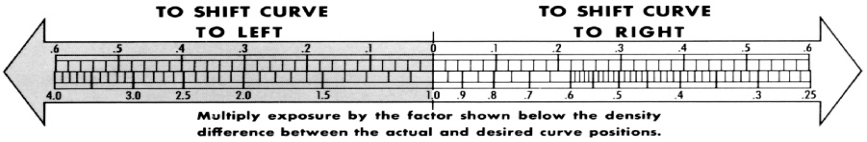


Figure 4

If the density ranges in the separation negatives are not essentially equal, all three negatives should be remade. The exposure correction can be found from Figure 4. If the density range of the transparency is satisfactorily recorded on the straight-line portion of one of the negatives, its exposure need not be changed. The exposure for each of the other negatives can be corrected by measuring the distance, in terms of the units on the "Density of Original" scale, that each of the curves needs to be moved either to the right or left. For example, if two curves are superimposed and the third is displaced to the right by a density difference of 0. 3, the exposing time for this negative should be multiplied by 2. The distance that the curves need to be shifted in order to bring the reproductions of a fairly neutral shadow density of the transparency to the recommended minimum density of 0.4 in the negatives is measured along the "Density of Original" scale.

Measuring the Gamma. The slope or angle that the line of plotting points makes with the horizontal axis is the gamma to which the negatives have been developed. Gamma can be determined by selecting any convenient point on the curve that is representative of the slope of the whole curve and counting at least 20 divisions to the right. From this point, count the number of divisions vertically until the curve is again reached. Divide the number of vertical steps by the number of horizontal steps taken. Figure 3 illustrates this procedure. For a properly exposed and processed separation negative, this value should be about 0. 70 if the original transparency was unmasked, or if both the original step tablet and the transparency were masked. If the color transparency was masked but the step tablet was not, the gamma should be about 0.90.

The set of negatives should be remade if there are sizable differences in the slopes of the three curves, because corrections for these differences cannot be made when the matrices are exposed and processed. If the slopes of the lines depart markedly from the recommended gamma, or if the three curves are not closely parallel,

the development time should be increased for a negative having a lower value than the recommended gamma, and decreased for a negative having a higher value

.Determining the Density Range. Once a set of well-balanced color-separation negatives has been obtained, determine the density range of the negatives. From the two points on the "Density of Original" scale corresponding to the highlight and shadow densities in the original transparency, draw lines vertically until they intersect the curves of the color-separation negatives. At these points, extend the lines horizontally to the left to the vertical "Density" scale. The difference between these values, which is the density range of the negatives, should be about 1.4. In the KODAK Dye Transfer Process, however, compensation for separation negative density ranges as low as 0. 9 or as high as 1. 8 can be introduced by altering the composition of the matrix film developer.

MAKING DIRECT SEPARATION NEGATIVES

A panchromatic film, such as KODAK SUPER-XX Panchromatic Sheet Film, can be used in a conventional camera to make separation negatives directly from still subjects. The camera must be firmly braced so that no movement takes place during the course of the three exposures. Since film does not always lie in the same plane in different film holders, it is best to use the same holder for all three exposures. The holder should be loaded and unloaded in total darkness.

The lighting requirements for direct separation negatives are much the same as those for other types of color photography. Normally, the lighting ratio should be between 2:1 and 3: 1. Higher ratios can be tolerated when the subject has a limited range of reflectance or for special effects.

The color quality of the light source affects the filter ratios for the three color filters. Once satisfactory exposure times have been determined for a particular light source, they can be used when other negatives are exposed by the same lighting.

If possible, place a paper reflection scale of neutral-gray steps in the scene. Either the KODAK Gray Scale included in KODAK Color Separation Guides or a KODAK Paper Gray Scale is suitable. The lighting of the gray scale should correspond as closely as possible to the lighting on the main part of the subject itself. From density readings of the gray scale in the processed negatives, you can determine variations in density and contrast. The gray scale should be located in such a position that it can be trimmed from the final print.

EXPOSING *KODAK* MATRIX FILM

Matrix exposures are made through the base of the KODAK Matrix Film (ESTAR Thick Base), with the color- separation negatives oriented in such a way that each matrix image will appear in its correct left-to-right position when seen through the base of the film. The dye images will then be oriented correctly when they are transferred to paper.

Matrices by Enlargement. To prevent misregister or color wedging and to ensure the maximum useful picture area in the finished prints, place each color- separation negative in the same position in the enlarger negative holder. The simplest procedure is to tape an oversize sheet of thin white paper on the enlarger easel. Trace on the paper a few key lines and points of the projected image of one of the negatives. The next negative can then be positioned by moving it in the negative carrier until the image falls approximately on the marks; do not move the easel.

When placing a matrix film in position for exposure, cover the white paper with half of a fold of the black interleaving paper which is packaged with the matrix film. Mask the film so that there will be an unexposed border about 3/8-inch wide to facilitate handling the matrices without damage to the relief images. Use a clean piece of plate glass to hold the film flat during the exposure.

The necessity for using a sheet of glass can be avoided by exposing the film on a KODAK Vacuum Register Board. However, the KODAK Matrix Film cannot be punched and placed over the register pins unless the enlarger head has provision for pin or edge register of the separation negatives. In this case, punch the unexposed sheets of matrix film, one at a time, and expose them in register.

To expose unpunched film on a register board, place a sheet of white paper of the same size as the matrix film in position over the vacuum channels, with one edge butted against the register pins. Mark the position of an adjacent edge with a piece of masking tape. After composing the picture on the white paper, position the films in the same way for exposure, using a black paper mask to keep the borders clear.

Place the separation negatives in the enlarger, emulsion side toward the light source; see Figure 1. The enlarged images will then be in their correct left-to- right positions as seen on the enlarger easel. Since the matrices are exposed through the base of the matrix film,

the matrix-dye images will also be correctly oriented when they are transferred to the paper in the final printing operation.

Matrices by Contact. For contact printing, an enlarger or a modified safelight lamp can be used as the light source. An enlarger is more convenient, because it allows easy control of exposure. Whatever the light source, the matrix film should be masked to provide an unexposed border or "safe edge" about 3/8 inch wide.

For matrices by contact, orient the separation negative and matrix film as shown in Figure 2. Maximum sharpness in the matrices is obtained by using a small light source at considerable distance from the printing frame.

Identification of Matrices. After each matrix is exposed, it should be identified to prevent mistakes in the later operations; see the instructions packaged with the matrix film.

Effect of Exposure on Print Quality

When a correctly exposed and processed matrix is dyed, and the dye image is transferred to paper, any diffuse white highlight area shows a just perceptible transfer of color. The exposure given to the cyan printer (the matrix exposed from the red-filter separation negative) is usually used to establish the overall density of the print. With a properly balanced set of dyes, whites, grays, and blacks in the picture will be reproduced as neutrals in the print when all three matrices have equal densities in the white, gray, and black areas. A slight adjustment of color balance may be required at the transfer stage, but the first objective is equal densities in the neutral areas of all three matrices. Compensation for any density differences among the separation negatives must therefore be made when exposing the individual matrices.

Determining Matrix Exposures

Make a test exposure as follows from each new set of separation negatives.

Expose a diffuse white highlight area of the subject from the red-filter negative onto KODAK Matrix Film, and process the film

through the wash-off step (see instructions packaged with KODAK Matrix Film). With your fingernail, scratch the white highlight area in the test strip. View the test strip against a dark background by oblique transmitted light. The unscratched area should be just perceptibly darker than the scratched area.

If you lack the experience to make this judgment, dye the test strip cyan and transfer the image onto KODAK Dye Transfer Paper as described in the section, "Making Prints," page 20. View the print through a red filter, such as the KODAK WRATTEN Filter No. 25 or No. 29. The cyan image from a correctly exposed matrix will look like a properly exposed black-and-white print.

With the proper matrix exposure known for the red-filter separation negative, the exposures for the green- and blue filter negatives can be determined by using a visual or electronic densitometer and the Color-Printing Computer in the KODAK Color Dataguide, sold by photo dealers. The KODAK Graphic Arts Computer, sold by graphic arts dealers, can be substituted for the Color-Printing Computer.

On a visual or electronic densitometer without any filters in the beam, read the density of the diffuse white highlight area in the red-separation negative. Turn the computer density scale until this density is opposite the time used to make the good test-strip exposure. The exposure time for each matrix now appears opposite the highlight density value of the corresponding negative.

If there is no diffuse highlight in the transparency that is a good neutral white, locate the step on the accompanying gray scale that is nearest in density to the highlights of the picture. Identify this step in all three color separation negatives; then use its densities on the computer in the same manner as specified for a diffuse white highlight.

If the magnification or the lens aperture is changed from that used in exposing the test matrix, proceed as follows: Set the density scale as described above and hold it in position. Turn the lens-aperture dial until the lens aperture used for the test exposure appears opposite the magnification used for the test exposure. For any set of negatives, move the density and lens-aperture dials together until the lens aperture and magnification to be used -appear opposite each other. The exposure time for each matrix now appears opposite the highlight density value of the corresponding negative.

NOTE: If you decide to use a matrix-developer dilution different from that used for the test strip, adjust the calculated exposure times as suggested in the contrast control table in the matrix film instructions.

Processing

Process the matrices as outlined in the instructions packaged with KODAK Matrix Film

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Registering Matrix Films

Unless matrices on KODAK Matrix Film have been exposed in register, they will have to be registered visually after they have been processed, dyed, and dried. To save time, the matrices can be dyed directly after processing, without drying. If this drying step is omitted, however, it is very important to use freshly filtered dyes; otherwise, foreign particles may become permanently embedded in the soft gelatin relief images. When they have been dried once, the relief images are somewhat more resistant to physical damage.In either case, the procedure for dyeing the matrices is the same. Carry out Steps 1, 2, 3, and 4 as given on page 22. Then hang the matrices up to dry, taking care to orient all three images in the same direction.

Mount the KODAK Register Punch in a fixed position relative to an illuminator surface which will support each matrix at the level of the slot in the punch. The slot is 5/16 inch above the bottom of the punch. Care should be taken to keep the glass on which the films are registered from becoming too warm. Excessive heat from the illuminator may lead to size changes and subsequent misregister of the dye images. The use of fluorescent illumination and air-spaced sheets of glass over the light source is recommended.

First superimpose the three dye images approximately in register and make sure that the matrices coincide to about 1/8 inch along the edge that is to be punched. If they do not, trim one or two of the matrices as required.

Then tape the cyan matrix in position for punching, emulsion side down, and punch it. Carefully superimpose the magenta matrix over the cyan matrix. With the aid of a magnifying glass, such as the KODAK Achromatic Magnifier, 5X, check the register at three widely spaced points. Use as guides any small, specular highlights, such as the catch lights

in eyes, or cross marks scratched with a sharp knife along two edges of the transparency before the color-separation negatives were made. Secure the matrix with tape which does not overlap the tape used on the cyan matrix. Punch the magenta matrix and remove it without disturbing the cyan matrix. Finally, register the yellow matrix over the cyan matrix and punch it.

EXPOSING *KODAK* PAN MATRIX FILM

Matrices are exposed with the emulsion side of the color negative or color internegative facing the base side of the KODAK Pan Matrix Film (ESTAR Thick Base). The matrix images then appear in their correct left-to-right positions when seen through the base of the matrix film, and the dye images are correctly oriented when transferred to paper.

The matrices of a set include one made through each of the following filters: KODAK WRATTEN No. 29 (red), No. 99 (green), and No. 47B (blue). Since the film is fast and panchromatic, it must be handled in total darkness.

KODAK Pan Matrix Film is supplied perforated for use with the Vacuum Register Board, so matrix register is automatic.

An enlarger is normally used as the light source for either enlarging or contact printing. In either case, the enlarger head should be equipped with baffles to prevent any stray light from reaching the matrix film.

Matrices by Enlargement. Check the enlarger head and its support thoroughly for rigidity. Any movement of the enlarger head during or between exposures will cause misregister. Avoid jarring the enlarger head while changing the filters.

An opaque mask must be used around the negative to prevent white light from getting past the negative plane. This mask must be in the negative carrier; it can be made from black interleaving paper.

A practical method for composing the picture on the KODAK Vacuum Register Board is to place on the board a sheet of paper (Dye Transfer or other kind) that is larger than the widest vacuum channel. Locate the paper in such a way that one end extends under the raised clamps and over the register pins. When the clamps are lowered, the pins will perforate the paper. Draw a line lightly with pencil along the location of each of the vacuum channels; then compose the picture within the proper channel. The paper can be kept and reused by replacing it over the pins.

Keep the picture margin ½ inch or more away from the register pins; otherwise, difficulty may arise during transfer of the dye images. On the other three sides, provide for a narrow, unexposed border to facilitate handling the matrices
without damage.

When the register board has been positioned properly for the negative to be printed, clamp or tape it securely to the enlarger baseboard to prevent any movement between exposures.

Matrices by Contact. If matrices are to be made by contact printing, attach a strip of film containing register perforations to the negative so that it can be positioned identically with respect to three separate sheets of KODAK Pan Matrix Film. The strip of film can be obtained from a discarded matrix; if a KODAK Register Punch is available, it can be used to punch a discarded sheet of some other type of film. In either case, the perforated strip of film should be wide enough to bring the edge of the negative at least ½ inch away from the pins on the register board.

Having attached the strip of film to the negative, fasten an opaque mask on the base side of the negative to prevent the edges of the matrix film from being exposed. If the Register Punch is used to perforate the register strip, it is convenient to mask the image area first, and then to punch both the register strip and the opaque mask simultaneously.

Since the vacuum channels of the Vacuum Register Board are not used to maintain contact between the negative and the matrix film, the KODAK Transfer Register Board is equally suitable for use in exposing matrices by contact. Use an enlarger as the light source and place the register board on the easel. With the red separation filter over the enlarger lens, place a sheet of Pan Matrix Film, emulsion side down, over the register pins. Place the color negative on top over the pins, emulsion side down. Lay a clean sheet of plate glass over the negative to hold it in contact with the matrix film and then make the exposure. Repeat the same procedure with the green and blue separation filters.

For matrix sizes up to 11 x 14 inches, the KODAK Register Printing Frame can also be used.

Identification of Matrices. After each matrix is exposed, it should be identified to prevent mistakes in the later operations; see the instructions packaged with Pan Matrix Film.

Determining Exposures

A correctly exposed matrix will show, after processing, a just-perceptible density in the diffuse white highlights of the subject. The exposure necessary to produce this density is found by making a trial exposure through the red separation filter, as described below.
The red-filter exposure found by trial determines the overall density of the final print. The color balance of the print depends upon the relative exposure received by the other two matrices. A balanced set of matrices shows equal densities in those areas that correspond to the neutral areas (white, gray, and black) in the subject originally photographed.

A KODAK Neutral Test Card should be included along the edge of the original scene when the color negatives are exposed. If it is inconvenient to include an image of the test card in each negative, a separate negative of the card can be made. However, this test-card image will serve as a reference area only for other negatives made under the same exposure and processing conditions. At least one test-card exposure should be made for each group of negatives exposed under similar lighting conditions, and at least one image of the test card should be developed in each processing batch.

Proper use of the Neutral Test Card provides reliable matrix exposure information. If a test-card image is not available, select an area of the negative that probably represents a neutral object.

Master Negative, For the first negative to be printed, select one exposed to a typical subject containing the KODAK Neutral Test Card. This negative is termed the "master negative." Before other negatives are printed, it is necessary to establish, as described below, a printing relationship between the master negative and the emulsion number of Pan Matrix Film in use. The printing times for other negatives can then be calculated from density readings made with a photometer or densitometer.

Test Procedure for New Emulsions. It is necessary to carry out the following procedure once for each new emulsion number of KODAK Pan Matrix Film used.

1. Using interleaving paper from the Pan Matrix Film box, make a mask that adequately covers the projected negative image on the vacuum register board. For large prints, two or more sheets of interleaving paper can be taped together. Mark the area of a diffuse highlight and the area of the gray card on the mask. Cutout these areas from the mask and reposition the mask on the easel. Tape one edge of the mask to the easel so that it can be folded back.
2. With the mask folded back, position a piece of tape on the vacuum register board alongside the projected diffuse highlight area so that the tape can be used as a guide to positioning a matrix test strip. If the diffuse -highlight and graycard areas are in widely separated portions of the projected image, place another piece of tape alongside the gray-card area.
3. Clip one end of the matrix test strip so that the first exposure area can be identified later and place the clipped end under the mask in the area of the diffuse white highlight. The base side of the film should face the lens. If the gray-card area is close to the highlight area, position the film so that both areas will be exposed. If the gray-card area is not close to the diffuse highlight area, cover the gray-card opening in the mask by taping a small piece of black paper over it. With the red filter over the lens, the trial exposure might be 30 seconds at f8 for a 2X enlargement. If the gray-card area was not exposed, move the test strip so that the image of the gray card will fall adjacent to the already exposed highlight image. Remove the black paper covering the gray-card area and place it over the highlight aperture, if this area is likely to cause an exposure on the test strip. Make another 30-second exposure.
4. With the test strip in a light tight drawer, replace the red filter with the green filter. Now position the test strip under the gray-card mask aperture so that the green exposure will fall adjacent to the red exposure on the strip. Make a 30second exposure. Repeat, using the blue filter, and give a 50-second exposure.
5. Process the test strip. It should show four exposed areas, readily identifiable by their positions in relation to the clipped end. If the green- or blue-filter areas are lighter or darker than the red-filter area, the time of exposure for these two must be lengthened or shortened until all three areas have the same density. Then the overall exposure level should be determined as follows. With your fingernail, scratch the diffuse-highlight area; place the test strip on the bottom of a white tray; the unscratched area should be noticeably darker than the scratched area.

On-Easel Exposure Determination with a Photometer. Once matrix exposure times from the master negative have been established by the test procedure just described, times for exposing other negatives on Pan Matrix Film of the same emulsion number can be determined with an easel photometer having suitable response to red, green, and blue light.

1. With the master negative in the enlarger, the magnification and lens at the same settings as for the test strip, and the photometer probe on either a gray-card or a flesh-tone area, adjust the photometer potentiometers so that the exposure times determined for the red, green, and blue filters are indicated on the meter time scale.

2. Place the new negative in the enlarger and set the lens and magnification at the same settings used for the master negative. Place the photometer probe on either a flesh tone or a gray-card area, whichever was used with the master negative. With the red- reading filter in place, adjust the lens opening so that the meter scale reads the same exposure time as for the master negative, then read the new green and blue exposure times directly.

The change in exposure time required by a change in magnification can be readily calculated by using the Color-Printing Computer in the KODAK Color Dataguide The KODAK Graphic Arts Computer, sold by graphic arts dealers, can also be used.

Off-Easel Exposure Determination with an Electronic Densitometer. An electronic densitometer can be used as follows to determine matrix exposure times for subsequent color negatives once the times have been established for the master negative by the procedure described on page 18, and as long as the same emulsion number of Pan Matrix Film is used.

1. Read and record the red, green, and blue densities of a flesh-tone or gray-card area in the master negative.

2. Read and record either the flesh tone or the gray-card densities of the new negative.

3. Using the Color-Printing Computer in the Kodak Color Dataguide, set the red density for the master negative opposite the red exposure for the master negative; then read the red exposure for the new negative opposite the red density of the new negative. Repeat with the green and blue densities.

When a flesh tone is used instead of a gray card, both of the above exposure- determination procedures tend to reproduce all flesh tones alike, regardless of individual variations in skin color or in the character of the lighting falling on the original scene. Similarly, all images of a gray card tend to be printed alike, regardless of the position of the card relative to the main light and other such considerations.

Processing

Process the matrices as outlined in the instructions packaged with KODAK Pan Matrix Film.

MAKING PRINTS

Most of the instructions in this section are the same for both KODAK Matrix and Pan Matrix Films. The instructions for the actual transfer operation are based on the use of the KODAK Transfer Register Board or the Vacuum Register Board.

Preparation

Making prints efficiently by the Dye Transfer Process requires adequate working space, including a sink area and a transfer area. Seven trays are needed for the working solutions.

For production work, an automatic tray rocker for the dye baths is recommended; see page 26.

The transfer area should be well lighted (at least 50 footcandles), preferably with the same type of illumination that will ultimately be used to view the prints, so that the print quality and color balance can be judged properly. Illumination of color quality corresponding to a color temperature of 3800 to 4000 K serves well for judging prints. This color quality is approximated by several types of fluorescent lamps (in fixtures), including General Electric Deluxe Cool White, Macbeth Avlite, Sylvania Deluxe Cool White, and Westinghouse Deluxe Cool White.

Mixing Solutions. Most of the chemicals for the Dye Transfer Process are available in prepared form. Follow carefully the mixing directions on the containers. Always use distilled water in making up the working dye baths. If possible, use distilled water in making up the first acid rinse bath also.

All of the other solutions can be made up with ordinary tap water. When tap water is used in the first acid rinse bath, white highlights and margins in prints may show a tint of color. This trouble, if it occurs, can often be eliminated by adding 10 to 40 cc of KODAK Matrix Highlight Reducer R-18 per gallon of 1 percent acetic acid rinse. Depending on the hardness of the water, it may be necessary to use much larger quantities. To make Highlight Reducer, add 18 grains (1.2 grams) of sodium hexametaphosphate or Calgon to 32 fluid ounces (1 liter) of water at about 90 F.

To prepare a solution of approximately 1 percent acetic acid, add I part of KODAK Glacial Acetic Acid to 100 parts of water or 1 part of 28 percent acid to 28 parts of water. Use 1 1/4 ounces (40 cc) of glacial acid per gallon (4 liters) of water or 4 ½ ounces (140 cc) of 28 percent acid per gallon (4 liters) of water.

Conditioning Paper. Use KODAK Dye Transfer Paper of the next size larger than the picture size. For best results, do not attempt to treat more than six sheets at a time.

First, to eliminate any loose gelatin specks along the edges of the paper, rinse each sheet in running water for 30 seconds with agitation and drain it thoroughly. Then immerse the sheets in the working solution of KODAK Dye Transfer Paper Conditioner, immediately interleafing them a few times. Agitate the tray periodically. (If available, an automatic tray rocker provides agitation conveniently. See Figure 5.) The time range for conditioning the paper is 15 minutes to 2 hours.

After rinsing in water, add sheets of paper individually to the paper-conditioner bath as the printing progresses. Lift and drain each sheet a few times to ensure uniform soaking. (If unused paper remains in the bath when printing is finished, it can be squeegeed to remove the excess conditioner and dried. It will then require only resoaking in the conditioner before use.)

When the volume of the paper- conditioner bath becomes insufficient to allow the paper to be completely immersed and to float freely, a fresh bath should be prepared. With extended use, the working solution may accumulate solids, such as paper or gelatin fragments and dust particles. In such cases, the conditioner should either be filtered or replaced.

Care of Solutions. Dye baths and paper conditioner in trays should not be left uncovered for extended periods of time, since evaporation will change their chemical composition.

Covers will also help prevent the solutions from accumulating dust and dirt, which may necessitate spotting work on the prints. For long storage periods, bottles with caps or stoppers are recommended. Do not use glass bottles that have previously been used to store strongly alkaline solutions.

Dyeing and Transferring

Uneven wetting may cause permanent damage to the films. Handle the matrices emulsion side up while they are in trays.

If matrices on KODAK Matrix Film are to be dyed to facilitate register before punching, carry out Steps 1, 2, 3, and 4. Then hang the matrices up to dry; orient all three images in the same direction.

1. Expand matrices. To bring the matrices to full expansion, soak them for 1 minute or more in individual trays filled with water at 100 F to 120 F.

2. Dye matrices. Remove the matrices from the hot water, drain them briefly , and place them in the working dye solutions. Dye the red-filter positive cyan, the green-filter positive magenta, and the blue-filter positive yellow. The time of treatment is at least 5 minutes at room temperature; longer dyeing does no harm. Agitate the trays frequently until dyeing is completed; an automatic tray rocker will be found convenient; see Figure 5.

The magenta and yellow matrices can be left in their respective dye baths while the cyan matrix is being transferred.

3. First acid rinse. Remove the cyan matrix from the dye bath and drain it until the dye solution begins to form droplets. Place the matrix in a 1 percent solution of acetic acid at room temperature and agitate it for 1 minute before draining and placing the matrix in the second acid rinse. Discard this first acid rinse solution after use.

4. Second acid rinse. Place the matrix in a larger tray filled to about three-quarters of its depth with 1 percent acetic acid solution. Lift and reimmerse the matrix at least twice to wash off first acid rinse solution adhering to the surface of the matrix. This bath can be reused until it discolors.

The second acid rinse is often known as the "holding bath," because matrices are left in it for a time ranging from 30

seconds up to 2 or 3 minutes. During this period, the paper is positioned on the transfer surface or, in the case of the magenta and yellow transfers, the preceding matrix is removed from the paper.

5. Position paper. Raise the clamps on the register board. Position the paper on the board, emulsion side up, in such a way that the image will fall on the paper when the matrix is registered over the pins. Squeegee the paper lightly several times to flatten it and remove excess paper conditioner.

To prevent bleeding of the dyes, sponge off the transfer surface around the paper with a sponge dampened with 1 percent acetic acid. Also rinse any paper conditioner off your hands with 1 percent acetic acid before handling matrices, but do not use the second acid rinse bath for this purpose.

6. Position matrix. Remove the matrix from the second acid rinse and drain it. With the matrix emulsion down, first locate the smaller punch hole over the pin on the register board and press the film down over the pin. Holding the matrix by the end away from the punch holes, locate the elongated hole over the other pin. Run your hand across the film between the holes to smooth the punched edge of the matrix into position and lower the two clamps.

During these operations, be sure to keep the matrix raised sufficiently to prevent the image from touching the paper. At the same time, it is important that a bead of second rinse solution is formed between the punched edge of the matrix and the paper. During the next step, this liquid will help expel air bubbles and ensure good contact between matrix and paper.

7. Roll matrix into contact. Use a KODAK Master Print Roller of a size larger than the width of the matrix. Lay the roller on the matrix near the pins of the register board and roll it firmly over the matrix once toward the hand that is still keeping the matrix from contact with the paper ahead of the roller. Do not pull hard on the matrix with your hand; use only enough tension to keep the matrix from the paper until the roller makes the contact. The weight of the roller plus a slight manual pressure gives adequate contact between the wet matrix and the paper. The proper pressure is just enough to allow the resilience of the soft rubber roller to be felt. Excessive pressure may cause register difficulties due to creeping of the paper. Also, if the KODAK Vacuum Register Board is used for the transfer operation, excessive pressure

may cause markings to appear in the picture directly over the vacuum channels. The cyan image transfers in about 4 minutes, depending on the amount of dye carried by the matrix. While it is transferring, prepare the magenta matrix for transfer. Remove the magenta matrix from the dye bath, drain it, and rinse it in a fresh bath of I percent acetic acid (Step 3). Agitate it in the same second acid rinse bath used for the cyan matrix (Step 4), and leave it there while proceeding to Step 8.

8. Remove matrix. Lay the roller on the matrix at the edge farthest from the pins and roll it back far enough so that you can grasp the edge of the matrix. Then pull the matrix back slowly, allowing it to push the roller back as far as the pins. Raise the clamps and carefully disengage the matrix from the pins. Start Step 10 and proceed immediately with Step 9.

9. Transfer magenta. As soon as cleaning of the cyan matrix has been started (Step 10), transfer the magenta matrix, repeating Steps 6 and 7. The image transfers in 4 to 5 minutes, depending on the amount of dye carried by the matrix. While the magenta dye is transferring, prepare the yellow matrix for transfer, repeating Steps 3 and 4.

10. Clean matrix. After each transfer, wash the matrix for 3 minutes in running water at 100 F before draining it and returning it to the dye bath. After every six transfers, treat each matrix in KODAK Matrix Clearing Bath CB-5. (To prepare stock solution of Matrix Clearing Bath, add 4 oz. E120 grams]

of KODAK Anti-Calcium and 1 t~2fl. oz. E48 cc] of ammonium hydroxide to 32 fl. oz. [1 liter] of water at 90 F. To prepare working solution, dilute I part stock solution in 11 parts water.) Agitate the matrix in the clearing bath for 30 seconds and wash it for 3 minutes in running water at 68 to 72 F. After a

clearing-bath treatment, rinse the matrix briefly in the holding bath before returning it to the dye bath. The clearing bath should be replaced at the end of each day, or more often if it becomes strongly discolored in use. With either treatment, drain each matrix thoroughly before returning it to its dye bath The purpose of this precaution is to minimize dilution of the dye baths. To avoid register difficulties, treat all three matrices of a set identically.

11. Transfer yellow. Remove the magenta matrix (Step 8), and put it in the warm water (Step 10). Then transfer the yellow

Matrix, repeating Steps 6 and 7. The image transfers i ' n 2 or 3 minutes. When transfer is complete, remove the yellow matrix (Step 8) and clean it (Step 10).

After the yellow transfers have been completed, it is good practice to swab off with damp absorbent cotton the first two prints from a set of matrices on Pan Matrix Film. This procedure will remove any unhardened gelatin adhering to the prints, thus preventing any veiling of highlights in the picture.

12. Dry print. Remove excess moisture from the surface of the print with a squeegee or windshield wiper blade. Squeegee both sides of the print with firm strokes and immediately hang the print up or lay it on a Frame covered with plastic screening or cheesecloth. Rapid drying gives maximum sharpness. Shrinkage of the print during drying can be minimized by removing excess moisture, then fastening all four edges of the print to a shellacked board with decorator's tape.

Prints on the F surface of KODAK Dye Transfer Paper can be hot ferrotyped in the normal manner, provided excessive heat is avoided. Ferrotype such prints immediately after the yellow transfer.

Subsequent Procedure

Additional prints are made by repeating the dyeing and transfer procedure as many times as necessary. Inmost cases, it will be found that some improvement in print quality can be obtained by use of the control techniques described in the following section.

Quantity Printing. By using 5-minute dyeing and transfer times for all matrices, one operator can print two subjects simultaneously on separate transfer boards. A time cycle is easily arranged.

Life of Matrices. The number of satisfactory prints that can be made from a set of matrices depends almost entirely on the care with which the matrices are handled during the dyeing and transfer operations. By keeping the solutions clean and avoiding physical damage to the relief images, as many as 100 prints or more can be made from a set of matrices.

Storage of Matrices. After the last print has been made, wash each matrix for 1 minute in running water at 100 F, and hang it up to dry, The best place to store the dry matrices is the box in which the film was originally packed. Place each matrix in a separate fold of interleaving paper.

Store the printing data with the matrices so that information about the dye contrast and any control solutions used in the first acid rinse is readily available if printing is resumed. This information can be entered on sheets taped on the outside of the film box or recorded directly on the box.

Automatic Troy Rocker

An automatic tray rocker is an optional piece of equipment that is convenient for dyeing matrices. The construction illustrated below has been found satisfactory for matrix sizes up to 16 x 20 inches.

The rocker should be pivoted in the center as shown; hinging at the front or rear puts an unnecessary strain on the motor. For smaller matrices, the width of the tray rocker can be decreased if a suitable correction is made in the eccentric.

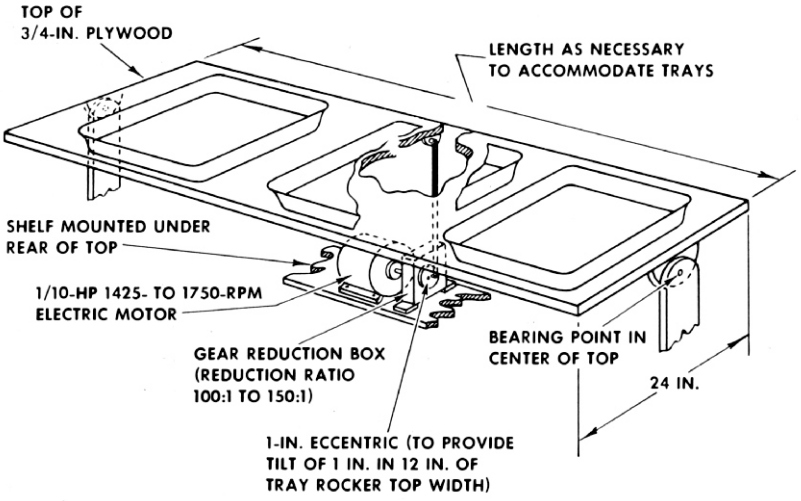

Figure 5

CONTROLLING COLOR BALANCE

Usually, some change in the first print is desirable, either to correct for small errors in exposure or processing, or to satisfy personal preference as to print quality. Briefly, overall print density can be reduced by adding sodium acetate to the rinse bath, or it can be increased slightly by adding acetic acid. Density in the highlights can be reduced by adding KODAK Matrix Highlight Reducer.

Reducing Print Density

One of the most useful controls in the dye transfer process is the addition of sodium acetate to the first rinse of one, two, or all three matrices. Equal treatment of all three matrices in the modified rinsing bath results in a lighter print.

However, suppose that a print shows an overall magenta cast. The density of the magenta dye image can be reduced by adding 5 percent solution of sodium acetate only to the first acid rinse bath used with the magenta matrix. Add 1 to 5 cc of the 5 percent sodium acetate solution per 150 cc of the standard rinse solution. Dye the magenta matrix in the usual manner, When lifting the matrix from the dye bath, drain it until the dye solution begins to run off in droplets before putting it in the acid rinse containing the sodium acetate. Agitate the dyed matrix for I minute in the rinse; then put it in the second acid rinse. More sodium acetate or a longer time can be used to reduce the density further.

In this example, only the rinse for the magenta matrix should contain sodium acetate. Depending on the direction in which the print is off balance, it may be necessary to add sodium acetate to the first acid rinse bath used with two of the matrices, perhaps with a difference in the sodium acetate concentration or in the time of treatment.

Rather large amounts of dye can be removed from matrices by the use of sodium acetate. However, there is a serious decline in photographic quality if you attempt to salvage a definitely overexposed or unbalanced set of matrices by this means.

To ensure consistent results, the sodium acetate solution should be mixed fresh daily.

Reducing Density in Highlights

When the test print is in good balance but the highlights are tinted, add 5 to 10 cc of a solution of KODAK Matrix Highlight Reducer R-18 per 150 cc of the first acid rinse used with the matrix carrying the color that tints the highlights. Agitate the matrix for 1 minute in the first acid rinse before placing it in the second rinse. If the use of sodium acetate is also necessary, the Matrix Highlight Reducer can be used in the same first rinse bath, and either the time of rinsing or the highlight reducer concentration can be varied as required to produce the desired contrast.

Changing Contrast

As stated in the instructions packaged with the matrix films, the preferred method of contrast control is adjustment of the degree of acidity of the dye baths. However, contrast can also be increased slightly by adding acetic acid to the first acid rinse bath. Add 3 to 10 cc of 28 percent acetic acid per 150 cc of the first acid rinse bath. When removing the matrix from the dye bath, transfer it directly, without draining, to the tray containing the rinse with excess acid. The object is to carry over a little dye into the rinse, so that the rinse bath becomes, in effect, a second dye bath. Agitate the matrix for I to 5 minutes in this bath, depending on the increase in contrast needed, and transfer it to the second rinse. As in reducing contrast, it may be necessary to modify the first acid rinse baths used with one, two, or all three of the matrices.

Assuming that the calculations involved in making a set of matrices were correct to within 5 or 10 percent, the use of extra acid usually provides adequate correction. If a greater contrast change is needed in one (or more) of the dye images, the matrix can be dyed in a modified dye bath prepared as described on the sheet packaged with the 1-gallon KODAK Matrix Dye Set or the 5-gallon size of KODAK Cyan Matrix Dye.

SPECIAL PROCEDURES

Extra Rinse Treatments

Sometimes a print shows a gradual shift in color balance f rom one side of the print to the other. This effect, known as "wedging," is usually the result of nonuniform processing.

Uniform color balance can sometimes be restored by additional rinsing of one or more matrices in an auxiliary 1 percent acid rinse containing sodium acetate and KODAK Matrix Highlight Reducer R- 18. For example, if one side of the print is too yellow, the corresponding side of the yellow matrix can be given extra rinsing in the auxiliary rinse bath after completion of the normal first acid rinse. The time of the extra rinse treatment can be varied across the film by dipping the matrix in gradually and withdrawing it gradually. The action of the extra rinse can be stopped at any time by placing the matrix in the second rinse bath.

When a print shows good color balance but has an excess of one color in a localized area, the chances are that one of the negatives or matrices did not receive full development in that area. Again, the correction is to rinse out some of the dye held by the corresponding matrix. The rinse solution can be applied locally with a camel's-hair brush. Alternatively, it can be applied with a washing bottle of the type sold by scientific supply houses for use in chemical laboratories.

Extra Transfers

Instead of removing dye by an extra rinse treatment, it is sometimes advantageous to put additional dye into the picture. The contrast of any of the dye images can be increased greatly by a second transfer from one of the matrices. It is, however, seldom desirable to transfer a second image of full strength. The amount of dye carried by the matrix can be adjusted by one of the following procedures:

1. Redye the matrix briefly. A dyeing time in the range of 10 to 30 seconds is usually satisfactory.
2. Redye the matrix completely, but rinse it afterward in water to remove the dye from all areas except deep shadows. Then rinse it briefly in the holding bath,
3. Instead of redyeing the matrix, return it to the first acid rinse bath, to which has been added 10 to 15 cc of 2 8 percent acetic acid per 150 cc of rinse solution. The rinse bath already contains dye carried over from the dye bath; if necessary, add a few additional cc of dye solution. Agitate the matrix in the rinse bath for 3 to 4 minutes.

When additional color is required only in certain areas, the following procedure may be useful: After the first transfer,

Clean the matrix as usual, but do not return it to the dye bath. Instead, use a soft brush of suitable size to put dye solution on the matrix in the areas where it is needed. Depending on the amount of additional color necessary, either a diluted dye solution or the working dye solution can be used. In either case, the application of dye should be followed by the usual first and second acid rinses before the additional dye is transferred to the print.

Removing Spots from Matrices

During the printing operation, matrices that initially gave satisfactory results sometimes pick up gelatin specks or foreign particles, with the result that small spots of heavy dye density appear in subsequent prints, In most cases, the specks can be removed by swabbing the matrix lightly with cotton while it is in the first acid rinse bath, provided the difficulty is discovered before the matrix has been transferred several times and before it has been dried.

Occasionally, however, the specks or particles adhere so tenaciously that they cannot be swabbed off without damage to the surrounding gelatin. If a number of prints of the same subject are required, the following corrective procedure may prevent the necessity of remaking the matrices or retouching each print individually.

Support the dyed and dried matrix on an illuminator; holding
• sharp etching knife almost at right angles to the matrix, use
• series of short, closely spaced strokes to break up the solid clump of dye and blend it with its surroundings. The fine knife marks will not be distinguishable on prints seen at normal viewing distances.

Matrix Reduction

If the colors in a print are satisfactory except, perhaps, for an area of green that is too dark, correction can be accomplished by treating the appropriate area of the magenta matrix with potassium permanganate. With a brush, carefully apply ½ percent solution to the dry matrix in the area where less transfer is desired. Any stain on the matrix can be removed with a 1 percent solution of sodium bisulfite. After washing, the matrix is ready for use and will absorb considerably less dye in the treated area.

There is some risk in using permanganate on areas of high density because of a tendency for it to cause the emulsion to strip from the film base. Actually, the middle and low densities are the ones that usually require correction. Also, since a ½ percent solution acts quite rapidly, use a weaker concentration until you gain experience with the procedure. Potassium permanganate affects the matrix permanently; once an area has been treated, it cannot be made to absorb as much dye as before.

Retouching

Small light spots can be filled in with diluted transfer dyes, mixed, if necessary, to provide the proper color. Spotting work can be done on either a wet or dry print. Best results are obtained by applying the dye with a small brush, allowing it to remain for a second or two, then blotting it. Spots in dark areas may require several applications, or undiluted transfer dyes can be used.

Dark spots can be removed without damage to the surface of the print by careful use of a permanganate bleach (KODAK Reducer R-2), followed by 1 percent sodium bisulfite solution and rinsing. Then add color to match the surrounding area.

An etching knife can be used on prints. After extensive etching, it may be necessary to spray the print with clear lacquer to hide the difference in surf ace seen by specular light.

Selective Dye Bleaching. Occasionally, it may be desirable to bleach individual dyes in prints. The following procedures work fairly well for experienced operators.

To remove cyan dye, use a weak solution of potassium permanganate (about 1/4 percent). Do not add acid to the solution and do not use a permanganate concentration high enough to leave a brown stain. You can remove a slight brown stain with I percent sodium bisulfite solution.

To remove magenta dye, use undiluted KODAK PHOTO- FLO 200 Solution. Apply the solution with a cotton swab.

To remove yellow dye, use a 5 percent solution of sodium hypochlorite. Alternatively, use a commercial bleach, such as Clorox or 101, full strength.

After any of these bleach treatments, rinse the treated area with 1/10 percent acetic acid and then blot it off.