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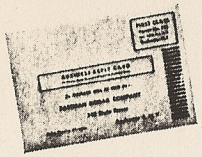
Color Separation AND MASKING

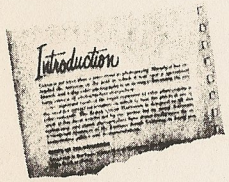
A KODAK COLOR DATA BOOK

FRANK N. McLAUGHLIN

Kodak Color Handbook



Return of the registration card brings to the Handbook owner an occasional newsletter on latest developments in color photography.



The introduction lists other Kodak publications, some free, which supplement the four Color Data Books in the basic Handbook.

COLOR

An easy-to-follow explanation of the principles of color and color photography. Describes how the Kodak color processes work and how results are influenced by visual effects. Profusely illustrated.

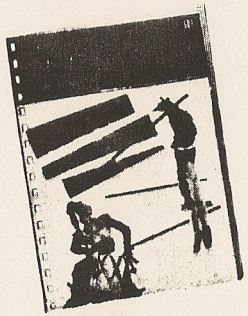
OUTDOORS

Tells how to make high-quality color pictures under a variety of natural illumination conditions. Includes sections on supplementary flash and scenic, illustrative, and architectural photography.

STUDIO

Saves time and film by providing the information needed to plan successful indoor pictures. Includes sections on portrait and commercial lighting, special problems, make-up, and flash technique.

FILMS



Contains full information on handling, processing, color balance and speed, use of filters, and related subjects. Includes a Data Sheet for each of the Kodak materials for still color photography.

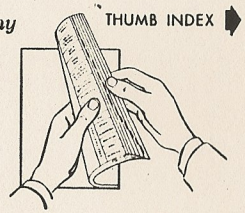
COLOR SEPARATION AND MASKING

FIRST EDITION, 1951—First Printing

This punching fits the *Kodak Color Handbook*. See your Kodak dealer.

FRONT COVER—ADAPTED FROM A KODAK EKTACHROME TRANSPARENCY BY S. J. COMFORT, EASTMAN KODAK COMPANY

THUMB INDEX



Color Separation
AND MASKING

THE *starting point of many photographic color-printing processes, such as the Kodak Dye Transfer Process, is a set of color-separation negatives. Excellent quality in the print requires that these negatives be closely matched in contrast and density. A balanced set requires care and knowledge in their preparation. This Data Book provides the color worker with complete instructions for making good negatives.*

After a brief summary of the underlying principles of color separation, an outline of the procedures and a survey of the equipment needed are given. The detailed instructions then cover the making of separation negatives from a Kodachrome or Kodak Ektachrome transparency or directly from the subject itself. The exposing and processing times and the filter recommendations are given in the Data Sheets at the end of the book. A convenient chart summarizing the steps appears on the inside back cover. This chart can be cut off and fastened to the darkroom wall for ready reference.

The theoretical aspects of masking are complex, but the photographic steps, described beginning on page 38, are not difficult. The improvement in the print usually more than justifies the extra time consumed. Highlight masking is applicable to certain subject types, and instructions are also given for making these masks. The illustrations have been selected to assist the worker in carrying out the various steps of the process and also to show what is accomplished by masking.

Use of the Kodak materials recommended for separation and masking work permits a high standard of photographic quality, because each has been designed to meet the requirements of a specific job. An exceptional degree of product uniformity, maintained by careful testing during manufacture, assures consistent results whenever exposure and development procedures are correspondingly standardized.

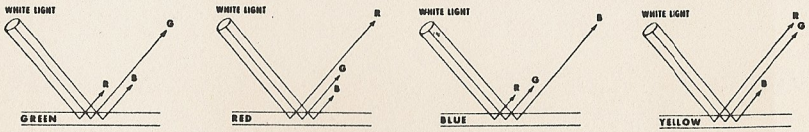
COLOR SEPARATION

THE colors in a landscape, in a garden scene, in a studio portrait subject, or in home decorations are many and varied. The hues range from purple and blue, through blue-green, green, and yellow-green, to yellow, orange, red, and magenta. The reds may be deep and rich, as in a gay party costume, or low in saturation, as the pinks in a delicately tinted flower. The appearance of the sky may range from the bright, soft blue of a clear day in the summer to the dark, threatening tone just before a storm. These examples depict the three attributes—hue, saturation, and brightness—in terms of which all colors may be described. These three variables and their complicated, interwoven effects constitute the great range which a successful color process must reproduce with a convincing degree of fidelity.

CONCEPT OF PRIMARIES

As a visual experiment, choose three filters—a red, a green, and a blue. Next, select as a reference point a nearby white or gray surface which reflects, more or less uniformly, light of the three colors. Then, examine this reference point successively through each of the three filters and compare its brightness with the brightnesses of the various colored objects which reflect light selectively, i.e., reflect more light of one color than of another. For example, if a gray book with a dark red band is examined, the red band may appear to have about the same brightness as the gray when examined through the red filter, but it will appear much darker when examined through the other two filters. If a light blue color is compared with a gray under the red filter, the blue may appear darker; under the green filter, somewhat lighter; and under the blue filter, lighter still.

As various colored objects are examined through the three filters, it becomes very apparent that even though a green object appears light under the green filter, it does not appear completely black under a red or blue filter. This behavior indicates that considerable blue and red light present in the white light falling on the object is being reflected.



Lengths of arrows indicate relative amounts of red, green, and blue light reflected from surfaces of differently colored objects. Note that no colors are completely absorbed.

Almost every colorant reflects light to some extent outside the region of principal reflectance. This effect is illustrated in the diagram on the previous page, where the different lengths of the arrows indicate the amounts of the three primary colors reflected from colored objects.

Photographic Color Separation

The seemingly arbitrary division of color processes into additive or subtractive systems has proved to be somewhat confusing. Actually, the separation or analysis of the colors in a scene is done in the same way in either case, by recording the relative amounts of red, green, and blue light reflected from the original subject. After these color-separation records are obtained, their recombination or synthesis to form a color reproduction can then be done either additively or subtractively. It is only necessary that the amounts of red, green, and blue light reaching the eye from each specific area in the reproduction be controlled in direct proportion to the relative amounts of light of these three colors reflected from each specific area in the original subject. Additively, this can be done, for example, by superimposing on a screen red, green, and blue images formed from three separate projectors. Subtractively, the red, green, and blue light reaching the eye can be controlled by the use of a red-absorbing (cyan-colored), a green-absorbing (magenta-colored), and a blue-absorbing (yellow-colored) set of photographic images, made from the color-separation records, all in register on a single piece of film or paper. The light by which this combination is viewed passes through all three images successively.

The theory and illustrations so far considered can now be applied directly to the photographic process. A camera is employed to photograph a scene by three successive exposures, each on a separate sheet of panchromatic film and with a different primary filter over the lens. When the negatives are developed, a record of the varying amounts of red-light reflectance is obtained in terms of varying densities of silver in the negative exposed behind the red filter; likewise, a green-light reflectance record and a blue-light reflectance record of the subject are obtained on the other two negatives. These negatives are called "separation negatives" because the colors of the original scene have been analyzed or separated in terms of the amounts of the three primaries present in each area of the scene.

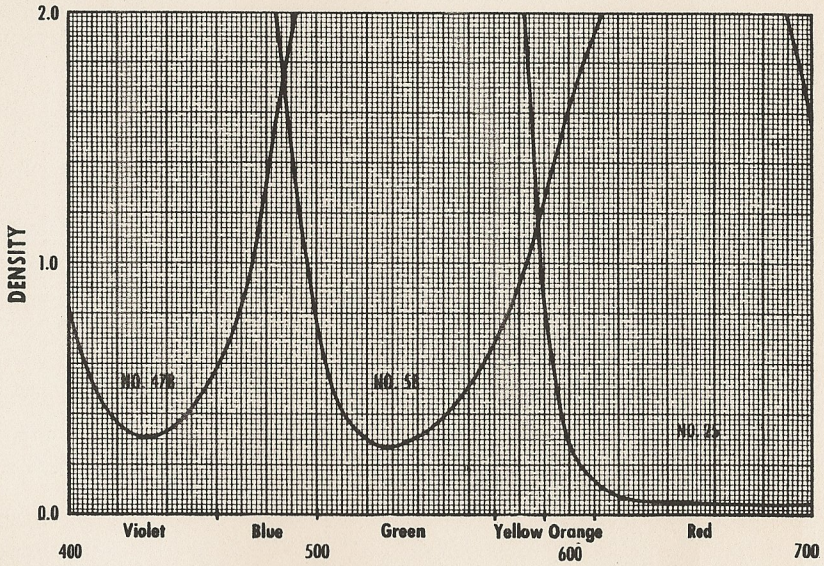
In most color photographic printing processes, a set of three images is made in register on a single film base or white paper. Each image is formed of a color which holds back or controls only one primary color, while freely transmitting the remaining two-thirds of the spectrum. Obviously, a silver deposit cannot be used for this purpose, because silver

is nonselective in its transmission properties; dyes*, therefore, must be employed. For the red-filter separation positive, a dye should be used which transmits freely the blue and green light of the white-light source. Varying quantities of this blue-green ("cyan") dye then absorb or control the transmission of varying amounts of the red component of the white light of the source. A dye which transmits blue and red and absorbs varying amounts of the green light in the light source appears blue-red ("magenta"). Further, a dye which transmits green and red and absorbs varying amounts of the blue light in the light source appears yellow. These three dyes, frequently called the "three subtractive primaries," are also often referred to as "minus red," "minus green," and "minus blue," respectively.

Separation Filters

The shapes of the red, green, and blue transmission curves have been the subject of considerable study. The desired characteristics are determined, at least in part, by the color response of the eye, the film sensitivity, and the characteristics of the subtractive dyes used in the printing process. When the separation negatives are made from a color transparency, the absorption of the dyes in the color film also affect the

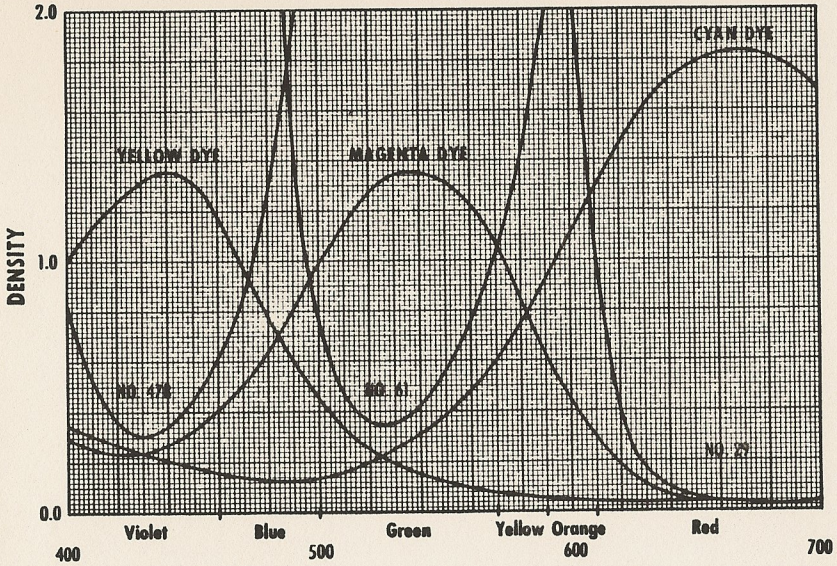
*The term "dyes," as used throughout this Data Book, will stand for all colorants, including pigments and inks.



Spectrophotometric curves show densities in different regions of the visible spectrum of the red, green, and blue filters used for exposing direct color-separation negatives.

characteristics sought in the filters. The spectral densities of the Kodak Wratten Filters closely match the desired values. In the diagram below, the densities of three filters used for direct separation of an original subject are shown plotted at each wave length.

In a color transparency, the color separation is accomplished by the individual layers of the film. When the transparency is printed, a separate record of each dye layer is required. From the dye density curves in the following diagram, it can be seen that the dyes do not transmit freely certain colors of light which they should. In order to isolate the individual dyes as much as possible, sharp-cutting filters provide maximum separation. However, it is not possible to isolate completely the three dye layers by the use of filters alone. For example, if a record of the magenta dye is sought by exposing the separation film with a sharp-cutting green filter, it is obvious that varying amounts of cyan dye will also affect the results since the cyan dye has considerable density in the green region. Ideally, the cyan dye should transmit blue and green freely and absorb only the red light. These unwanted absorptions can be dealt with by photographic masking procedures, a subject which will be discussed later.



Curves show the spectral densities of filters used for separation negatives made from color transparencies, together with those of three subtractive dyes used in a transparency.

OUTLINE OF SEPARATION PROCEDURE

THE various procedures by which an original scene can be photographed and printed in color are diagrammed on page 9. Separation negatives can be made of many subjects in a single- or double-mirror one-shot camera; from positive color transparencies; or of still-life subjects by three successive exposures in a conventional camera with a different filter over the lens for each exposure. For photomechanical reproduction, the negatives are made on either film or plates. For photographic printing, such as by the Kodak Dye Transfer Process, film is more frequently used. To minimize any dimensional changes, however, separation negatives on film should be handled uniformly in processing, drying and storage. They should not be subjected to excessive heat in the enlarger or during the time work is being done on the retouching desk.

Kodak Super-XX Panchromatic Film and Kodak Separation Plates, Type I, are particularly suitable for separation work. These materials yield a long straight-line portion of the characteristic curve and closely matched curve shapes when exposed through the separation filters and processed in accordance with the instructions.

SEPARATION NEGATIVES FROM A TRANSPARENCY

ONE important factor in obtaining a good reproduction is the careful selection of a transparency of excellent photographic quality. Seldom is it possible to obtain a reproduction which is an improvement over the original transparency. The transparency selected should therefore be properly exposed, of relatively low lighting contrast, sharply focused, and free from physical defects such as scratches, dirt, and other blemishes. Overexposure of the original transparency may result in a lack of gradation and color in the highlights, and a loss of over-all color saturation. Underexposure may result in a loss of shadow detail and distortion of the color balance in other parts of the scale. Excessive lighting contrast may result in a loss of both highlight and shadow detail and in problems in the reproduction process. Best prints are obtained from a transparency which has a somewhat restricted lighting ratio and is slightly darker than what is considered normal for ordinary viewing purposes.

To sum up, if you want to make a good color print from a transparency, start with a good original. This simple rule is all too often ignored by enthusiastic beginners.

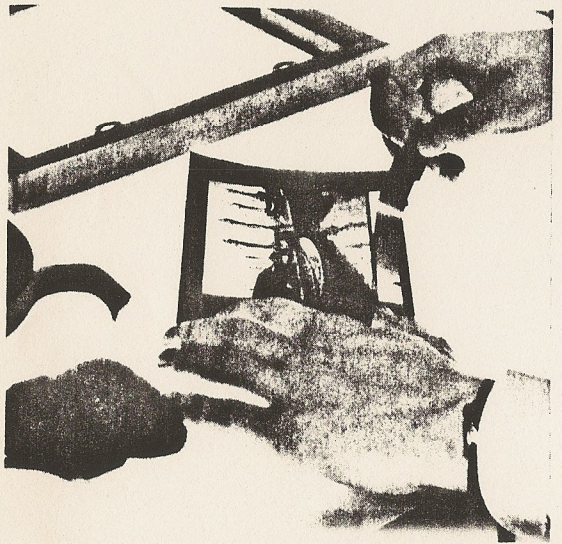
Precautions

All possible care should be exercised at each step of the process to remove dust and dirt particles from the films and equipment with a soft brush, such as a Kodak Camel's-Hair Brush. If necessary, fingerprints and tenacious dirt particles can be removed from the transparency, separation negatives, or masks with Kodak Film Cleaner.

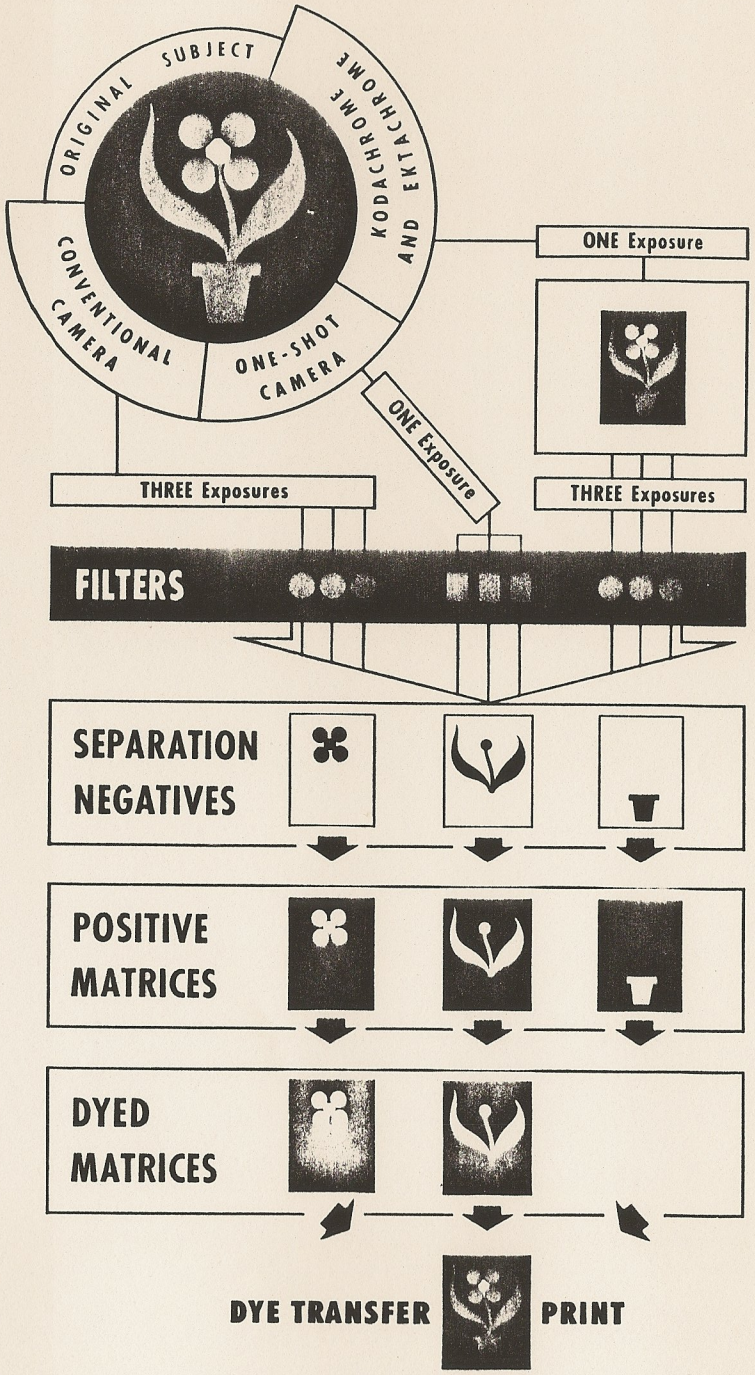
The precautions required in handling films are also necessary in keeping printing equipment clean. The glass in the negative carrier or in the printing frame should be cleaned thoroughly and examined for scratches and defects. When dust has accumulated on lenses, it should be brushed away carefully with a camel's-hair brush or with wadded Kodak Lens Cleaning Paper. To avoid any changes in the color of the light, produced by corrosion or dirt, the lamp house and condensing system of the equipment should be cleaned frequently. The lamp itself should be replaced whenever any darkening appears within the bulb.

Making Contact or Enlarged Negatives

Once the transparency has been selected, and cleaned, if necessary, separation negatives can be made either by contact or by enlargement. The choice depends upon: (1) the size of the original transparency, (2) the size of the final reproductions, and (3) the equipment available. Enlarged separation negatives are usually made from transparencies exposed in miniature cameras and in cameras taking film in sizes up to 2¼ x 3¼ inches. Contact separation negatives are customarily made from sheet-film transparencies 3¼ x 4¼ inches and larger. It is preferable, where possible, to make the negatives by contact because flare light in an optical system reduces the contrast. Matrices are most frequently made by enlargement, and an enlarger of sufficient size and range to handle the negatives should be available.



Transparency and step tablet being mounted in a mask cut to the proper opening. An illuminator built into the table top provides a convenient working area. A camel's-hair brush is used to remove loose dirt and dust particles.



For contact separation negatives, a silver gray scale, such as a Kodak Photographic Step Tablet, should be taped to the transparency and the transparency placed in a printing frame. An enlarger or a special printing light can be used as a source. A sheet of Kodak Super-XX Panchromatic Film is placed in contact with the transparency and exposed with the separation filters over the light source.

For enlarged separation negatives, the transparency and step tablet should be placed in the negative carrier of the enlarger, the enlarger adjusted to the proper degree of magnification, and the red separation filter placed over the lens. The Super-XX Film should be placed on the easel and the exposure made. The other two negatives should be made in the same way with appropriate changes in the exposing times.

If a photographic mask is used in order to reduce the contrast of the original transparency and to effect color correction, it should be mounted in register with the transparency prior to the time the separation negatives are exposed. Because of the contrast-reduction effect of the mask, the separation negatives must be developed for a somewhat longer time than if no mask were used.

DIRECT SEPARATION NEGATIVES

For still-life subjects, a conventional camera can be used to make three successive exposures through red, green, and blue filters such as the Kodak Wratten No. 25, No. 58, and No. 47 or 47B, respectively. An extremely rigid support for the camera is necessary, as well as identical positioning of the film plane, relative to the camera back, in the three holders. The exposing times for the three negatives vary, depending upon the light source. The developing times should be checked against the recommendations given in the Data Sheets. A reflection gray scale should be included in the scene to check the balance of the three negatives.

Separation negatives can also be made of almost any type of subject by the use of a one-shot camera. In these complex cameras, the three negatives are exposed simultaneously through the appropriate filters. Of necessity, the camera back is rigid and the adjustments to the lens board are somewhat more restricted than with conventional film or plate cameras. Various types of panchromatic materials are recommended by the camera manufacturers, who should be consulted for information on the use of their equipment.

EQUIPMENT

Specialized equipment is not necessary for making color-separation negatives. Mechanical rigidity and optical alignment of the lenses and negative carriers in the cameras and enlargers are highly important, so that there is not the slightest change between exposures. The lenses used should be adequately color-corrected. All Kodak lenses of three or more elements are entirely suitable. Kodak Ektar and Kodak Projection Ektar Lenses are highly recommended for color work. The darkroom equipment customarily used for black-and-white processing and printing is usually suitable for color-separation work.

CAMERAS AND ENLARGERS

Cameras for direct separation work should be of rigid construction and have a provision for locking all adjusting screws in place. The holders should be selected so that the films or plates are held at precisely the same distance from the lens in all three holders. If photographic tests show poor register in the negatives, checking can be done with a depth gauge and a sheet of film in the holder.

The field of illumination from the enlarger must be as uniform as possible in the exposing plane. Uniformity can be improved by reducing the size of the field by masking the edges of the negative in a suitable manner. Decreasing the lens aperture will usually improve the uniformity of illumination.

The enlarger should be rigidly constructed, and the locking mechanism should hold the enlarging head firmly at the degree of magnification required. The negative carrier should position the three negatives successively in the same plane. If considerable stray light leaks out around the negative carrier and lamp house, the darkroom walls surrounding the enlarger should be covered with a matte-black material similar to the black interleaving paper packed with film. Black photographic tape can be used around the negative carrier to reduce stray light to a minimum. To prevent scattering of image-forming light, the surfaces of the separation filters should be free from scratches, fingerprints, and dust or dirt. They should be located over the lens in such a way that all of the exposing light passes through them.

EXPOSING LIGHT SOURCE

A Kodak Auto-Focus Enlarger, Model E, or some similar enlarger equipped with a photographic enlarging lamp (tungsten) can be used

by contact in a printing frame. Ordinary contact printers cannot be readily converted to this specialized use because of the cost of filters large enough to cover the negative area and the need for a much lower level of even illumination. In cases where the illumination from the enlarger is not adequate, a separate source can be devised. Usually, at least 3 foot-candles is necessary for ordinary work.

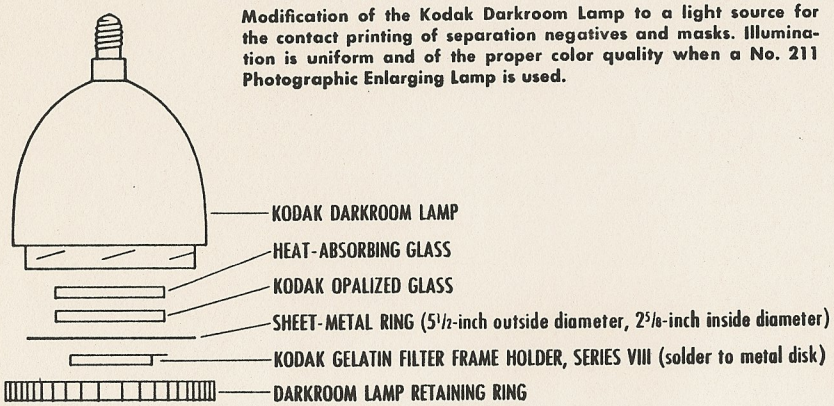
A Kodak Darkroom Lamp can easily be adapted to serve as an exposing light source for all ordinary work. The safelight filter should be replaced with a metal disk with a 3-inch hole cut in the center. A 3⅝ to 4-inch square piece of Kodak Opalized Glass is then placed over the hole to improve the uniformity of illumination. A 3-inch Kodak Filter Frame Holder, which accepts gelatin filters mounted in 3-inch Kodak Gelatin Filter Frames, is soldered or screwed to the metal disk. A piece of heat-absorbing glass should be placed between the filters and the lamp itself to protect the filters. When a Photographic Enlarger Lamp No. 211 is used with the heat-absorbing glass, the color of the light is such that the exposing times are approximately the same as those used with the Kodak Auto-Focus Enlarger. Heat-absorbing glass is manufactured or sold by the following companies:

Libby-Owens-Ford, Blue Ridge Division, Kingsport, Tennessee
(⅛-inch Blue Ridge Heat Absorbing Glass)

Corning Glass Works, 1949 Crystal Street, Corning, New York
(Light Shade Aklo, No. 3965, polished, approximately 2mm)

Semon-Bache & Company, Greenwich and Morton Streets, New York 14, New York
(No. 125 Heat Absorbing Glass)

The drawing below shows how the Kodak Darkroom Lamp can be adapted for this purpose.



Modification of the Kodak Darkroom Lamp to a light source for the contact printing of separation negatives and masks. Illumination is uniform and of the proper color quality when a No. 211 Photographic Enlarging Lamp is used.

The Kodak Darkroom Lamp as sold is approved by the Underwriters' Laboratories for continuous use with a 15-watt incandescent lamp. Higher-wattage lamps may cause damage to the socket from excessive heat if the lamp is allowed to remain on continuously. In no case should a lamp of over 100 watts be used.

Voltage Control. The intensity and color of the exposing light change with voltage variations, and changes in the relative exposing times result. With tungsten lamps designed to operate at 115 volts, a change of 1 volt may produce a color-temperature change of approximately 10 K. A constant-voltage transformer can be used to deliver a predetermined voltage which is unaffected by small supply-line voltage fluctuations. A unit rated at 5 amperes is recommended for use with the light source so that the same unit can be used with the enlarger when the matrices are made from the separation negatives. Such units are manufactured and sold by:

Sola Electric Company
4638 West 16th Street
Chicago 50, Illinois
Model CV 3808 500 VA

General Electric Company
(Contact local distributor)
Catalog No. 69G851

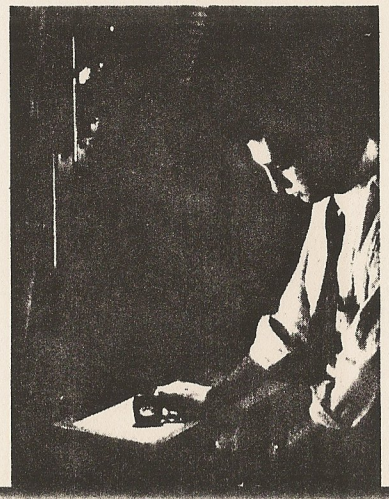
Nonautomatic voltage regulation can be accomplished less expensively with an adjustable transformer and an alternating-current voltmeter connected across the feed to the lamp. The transformer should be adjusted so that the desired voltage is obtained on the lamp just prior to making the exposure. These transformers are available from:

General Radio Company
30 State Street
Cambridge 39, Massachusetts
Variac, Type V-5 MT

Superior Electric Company
385 Laurel Street
Bristol, Connecticut
Powerstat Type 116

Illumination Measurements. These measurements can be taken with an illumination meter, such as the Weston Analyzer, or any incident-light exposure meter capable of reading illumination values as low as 1 foot-candle, such as the General Electric Exposure Meter, Model No. DW-68, or the Norwood Director. The light-sensitive cell should be held in the actual exposing plane. This requirement means that if the meter is placed on the ex-

Measuring the illumination from a Kodak Auto-Focus Enlarger with an incident-light meter.



posing plane, the light source must be moved away temporarily by an amount equal to the height of the light cell above the plane. The thickness of the contact printing frame may also have to be taken into consideration. Uniformity measurements should be made in the center and in each corner of the exposing plane. If necessary, the uniformity can be improved by restricting the size of the illuminated field.

If a suitable incident-light meter is not available, the illumination level can be checked photographically. A sheet of Kodak Super-XX Panchromatic Film should be placed in contact with a photographic step tablet in a printing frame located on the exposing plane. An exposure of 10 seconds is given through a Kodak Wratten Filter No. 61. The film is then developed for 4 minutes in a tray of Kodak Developer DK-50, diluted 1 to 1, at 68 F (20 C). If the illumination level was 3 foot-candles, a density of 0.3 should be obtained in the resulting negative under the step in the tablet having a density of 3.0.

STEP TABLET

When separation negatives are made from a positive transparency, a silver step tablet should be attached to the transparency and exposed along with it. Thus, each separation negative will contain a reproduction of the same set of neutral-gray densities. These densities are then read and plotted on graph paper to give an indication of the exposure balance of the three negatives. The step tablet should be of convenient size, usually about as long as the width of the transparency being reproduced. The Kodak Photographic Step Tablet No. 1A is recommended when separation negatives are being made of a transparency on miniature-camera film. The steps are of such a size that they coincide exactly with the spacing of the perforations in K135 size film. The Kodak Photographic Step Tablet No. 2 is recommended when contact negatives are to be made from transparencies as large as 4 by 5 inches or 5 by 7 inches. The Kodak Photographic Step Tablet No. 3 is recommended for use with larger transparencies. When direct separation negatives are made, a reflection-type gray scale, such as the Kodak Gray Scale packed with the Kodak Color Separation Guide, should be included in the picture where it can be subsequently trimmed off the print. If a reflection densitometer is not available, a calibrated Kodak Paper Gray Scale should be used.

DENSITY MEASUREMENTS

Some means of reasonably accurate density determination should be employed to insure correctly balanced separation negatives. Density values can be estimated closely with a Density Kodaguide. The areas

to be evaluated in the transparency or negative must be along the edge so that the film can be trimmed and inserted in the slot provided.

If color work is to be undertaken on any sort of a quantity basis, an accurate densitometer is an essential piece of equipment. A densitometer, such as the Kodak Color Densitometer, will save many times its cost in film and time saved, as well as increase the quality of the prints turned out. Although the density values can be plotted on ordinary graph paper, the Kodak Color Separation Record Sheets provide a very convenient means of recording the necessary information and plotting the characteristic curves. A description of the method for plotting these curves is given, beginning on page 29.

EQUIPMENT LIST

In addition to the equipment which has been described in detail, the materials ordinarily used for handling black-and-white films are also needed for making color-separation negatives. The following list serves as a check:

- Printing frame (Size governed by the maximum size of the negatives made by contact)
- Kodak Anti-Newton-Ring Glass (Necessary if trouble is experienced with Newton's rings)
- 3 trays or 3 developing tanks
- Film hangers (Necessary if developing tanks are used)
- Kodak Developer DK-50
- Kodak Stop Bath SB-1a
- Fixing Bath (Kodak Acid Fixer, Kodak Rapid Fixing Bath F-7, or Kodak Rapid Liquid Fixer with Hardener)
- Kodak Photo-Flo Solution
- Kodak Super-XX Panchromatic Film or Kodak Separation Negative Plates, Type I or Type I Matte
- Kodak Wratten Filters
  - No. 25, 58, and 47 or 47B (For direct separation negatives)
  - No. 29, 61, and 47B (For separation negatives from Kodachrome and Kodak Ektachrome transparencies)
  - No. 33 (For single-mask procedure from transparencies)
- Kodak Process Thermometer
- Kodak Mask Charts

NEGATIVES FROM A COLOR TRANSPARENCY

THE procedures for making separation negatives from positive transparencies are similar for both contact and projection methods.

PRELIMINARY STEPS

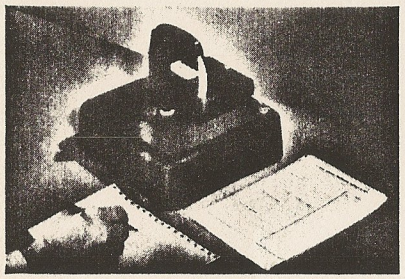
IN printing a color transparency, especially one which contains no sharp detail, it is often desirable to make three X's with a knife or razor blade along two sides of the transparency outside the picture area. The reproduction of these marks can then be used in checking the register of the separation negatives and in registering masks and matrices.

The density difference between the brightest, nonspecular, white highlight and the darkest shadow region in which detail must be preserved in the final print is the density range of the transparency. These densities should be read on a densitometer, such as the Kodak Color Densitometer, or estimated with a Density Kodaguide. The filters furnished with the Kodak Densitometer are helpful when the areas are not neutral in color. In this case, use a filter which is similar in color to that of the highlights to obtain as low a density reading as possible; for example, a red filter for flesh tones. Use a filter complementary in color to the shadow regions to obtain as high a density reading as possible; for example, a green filter for warm shadows. Record these values on a Kodak Color Separation Record Sheet.

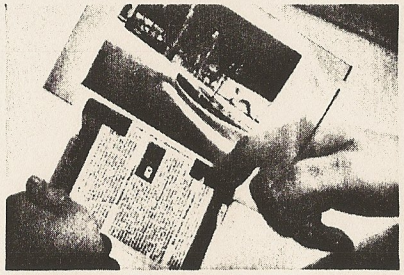
Identification

Proper identification of the films, either immediately before or after exposure, is necessary to avoid subsequent confusion, particularly if the photograph does not include the Kodak Gray Scale of the Kodak Color Separation Guides. Strips of red, green, and blue filter material

Plotting step tablet densities, read on a Kodak Color Densitometer, on record sheets.



Comparing densities in separation negative with the scale in a Density Kodaguide.



or spots of transparent water colors or inks can be used on the clear end of the step tablet. The spot having the color of the exposing filter will reproduce with high density in the negative, whereas the other two colored spots will appear relatively light. Other methods of identification are to notch the film with a punch or to trim the corners with scissors. Usually, the red-filter negative is left unnotched, the green has one notch, and the blue has two notches. Each film hanger should also have a corresponding number of notches filed in the top bar for easy identification in the dark. Plates can be marked by scraping off the emulsion with a fingernail from the appropriate number of corners.

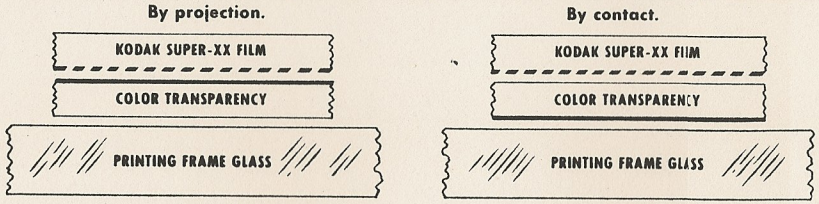
ARRANGEMENT FOR CONTACT NEGATIVES

THE glass in the printing frame, the transparency, and the step tablet should be examined for cleanliness by both transmitted and reflected light. Place the exposing light source in its proper position and adjust the intensity to the recommended level. Place the separation-negative filters, the Kodak Wratten Filters No. 29, 61, and 47B for the red-, green-, and blue-filter negatives, respectively, on the bench top where they can be located conveniently in the dark.

In the Kodak Mask Chart, cut an opening of the proper dimensions to accommodate the transparency and the Kodak Photographic Step Tablet and tape them in place. To identify corresponding steps in the masks and separation negatives, use small arrows cut out of black photographic masking tape. These pieces of tape can be attached to the middle step or to the two steps which have the same densities as the diffuse highlight and shadow regions in the transparency itself.

For maximum sharpness in the negatives, good contact should be obtained between the transparency and the separation-negative film. If matrices are to be made subsequently by projection from the negatives, the emulsion sides of the two films should be in contact as shown in the diagram below. If contact matrices are to be made, the emulsion sides of both films should face the light source. The code notches of the three negative films should be in the same corner of the printing frame to facilitate orienting the films properly for processing later.

Orientation of films for contact printing the negatives when the matrices are to be made:



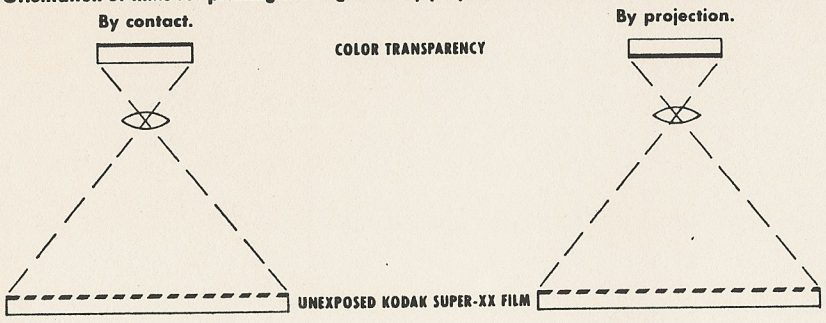
Problem of Newton's Rings. The interference patterns known as "Newton's rings" are frequently produced, under conditions of high relative humidity, in the close-to-optical contact between the transparency and the printing-frame glass. These irregular, colored patterns are most readily seen by reflected light. Measures to eliminate the interference patterns must destroy this optical contact. One method is to rub the glass surface involved with a wad of damp cotton which has been dipped in a fine abrasive. Grade 00 pumice, which is available at paint stores, is recommended. The minute scratches produced by this material are practically invisible to the eye, but they usually are sufficient to eliminate the Newton's rings. Another method is to replace the clear glass in the printing frame with a piece of Kodak Anti-Newton-Ring Glass. Diffusion of the light source should be provided, as outlined in the instructions packed with the glass.

ARRANGEMENT FOR ENLARGED NEGATIVES

TAPE the transparency and the photographic step tablet to a Kodak Mask Chart and place in the center of the carrier. If contact matrices are to be made from the enlarged negatives, put the transparency, with its emulsion side toward the light, in the enlarger as shown in the diagram below. Check the focus of the enlarger, and, if necessary, compensate for the slight displacement of the emulsion from the normal plane. If enlarged matrices are to be made from the enlarged separation negatives, place the emulsion side of the transparency down toward the easel. Make certain that there are no light leaks around the transparency in the negative carrier.

Mount the three separation filters in Kodak Gelatin Filter Frame Holders for use over the lens. Unless the masking frame on the easel holds the negative material down in contact with the board, use one film holder successively for the three exposures, since thickness variations from holder to holder may cause register difficulties later.

Orientation of films for printing the negatives by projection when the matrices are to be made:



Select a size of film which is larger than the projected image. Leave clear borders around the edges of the image in the negative so that any processing nonuniformity will not extend into the image area.

EXPOSURE

THE exposure times for contact separation negatives from Kodachrome and Kodak Ektachrome transparencies are given in the Data Sheets beginning on page 51 and in the summary of steps on the inside back cover. These recommendations are based on the use of (1) the No. 29, 61, and 47B filters, (2) the illumination level specified in the table on page 21 with the indicated light source, and before the insertion of the separation filters over the lens, (3) Kodak Super-XX Panchromatic Film, and (4) the negative processing recommended in the Data Sheet. A change in any one of these conditions can result in a large density mismatch in the steps of the gray scales.

Determining Exposure Level

The exposure for separation negatives from transparencies which have a density range of *less* than 2.4 is based upon the *shadow* density in the transparency. The deepest shadow area in which detail is required should have a density of around 0.4 in the negative. This value results in a minimum loss of detail in both sunlight and shadow regions.

The exposure for the separation negatives made from transparencies which have a density range *greater* than 2.4 is based on the *highlight* density in the transparency. The exposure should produce a maximum density of approximately 1.8 in the brightest highlight in which detail must be retained in the negative. Thus overexposure in the highlights, in which color balance is especially important, is avoided even though detail in some of the deep shadows may be lost.

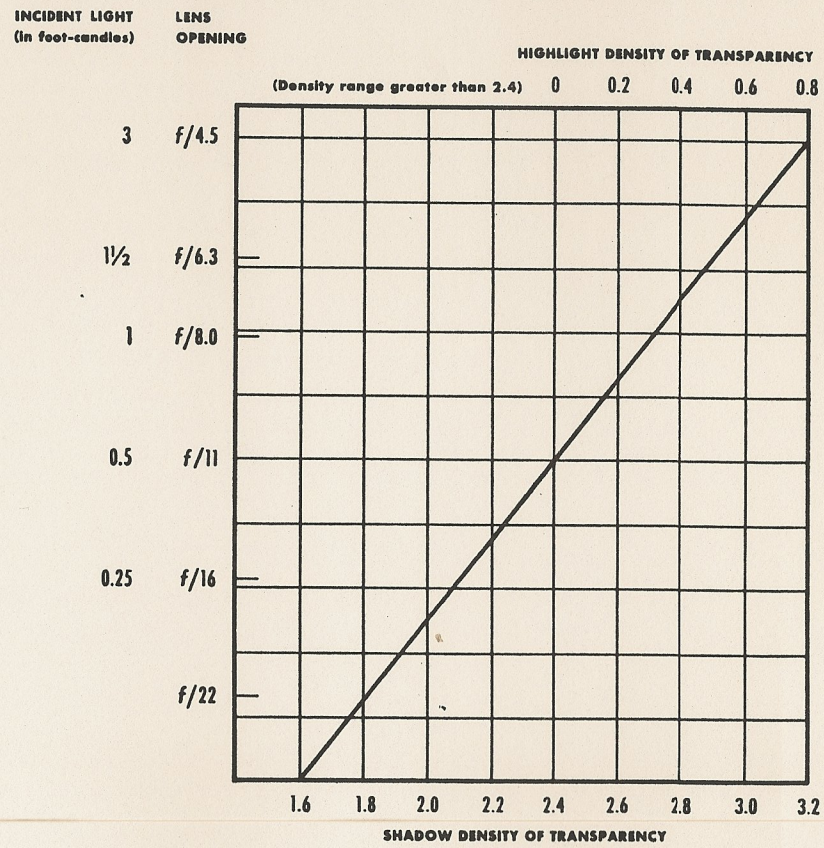
If density measurements cannot be made, a shadow density of 2.8 in the transparency should be assumed and a trial exposure made. When the negative is processed, detail should be visible in the shadow regions to the same degree that it appears in the transparency.

The following chart provides a means of predetermining the exposure, if the highlight and shadow densities, and therefore the density range, of the transparency are known. For transparencies with a range less than 2.4, the horizontal scale across the bottom of the chart should be used. The vertical scale at the left is marked in both illumination levels and lens openings. If a tungsten-light enlarger, such as the Kodak Auto-Focus Enlarger, Model E, is used for enlarged separation negatives or as a light source for contact negatives, the magnification should be adjusted to give 3 foot-candles at the exposing plane. The measure-

ment of the incident light should be made with the edges of the negative carrier sharply focused on the easel and the lens set at *f*/4.5. The lens opening should then be set according to the chart.

If a light source is devised in which there is no calibrated aperture, the illumination levels must be set with a meter. Accurate measurement of these low illumination levels may prove to be difficult, in which case a level of 3 foot-candles or more should be used and the appropriate density of the Kodak Wratten Filter No. 96 placed over the aperture of the source to cut down the illumination. As an example, if 3 foot-candles are measured at the exposing plane and the shadow density of the transparency is 2.6, a density of 0.6 will cut down the illumination to ¼ of 3, or 0.75, foot-candle. The amount of illumination is halved each time a density of 0.3 is used over the source.

Chart for determining separation-negative exposures from density readings of transparency.

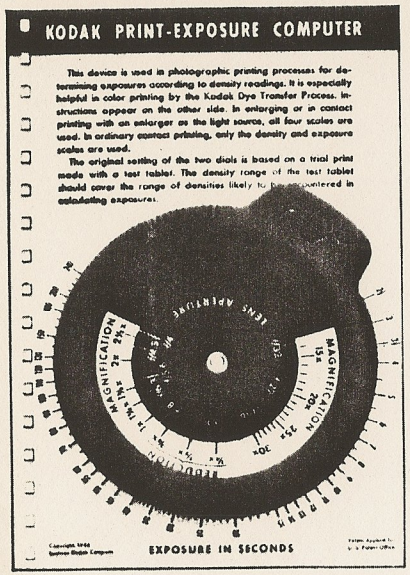


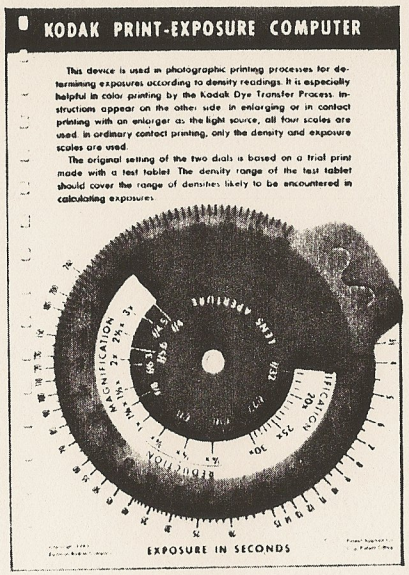
FROM A KODAK EKTACHROME TRANSPARENCY BY WILLIAM BECKER

Exposure for Enlarged Negatives

The same exposure times as are recommended for contact negatives can be used for enlarged separation negatives, provided the illumination level or the degree of magnification is the same as that given in the table. The Kodak Print Exposure Computer can be used to determine exposure times for different illumination levels or magnifications. For example, the illumination level of 3 foot-candles, upon which the exposure chart is based, is obtained with the Kodak Auto-Focus Enlarger, Model E, with its magnification set at approximately 2¼ times and its lens aperture at *f*/4.5. On the two inside scales of the Print Exposure Computer, the magnification of 2¼ times should be set opposite *f*/4.5 as shown in the illustration below. On the two outside scales, the exposure time of 25 seconds for the red-filter negative should be set opposite any convenient density setting (1.0 for example) without changing the setting of the two inside scales. The two movable scales should then be turned together to bring *f*/4.5 opposite the desired magnification. The exposure time can then be read opposite the same density value (1.0) as was used previously. The settings for the Print Exposure Computer are shown in the two illustrations below. The same procedure can be followed for the green- and blue-filter negatives, or the times can be determined by the use of the appropriate filter ratio.

Kodak Print Exposure Computer used to determine the exposing times for separation negatives made by projection when the illumination level is other than 3 foot-candles.





PROCESSING

SEPARATION negatives should be handled in total darkness, at least until the development is half completed. When a safelight is used, it should be fitted with a Kodak Safelight Filter, Wratten Series 3, and a lamp of no more then 15 watts. The safelight should be at least 4 feet away from the film tray or tank. It is preferable not to allow the light to fall directly on the film and to turn on the safelight only as needed.

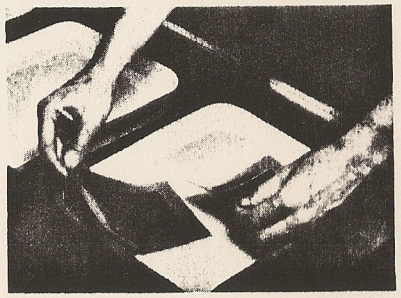
In order to hold the temperature of the developer constant at 68 F for the duration of the developing time, the tray or tank in which the film is processed should be surrounded with a water jacket. The solution temperature should be checked with an accurate thermometer, such as the Kodak Process Thermometer, just before the darkroom lights are turned off. The temperatures of the other solutions should be between 65 F and 75 F. For maximum accuracy, a timer, such as a Kodak Timer, with a large dial and sweep second hand should be used.

Tray Processing

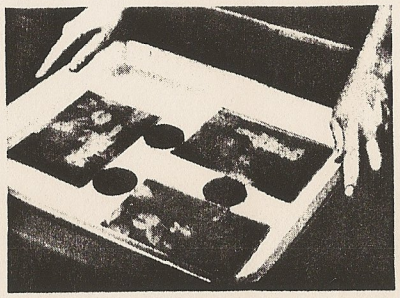
The three negatives should receive identical treatment under carefully controlled processing conditions. Throughout the processing steps, the code notches on the three films should be kept in the same relative positions. As a general rule, tray processing with continuous agitation is recommended because more uniform results are possible than with tank processing. Tray processing also makes it practical to use fresh developer for each set of the three negatives. The tray should be considerably larger than the film, and at least 300 cc (10 oz) of Kodak Developer DK-50, diluted 1 to 1, should be used per 80 square inches of film.

The exposed films should be immersed in the developer one at a time and emulsion side up. The blue-filter negative should be put into the developer ahead of the other two negatives by a time equal to the increased length of development time required by that negative. This

Recommended agitation when three films are developed in a tray at one time.



Rubber suction cups attached to bottom of tray to prevent plates from overlapping.



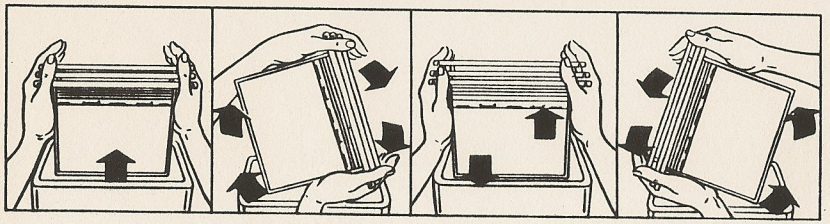
procedure assures uniform treatment because the three negatives can be removed at the same time and handled together in the subsequent processing steps. To prevent the films from sticking together, each sheet should be thoroughly covered with the developing solution before the next sheet is added. Uniform agitation should be provided by constantly removing the bottom film and placing it on top. Although there is more danger of damage through careless handling in one tray than in three separate trays, the development is more uniform and repeatable.

If the separation negatives are made on plates, development in a tray large enough to hold all the plates on the bottom is necessary. Enough developer should be provided to cover the plates at all times as the tray is rocked. Overlapping of the plates during processing can be avoided by the use of rubber suction cups attached to the bottom of the tray in such a way as to keep the plates separated.

Tank Processing

Wherever possible, tray processing should be used for the sake of uniformity of results. When several sets of films or plates must be developed at one time, however, rack and tank processing is a practical necessity. No more films or plates should be developed than can be accommodated with at least a ½-inch separation between the hangers. It is important to maintain this separation; when the hangers are lifted for agitation, this can be done by some means such as the use of a suitable developing hanger rack. Hangers may be either of the channel or clip type. In the channel type, the film or plate is retained by a "U"-shaped groove around the periphery of the frame, whereas the clip type consists of a rectangular frame with clips attached to each corner. Arrange the tank so that the film surface will be parallel to the edge of the bench or sink. With the processing solutions at a temperature of 68 F (20 C), turn out the light, load and assemble the developing hangers, and proceed as follows:

Start the timer. Lower the hangers as a unit smoothly and carefully into the developer. Immediately tap the hangers sharply two or three times on the upper edge of the tank to dislodge any air bells clinging



Recommended agitation for films and plates when they are processed in a tank.

Red-, green-, and blue-filter negatives from transparency reproduced on page 20.

to the emulsion. Check the spacing of the hangers to make certain that they are at least ½ inch apart.

Allow the hangers to remain undisturbed for the remainder of the first minute. Then quickly lift them clear of the solution and, keeping the plane of the films parallel to the edge of the bench or sink, rotate them either clockwise or counterclockwise. Immediately reimmerse them and again lift them clear of the solution, rotating them in the opposite direction. It is important that the angle of rotation should not be appreciably less than 90 degrees. Reimmerse the hangers quickly in the solution and check their spacing. The entire cycle of lifting and reimmersion should be as rapid as possible (5 to 7 seconds) without interfering with smooth operation. Repeat at 1-minute intervals.

Finishing

After the negatives have been developed for the proper length of time, they should be rinsed, fixed, washed, and dried in accordance with the instructions packed with all Kodak films and plates.

Identical treatment of all three negatives should be used in the drying step. The films or plates should all be removed from any processing racks used and dried with the images oriented in the same direction. If the negatives do not dry quickly, a gentle breeze from a fan can be used. A drying compartment can be used provided the temperature is not allowed to exceed 85 F.

The negatives should be examined carefully for pinholes, scratches, and other blemishes. If the original subject was a portrait, the blue-filter negative will appear to have more blemishes, as well as a lower apparent contrast, than the other two negatives. Facial blemishes in portraits and variations in the surface reflection characteristics of painted or polished materials seem to be emphasized under blue light. However, these photographic defects are seldom detected in the final reproduction because of the low visual contrast of the yellow dye.

DIRECT SEPARATION NEGATIVES

Kodak Super-XX Panchromatic Film or Kodak Separation Negative Plates, Type I, are recommended when separation negatives are made directly from the subject in a conventional camera. For "one-shot" or single-exposure cameras, no one negative material can be recommended because of the different transmission characteristics of the mirrors or pellicles used in these cameras. Detailed information on specific equipment should be obtained from the manufacturer.

LIGHTING

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

For direct separation work, the color quality of the light source affects the filter ratios for the three color filters. All the lights used for a particular picture should be of the same color quality. Once a satisfactory set of exposure times has been determined for the particular source, these same exposure times can be employed with the given light source when other sets of negatives are exposed. The tables on pages 51 and 53 give the recommended filter ratios to be used with a clear-bulb, high-efficiency lamp without an optical system. The proper exposure should be determined by the use of an exposure meter set to the appropriate Exposure Index (given in the Data Sheets) or by trial through the Kodak Wratten Filter No. 25. This time can then be converted into the required exposure times through the other filters by multiplying the calculated exposure through the No. 25 filter by the appropriate filter ratios. For example, the filter ratio for the No. 25 filter is 1.0 for Kodak Super-XX Panchromatic Film exposed to a scene illuminated by tungsten lamps and processed according to the recommendations. If the correct exposure through the red filter is found by trial or measurement to be 10 seconds, the exposure time for the No. 58 and No. 47B filters will be 15 and 40 seconds, respectively.

USE OF THE REFLECTION GRAY SCALE

A reflection-type scale of neutral-gray steps, such as the Kodak Gray Scale, should, if possible, be placed in the scene when direct separation negatives are made. The densities of the steps in the scale should

be read on a reflection densitometer or a calibrated Kodak Paper Gray Scale should be used. The brightness range of the gray scale should correspond as closely as possible to the brightness range of the subject itself. Steps that are lighter or darker than any areas of the subject should not be used in interpreting the negatives. The darkest step on the reflection tablet should not be taken as an index of shadow density because there may be areas of the subject which actually reflect less light than this step. The brightness ranges of the subject and of the reflection gray scale can be compared on the ground glass.

From density readings of the gray scale in the processed negatives, the density and contrast variations among them can be determined. Allowance for these differences can then be made when the positives are exposed. The Kodak Gray Scale with its color patches can be used to identify the negatives. The Kodak Gray Scale, the Color Control Patches, and two strips of Kodak Register Marks constitute a packaged unit called the "Kodak Color Separation Guides." The Color Separation Guide, Small, is approximately 7 inches long and is a convenient size for portraits and indoor close-ups of still-life subjects such as glassware, textiles, or flowers. When the picture will cover a larger area, such as that of a room interior or a furniture display, the Color Separation Guide, Large, (14-inch) is more suitable. The image size in the negatives should be just large enough to be read on the Kodak Color Densitometer or Density Kodaguide; a larger image wastes film space.

Placement of Gray Scale

The gray scale should be located in a section of the scene where it can be trimmed off the final print. It is important that the amount of light falling on the gray scale be the same as that falling on the principal subject and that the color quality of the light be the same. Reflections from colored surroundings should be avoided as well as specular reflections arising from the light sources themselves. It should be noted that the readings made of a photograph of a reflection gray scale always contain a certain proportion of density caused by flare light. Flare, present in any lens system, reduces the contrast of the image.

Processing

The films or plates should be developed in Kodak Developer DK-50, diluted 1 to 1, in either trays or tanks. Tray processing is preferable in the interests of uniformity. The times of development given in the Data Sheets for direct separation negatives are somewhat longer than those for negatives made from transparencies. The previously recommended procedures for agitation (page 23) should be followed.

For the portrait reproduced above, the Kodak Gray Scales and Color Control Patches were placed as shown at the left. The lighting on the face of the model and on the gray scales was approximately the same. Locating the scales along the bottom edge of the picture area made it easy to trim them off the prints without affecting the composition.

After the negatives have been fixed, washed, and dried, the densities of the highlights and shadows should be read or estimated. A properly exposed and developed negative should have a density of approximately 0.4 in the shadow regions and 1.8 in the important highlight areas, or a density range of 1.4. However, the controls of the Kodak Dye Transfer Process permit the making of satisfactory prints from separation negatives having density ranges from 1.0 to 1.8.

INTERPRETATION OF GRAY SCALES

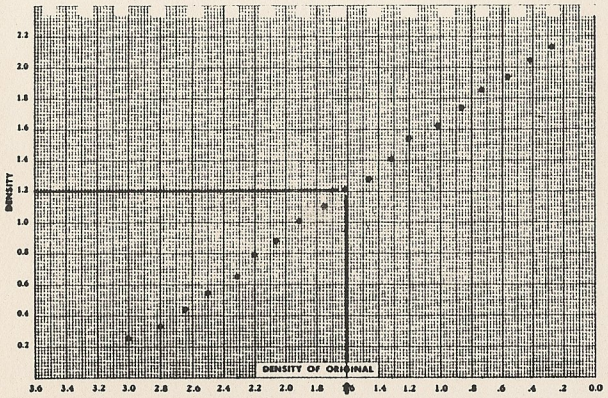
THE separation negatives of a color-balanced set should have the same contrast, as well as approximately equal densities, in corresponding steps of the gray scale. In order to evaluate the results, the densities of the steps in the three gray scales should be read and plotted. When direct separation negatives have been made of a scene in which a Kodak Gray Scale or calibrated Kodak Paper Gray Scale has been included, the reproduction of these reflection scales is affected by varying quantities of flare light in the camera. Thus, accurate contrast measurements are not available from the resulting curves although, for a balanced set, the curves should be alike in slope and closely superimposed.

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 which most closely match those of the diffuse highlight density and the shadow density in the red-filter negative. From the highlight readings, the exposing times can be computed for the matrices from the test exposure on the red-filter negative with a Kodak Print Exposure Computer.

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. If a reflection gray scale has been used in making the original transparency, density readings of its reproduction in the negatives provide an even better indication of the color balance. With direct separation negatives, all measurements have to be made from this gray scale unless a transmission step tablet can be printed by contact on the negatives with light of the same quality as that used for the camera exposure.

The step-tablet densities or the reflection gray-scale densities should be plotted along the bottom scale of a Kodak Color Separation Record Sheet or on a sheet of ordinary graph paper. Next, read the densities of the steps in the red-filter negative, beginning with one of the marked steps. These densities should then be plotted as follows: From the point where the original step-tablet density is plotted on the "Density



Step-tablet densities in red-filter negative plotted against densities in photographic step tablet attached to color transparency.

of Original" scale at the bottom of the paper, move upward along a vertical line and locate the point opposite the appropriate value on the vertical "Density" scale. The plotting points for each one of the successive steps of the separation-negative scales are fixed by the intersection of two lines, the one extended vertically from the plotting point of that step from the photographic step tablet itself, and the other extended horizontally from the density value read on the separation negative. This procedure is illustrated in the above diagram.

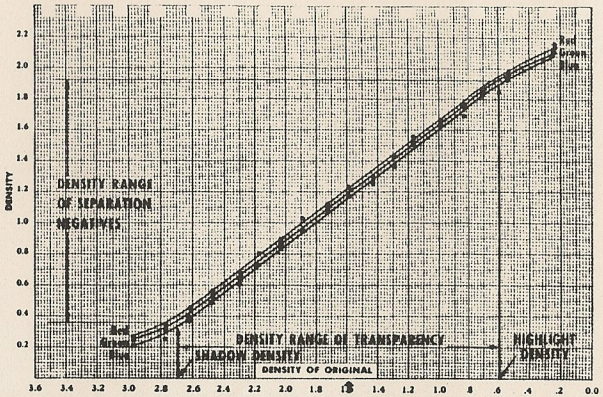
As the values are plotted for the various steps on either side of the marked step, keep in mind the fact that the less dense steps in the step tablet produced the more dense steps in the separation negative. Thus the row of plotting points should extend from the lower left-hand section of the paper to the upper right.

Lay a straightedge or ruler 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. If the densities at either end of the curve do not lie on the straight line, disregard them.

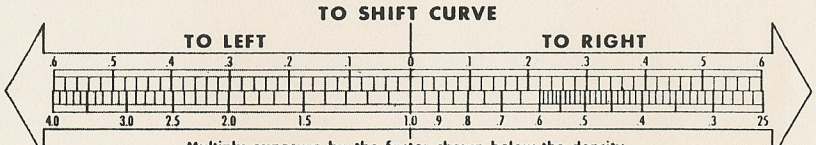
INTERPRETATION OF CURVES

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 used were correct but the three exposure times were not properly balanced. If the density range of the transparency is recorded on the straight-line portion of all three curves, compensation for lack of coincidence can be made when the matrices are exposed. If the highlight or shadow regions

Curves for balanced set of negatives showing density range of transparency and of each negative.



of the transparency are recorded on a part of the curve which is not straight, all three negatives should be remade together. The exposure correction can be found from the chart below. 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 difference of 0.3, the exposing time for this negative should be multiplied by 2.0. If the density range of the transparency is not recorded on the straight-line portion of any of the three negatives, all three exposures should be corrected. The distance that the curves need to be shifted in order to bring the reproductions of the shadow density of the transparency to the recommended density of 0.4 in the negatives is again measured along the "Density of Original" scale.



Multiply exposure by the factor shown below the density difference between the actual and desired curve positions.

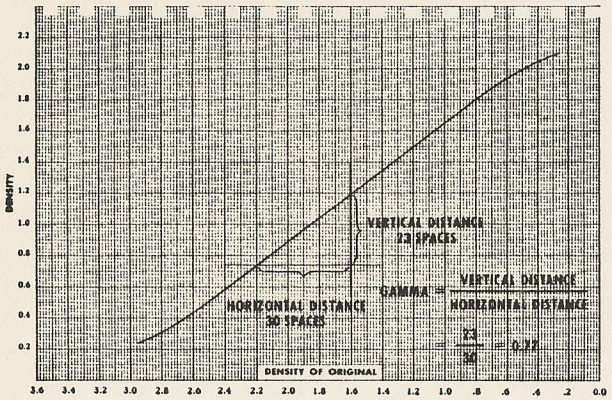
Measurement of Gamma

The slope or angle that the line of plotting points makes with the horizontal is the gamma to which the negatives have been developed. Gamma can be determined by selecting any convenient point on the

curve which 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. The diagram below illustrates this procedure. For a properly processed separation negative, this value should be 0.7 if the original transparency was unmasked, or if 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 approximately 0.9.

Corrections for sizable differences in the slopes of the three curves 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.

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 1.4. When prints are made by the Kodak Dye Transfer Process, however, density ranges between the extremes of 1.0 and 1.8 can be compensated by altering the composition of the developer in accordance with the instructions packed with the Kodak Matrix Film.



Determination of gamma to which negative has been developed by measuring slope of curve.

MASKING

Color correction is often necessary because available dyes do not have the characteristics of theoretically perfect dyes. It should be noted that the causes for possible reproduction errors are not peculiar to any one process, but are inherent in all of the photographic processes now used. Consequently, a color transparency is an approximation, although generally a satisfactory and pleasing one, of the original subject. When the transparency is reproduced, the print becomes an "approximation of an approximation" and is frequently neither satisfactory nor pleasing, particularly when the original subject and the print are compared. A satisfactory reproduction of the transparency can be obtained by correcting for the dyes in the color film. This correction procedure, known as "masking," constitutes an additional step in the reproduction process, but resulting improvements usually more than justify the extra effort involved. Theoretically, it is possible (although it is seldom done) to obtain a more accurate reproduction of the original subject by masking both the transparency and the separation negatives, thus correcting for both sets of dyes.

Masking is more often required with positive color transparencies than with color-separation negatives which have been made directly from the subject. However, masking procedures must be employed in the latter case if compensation for the dyes in the printing process is necessary. The theoretical aspects of masking are discussed in this section; practical working instructions are given in the next section.

The colored couplers in negatives on Kodak Ektacolor and Kodacolor Films provide automatic color correction and eliminate the need for supplementary masking procedures at the first printing stage. However, if these films are employed in making a second-generation reproduction, supplementary masking is necessary at the positive stage.

REPRODUCTION ERRORS

Satisfactory reproductions of many original color transparencies can be made by a color-printing process, such as the Kodak Dye Transfer Process, without the benefit of masking. Departures from accurate color rendering are always present, however, and with some originals the nature and range of the colors to be reproduced are such that the results obtained in uncorrected prints are not acceptable. Photographs in which blues and greens predominate are often greatly improved by masking. Flesh tones, on the other hand, show little change when a

masked print is compared with an unmasked one. Other colors will fall between these two extremes in the extent to which they differ from the original subject.

When a print is made from an unmasked transparency, it can be stated as a general rule that the warm half of the spectrum gets lighter and desaturated; the cold half, darker and degraded.

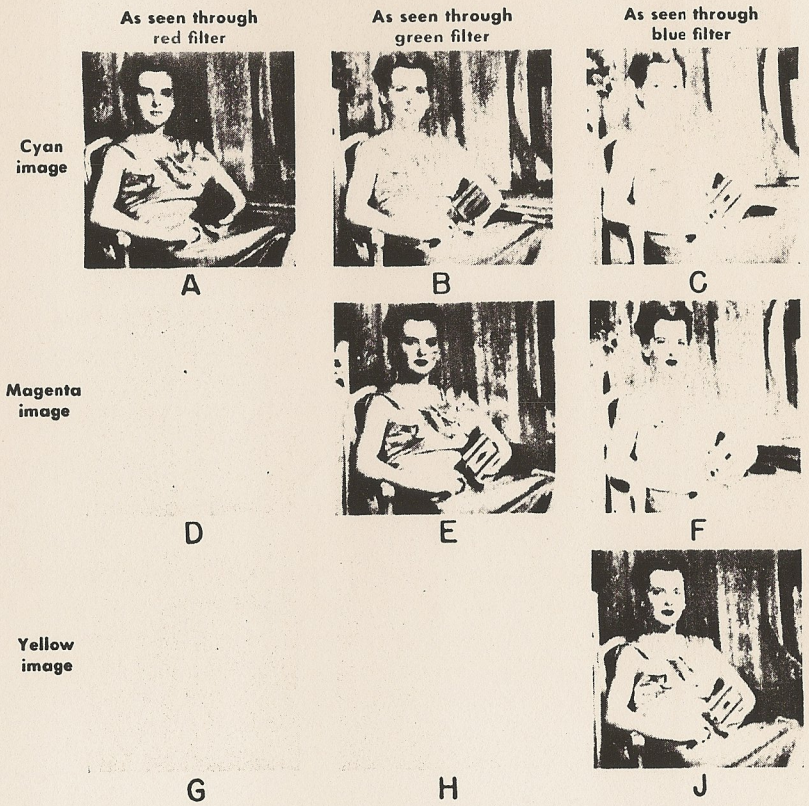
The reproductions on page 37 are a comparison between the results obtained from a masked and from an unmasked color transparency. The Kodak Ektachrome transparency was masked with red- and green-light masks in the proper sequence when separation negatives were exposed. If corresponding areas in the pictures are compared, the color differences are readily visible.

Theoretically, it is possible to correct completely for all the shifts in hue, changes in brightness, and distortions of the tone scale which occur in the printing process if a sufficient number of masks are used. Practically, the mechanical problems of register and maintaining definition, as well as the progressively smaller improvement gained with each successive mask employed, impose an effective limit on the use of multiple masks. Usually, one mask is used to correct for the relative-brightness and saturation errors—darkening of the greens and blues—and a second one to improve the saturation of the yellows and to correct the most serious hue-shift errors—the hue changes of the magenta and red areas. A third mask, a so-called "highlight mask," can be used in contact with transparencies with light highlights and important detail, when the other masks are exposed, to increase the highlight contrast in the print.

THEORETICAL ASPECTS

In the illustration on the opposite page, a transparency has, in effect, been taken apart, and each dye layer photographed through a red, a green, and a blue filter. Although the cyan dye image (A) should control only the red light passing through the transparency, it is not completely transparent to blue and green light. Images (B and C) are formed when the blue and green records are made of the other dye layers. For somewhat the same reason, when the magenta dye is photographed with a blue filter (F), it produces an image instead of being totally transparent to light of that color. Thus the red-filter separation negative is a record of the cyan dye (A) alone. The green-filter separation negative is a record of the magenta dye (E) and also, to a lesser degree, of the cyan dye (B). The blue-filter negative is primarily a record of the yellow dye (J), but it is also a record of the cyan (C) and magenta (F) dyes.

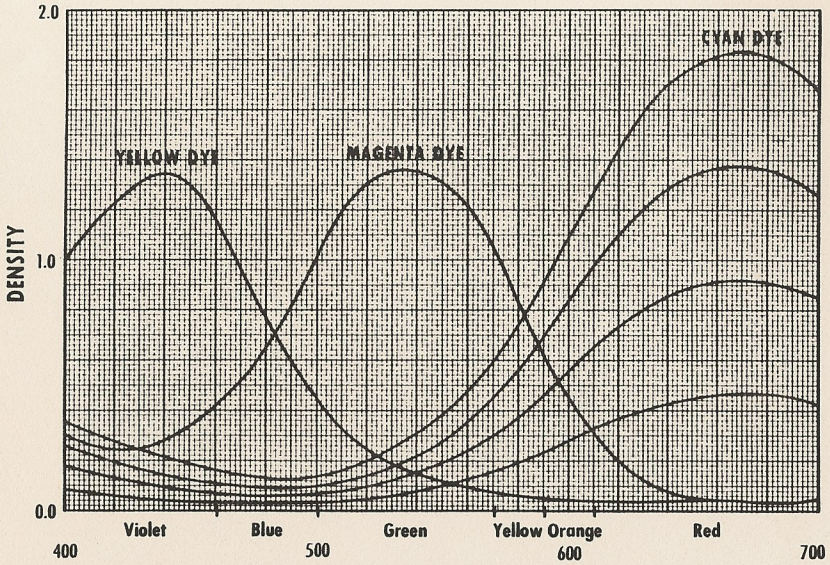
APPEARANCE OF INDIVIDUAL DYE IMAGES



The spectral densities of unit quantities of a yellow and a magenta dye and four different quantities of a cyan dye are shown on the next page. It can be seen that the proper red filter will isolate or separate various cyan-dye densities from the other dyes. It can also be seen that no filter, no matter how narrow is its transmission band, can separate the magenta- or yellow-dye densities from the cyan dye.

Correction for Unwanted Cyan-Dye Absorption

Absorption of the cyan dye in the green and blue regions is directly proportional to its absorption in the red region. If a contact print is made on panchromatic film with a red filter over the exposing source, the black-and-white densities in the resulting negative are a record of the cyan dye. The contrast of this record can be so chosen that it is approximately equal to the contrast of the cyan-dye image in the blue



Spectral density curves showing the effect in the green and blue regions of different amounts of cyan dye superimposed upon uniform densities of yellow and magenta dye.

and green regions. If this negative mask is then bound up with the color transparency and viewed or photographed through a green filter, the image of the cyan dye is cancelled out, leaving only the image of the magenta dye (and a very low-contrast image of the yellow dye).

Correction for Unwanted Blue Absorption

Magenta colors in an original transparency shift toward red in a reproduction, while yellow colors suffer a marked loss of saturation and a slight shift toward orange. These changes occur even though a red-light mask is used on the transparency when the reproduction is made.

Instead of using individual masks of the unwanted absorptions of the magenta and cyan dyes alone in the blue region (a procedure which would involve several register steps), a compromise correction is effected by the use of a green-light mask. The green-light mask is a combined record of the magenta, cyan, and yellow images. This mask is developed to the same gamma as the red-light mask in order that all three separation negatives can also be developed to the same gamma. This green-light mask is then registered with the transparency to partially correct for the unwanted absorption of the magenta and cyan dyes in the blue region. The correction is a compromise because the densities of the cyan and magenta dyes do not bear the same relationship to each other in the blue region as they do in the green.

(Above) Two masks, exposed with red and green light, were used in making this Dye Transfer print from a Kodak Ektachrome transparency. (Below) Print made from the same original without masking. Note the saturation losses and the hue shifts, which cannot be avoided unless two masks are used. Photograph by D. E. Inkley, Eastman Kodak Company.

MASKING FOR COLOR CORRECTION

THE recommended mask is a silver negative exposed in contact with the original by filtered light and developed to low contrast. With most color transparencies, one such mask gives acceptable results. However, considerably better color correction can be obtained by the use of two masks. Experience will indicate which procedure is necessary to produce the required accuracy of reproduction.

Effect of a Single Mask. The primary function of a single mask is to correct relative brightness and saturation errors. Practically speaking, the effect of a single mask with prints made to normal contrast is to increase the saturation of all colors, and to lighten the reproduction of colors complementary to the color of the filter used in exposing the mask. For example, a magenta filter absorbs green light and thus allows less exposure of the mask through the greens in the picture than it does through the other colors. When the mask has been developed and registered with the transparency, the greens are effectively lightened in relation to the other colors. Similarly, a mask exposed with a red filter, which absorbs both blue and green light, lightens both the blues and the greens.

Effect of Two Masks. Regardless of the color of light used to expose it, a single mask used in exposing all three color-separation negatives can accomplish no hue-shift correction. With two masks, however, it is possible to correct not only the relative brightness and saturation errors, but also the most serious hue-shift errors.

Kodak Pan Masking Film. Kodak Pan Masking Film is designed specifically for the preparation of masks for color transparencies, and yields fine-grain images which are approximately neutral in tone even at low contrast. In order to facilitate subsequent register of the mask on the original, the emulsion is coated on a thin, low-shrinkage base.

Kodak Pan Masking Film must be handled and developed in total darkness. A Kodak Safelight Filter, Wratten Series 3 (dark green), in a suitable safelight lamp with a 15-watt bulb at not less than 4 feet can be used for a few seconds after development is half complete.

SINGLE-MASK PROCEDURE

IF the greatest accuracy is not required, prepare a single mask from the transparency by exposing Kodak Pan Masking Film through a magenta filter, such as the Kodak Wratten Filter No. 33. When this filter is used, the light source should have a color temperature of at least 3200 K.

The principal effect of using a magenta filter is to lighten the reproduction of greens. If lighter blues are also desired, use a red filter such as the Kodak Wratten F Filter (No. 29).

Arrangements for Exposure and Diffusion

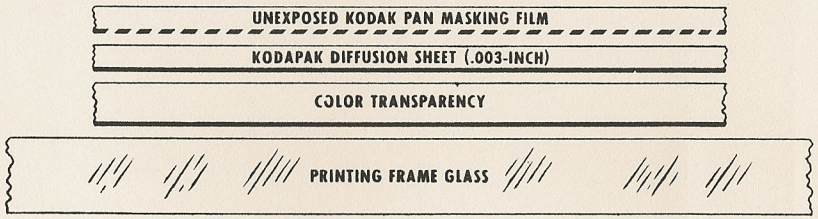
An enlarger equipped with a tungsten lamp, such as the Kodak Auto-Focus Enlarger, Model E, is recommended as a light source. If such equipment is not available, a light source can be devised from a Kodak Darkroom Lamp, as described on page 11. The transparency and Pan Masking Film can be placed in a printing frame on the exposing plane. If the inside of the printing frame pressure pad is light-colored, a piece of black photographic interleaving paper should be placed against it to prevent halation in the highlight areas of the mask.

If a gray scale has not been included in the picture, a Kodak Photographic Step Tablet should be placed beside the transparency when the mask is exposed. To facilitate subsequent register of the gray-scale image, the step tablet should be attached securely to the transparency rather than merely taped to the printing-frame glass.

During exposure, the mask image is slightly diffused by a piece of Kodapak Diffusion Sheet (.003-inch) placed between the transparency and the masking film as shown in the diagram below. Considering the matte side of the diffuser as the emulsion side, all three emulsion sides should face the light source; otherwise, the proper degree of diffusion will not be secured. Kodapak Diffusion Sheets (.003-inch) are sold by Kodak dealers in packages of 12 sheets, 8 by 10 or 11 by 14 inches in size. When the sheet gets scratched or dirty, it should be replaced.

The introduction of diffusion in making the mask greatly simplifies the subsequent register of the mask on the original. If the mask were perfectly sharp, the slightest error in register would cause an objectionable relief effect. Diffusion of the mask does not harm the sharpness of the reproduction—in fact, it actually makes the print appear sharper than it otherwise would. The reason for this effect is that the edges of

Orientation of color transparency, diffusion material, and unexposed Kodak Pan Masking Film in a printing frame when the principal mask is exposed.



fine detail in the transparency are covered by a more or less uniform silver deposit in the mask; thus their contrast is preserved even though the contrast between larger areas is decreased by the negative mask.

Exposure

The exposure should be adjusted so that the darkest shadow detail in the transparency is just perceptible in the mask. In other words, the lowest density in the picture area of the mask should be just slightly higher than the fog density of the masking film.

Although the mask exposure is not too critical, an underexposed mask will tend to give flat highlights and excessive shadow contrast in the print. Conversely, a seriously overexposed mask will give a print with low shadow contrast and excessively contrasty highlights. With 3 foot-candles at the film plane, the exposure required in making a mask for a Kodachrome or Kodak Ektachrome transparency is approximately 100 seconds with either the Kodak Wratten Filter No. 33 or 29. Greater illumination can be used to reduce the exposure time proportionately.

Development

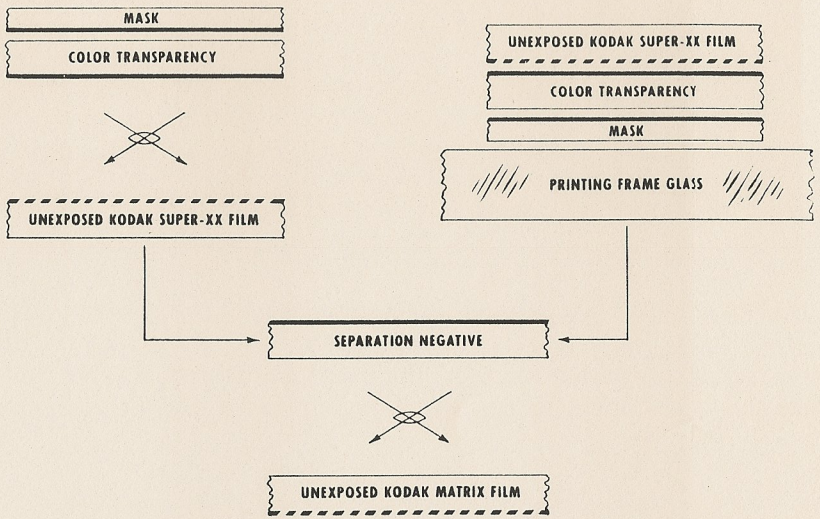
A satisfactory mask should have a density range between one-quarter and one-third that of the transparency. (If a highlight mask is used, as described on pages 44 to 47, the density range of the transparency should be measured between the shadow density and the step of the gray scale which appears lightest with the highlight mask in place.) A mask of higher density range tends to overcorrect relative brightness errors and thus lighten the cool colors too much, while a mask of lower density range tends to give too little correction.

Development recommendations for Kodak Pan Masking Film are given in the Data Sheets and in the instruction sheet packed with the film. If necessary, adjust the time to obtain the proper range.

Registering the Mask

After processing, the mask is registered on either the base or the emulsion side of the original color transparency, depending on the method to be used in exposing the matrices. (Refer to the diagram on the next page while reading the following paragraphs.) This mask remains on the transparency during the exposure of all three negatives.

For Enlarged Matrices. If the matrices are to be exposed by enlarging the 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, thus assuring maximum sharpness in the negatives.

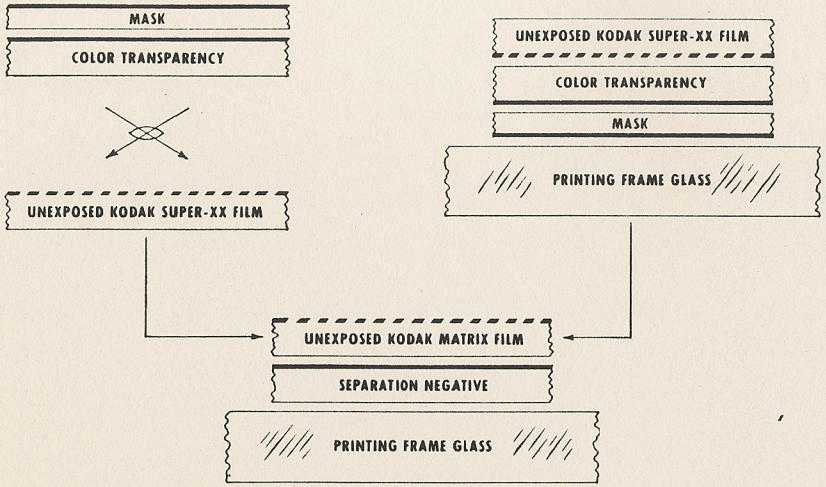


Orientation of color transparency and principal mask in either contact printing frame or negative carrier of enlarger when separation negatives are to be made by projection.

Place the separation negatives in the enlarger, emulsion side toward the light source. The enlarged images will then be in their correct left-to-right positions as seen on the easel of the enlarger. 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 paper in the final printing operation. Exposure by enlarging through the base of the negatives does not affect the sharpness of the matrices; however, the focus of the enlarger should be checked, and, if necessary, compensation should be made for the fact that the negative images are slightly removed from the normal plane.

For Contact Matrices. If the matrices are to be exposed by contact, prepare to make color-separation negatives by registering the mask on the emulsion side of the transparency. Then place the transparency so that the base side faces the emulsion side of the separation-negative material and the emulsion sides of the mask, transparency, and negative material all face the light source. Print the negatives either by contact or enlarging.

Since the transparency is reversed from left to right as seen from the emulsion side, the separation negatives will also be reversed from left to right, whether they are exposed by contact or by enlarging. However, when the separation negatives are turned over and placed with their emulsion sides in contact with the base side of the matrix film, they will then appear correct from left to right. Hence the matrix



Orientation of color transparency and principal mask in either contact printing frame or negative carrier of enlarger when separation negatives are to be made by contact.

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

Note that in this latter method the separation negatives are exposed through the base of the color transparency. The matrices can then be exposed with the emulsion sides of the negatives in contact with the base of the matrix film. A sharper print is obtained than as though the negatives were exposed with their emulsion sides in contact with the emulsion side of the transparency. Then to orient the final print correctly, the emulsion sides of the negatives must face away from the base of the matrix film.

If the masking film is larger than the transparency, tape the transparency to the mask on two opposite edges. If the masking film is the same size as the transparency, trim about 1/16 inch from the mask on two opposite edges; then tape the mask to the transparency at these edges. Most transparencies have ⅛ inch or more of black border caused by the film holders; sufficient binding can be obtained by using only this narrow edge. Care should always be taken to let the tape touch only the edges of the transparency; if it touches the picture area, some of the adhesive may remain to cause trouble with dirt spots.

TWO-MASK PROCEDURE

As previously noted, the use of two masks substantially reduces hue-shift errors, as well as correcting relative brightness and saturation errors. For improved color correction, two masks should be made. One

mask should be exposed through the Kodak Wratten Filter No. 29 (red), the other through the No. 61 (green). Except for the difference in the filters used, the procedure for exposing and developing each of the two masks is exactly the same as that described above for a single mask.

With 3 foot-candles of illumination at the film plane, typical exposures in making masks for Kodachrome or Kodak Ektachrome originals on Kodak Pan Masking Film are 100 seconds at *f*/4.5 with the No. 29 filter and 150 seconds with the No. 61 filter. Higher illumination levels can be used to reduce the exposing time in proportion to these values.

After development, the red-filter mask is taped in register with the transparency and left there while the red- and green-filter color-separation negatives are being exposed. It is then replaced by the green-filter mask during the exposure of the blue-filter color-separation negative. The result of this masking procedure is that the effects of the unwanted blue absorption of the magenta dye and the unwanted blue and green absorptions of the cyan dye are reduced. In other words, the masks help prevent reds from reproducing too orange, and greens and blues from becoming degraded.

NEGATIVES FROM MASKED ORIGINALS

THE table in the Data Sheet on page 52 gives exposure recommendations for color-separation negatives from masked transparencies. The lens opening required for the exposure times given in the table depends on the shadow density of the transparency, which should be measured with a mask in place. When this density has been determined, the proper lens opening can be read from the chart on page 21.

The use of color-correction masks reduces the contrast and density range of the transparency. In order to compensate for this reduction, separation negatives from masked transparencies should be developed for longer times than those from unmasked transparencies. The development times given in the Data Sheets will give the recommended density range of approximately 1.4 from an average transparency.

HIGHLIGHT MASKING

In many positive color transparencies, the diffuse highlights fall somewhere along the toe portion of the characteristic curve, and their contrast is therefore lower than that of the middle tones. When a print is made, the contrast of the highlights in relation to that of the middle tones tends to be lowered further because the highlights again fall on a flatter portion of the reproduction curve.

With subjects containing important highlight areas, it is often worth while to correct this error by introducing a highlight mask before making a principal mask or masks as described in the preceding sections. The highlight masking procedure described here can be used only in conjunction with other masks; in other words, it is supplementary to one of the previously recommended masking procedures.

Kodak Highlight Masking Film. This film is designed for use in making color prints from transparencies containing important highlight detail. It has a fine-grain, orthochromatic emulsion of high contrast, coated on a thin base of low shrinkage characteristics. This film should be handled under a Kodak Safelight Filter, Wratten Series 1A.

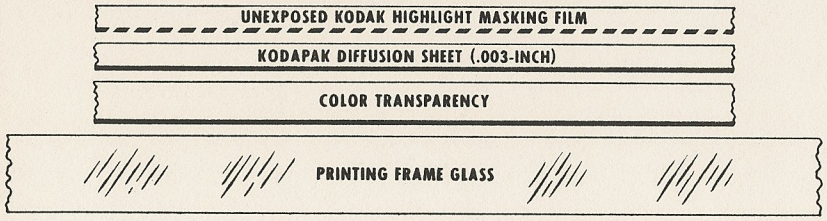
HIGHLIGHT MASKING PROCEDURE

The recommended type of highlight mask is very much higher in contrast than a principal mask. It should contain densities corresponding to the highlights of the transparency only; other areas should be clear.

Arrangements for Exposure and Diffusion

As in the case of principal masks, it is convenient to expose highlight masks in a printing frame placed on the easel of an enlarger equipped with a tungsten light source or a printing lamp. The method of diffusion and the arrangement of the films are shown in the diagram below.

Orientation of color transparency, diffusion material, and unexposed Kodak Highlight Masking Film in a printing frame for exposing the highlight mask.

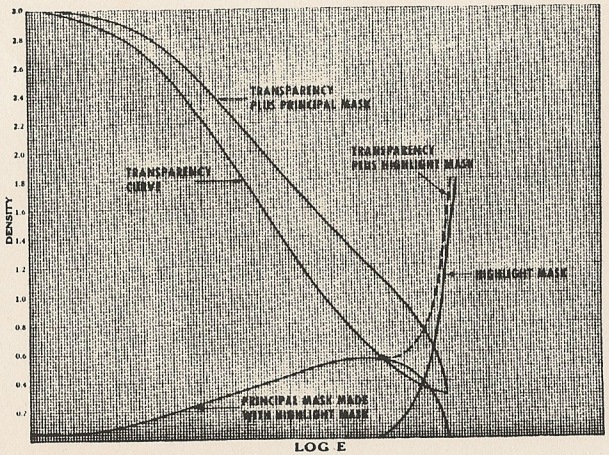


Exposure. The exposure of the highlight mask is fairly critical, and an exposure test should be made with each transparency. When a tungsten enlarger is used as a light source for the contact exposure, the magnification should be adjusted to give 3 foot-candles at the exposing plane with the lens set at $f/4.5$. A typical highlight mask exposure for a Kodachrome transparency with the lens stopped down to $f/22$ is 10 seconds. If a printing lamp is used in which there is no lens system, the height of the source should be adjusted to give 3 foot-candles, then a neutral-density filter of approximately 1.4 should be placed over it to reduce the 3 foot-candles to about 0.125, and a 10-second exposure used. The exposure required in making a highlight mask from a Kodak Ektachrome transparency is generally somewhat greater, because the highlight densities of Ektachrome transparencies are usually, although not always, higher than those of Kodachrome transparencies.

After some experience in highlight masking, the operator will find that it is fairly easy to judge whether the correct exposure has been given. If the mask is underexposed, maximum highlight tone correction in the print will not be obtained. On the other hand, overexposure will extend the increase in contrast to the lighter middle tones and result in a harsh effect in the print. Overexposure will also interfere with accurate register of the highlight mask on the original and may cause edge effects around the whites in a principal mask.

A correctly exposed and developed highlight mask for a full-scale Kodachrome or Ektachrome transparency will usually have densities between 1.5 and 2.0 in the areas corresponding to diffuse highlights in the transparency. It should be noted, however, that the highlight densities of Ektachrome transparencies vary over a wider range than those of Kodachrome transparencies. As a consequence, it may be desirable to adjust the mask exposure if the highlights of the original are exceptionally dark or exceptionally light.

Note: The density values recommended here for highlight masks are satisfactory for use with normal types of originals. Occasionally, however, an original having exceptionally prominent highlights will be encountered, and in this case, the mask may overcorrect the highlight tones to such an extent that they will appear bare and colorless in the print, lacking the desired detail. With such originals, the highlight mask exposure should be decreased to the point where it gives densities of 1.0 to 1.5 in the areas corresponding to diffuse highlights in the transparency. In case of doubt as to the required correction, it is safer to use a highlight mask of the lower density values, because undercorrection gives more pleasing results in prints than overcorrection.



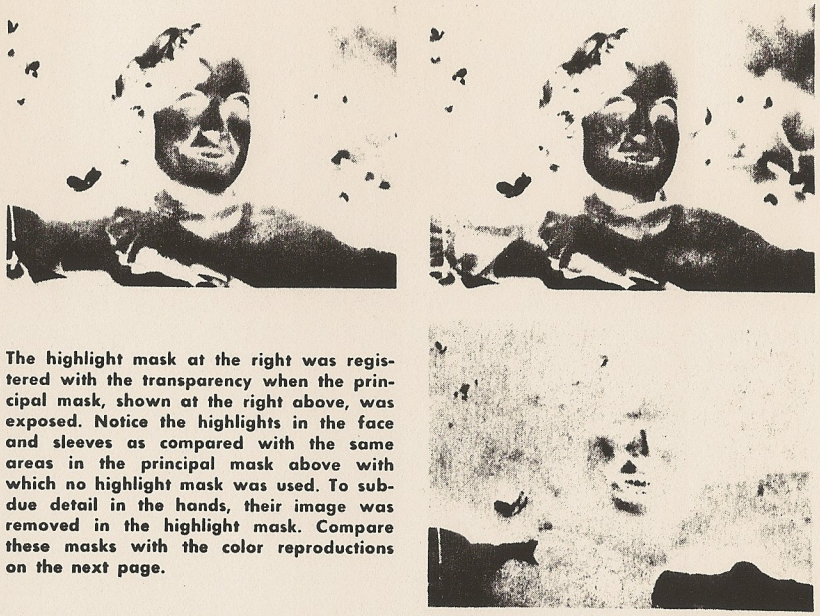
Curves show how the contrast of the color transparency is reduced by the use of a principal mask. Note increase in contrast in highlight regions resulting from the use of the highlight mask.

Development. Recommendations for developing Kodak Highlight Masking Film in Kodak Highlight Mask Developer are included in the instruction sheet packed with the film. Best results are obtained by adhering to the recommended time and adjusting the exposure to produce a mask of the proper characteristics. Underdevelopment is especially undesirable, because it will lower the contrast of the mask and prevent good results from being obtained at any exposure level.

NOTE: In certain cases, depending on the subject material, highlight correction may be desirable in some but not all areas of the picture. If this situation occurs, Kodak Farmer's Reducer, available in prepared form, can be used locally on the densities in the highlight mask which are not needed. The reducer is best applied to the wet mask after it has been fixed and rinsed briefly in running water.

Registering the Mask. The developed highlight mask is registered on the emulsion side of the transparency. Some misregister of the mask may be evident, especially with a transparency which contains large areas of fine detail. In such an instance, the mask should be registered most accurately at the most important points in the transparency. The misregister distributed over areas of less importance will be prevented from showing by the diffusion introduced in making the principal mask or masks. After registering the mask, tape it to the original, being careful to let the tape touch only the extreme edges of the transparency.

When the highlight mask is placed over the original, it will make the highlights of the subject nearly as dense as the deepest shadows, while the middle tones of the subject remain unchanged. This effect gives a rather strange appearance to the transparency, but it is perfectly normal. The temporary reversal of the highlights will disappear when the highlight mask is replaced by a principal mask.



The highlight mask at the right was registered with the transparency when the principal mask, shown at the right above, was exposed. Notice the highlights in the face and sleeves as compared with the same areas in the principal mask above with which no highlight mask was used. To subdue detail in the hands, their image was removed in the highlight mask. Compare these masks with the color reproductions on the next page.

Subsequent Procedure. The principal mask or masks are made in exactly the same way that they would be made if there were no highlight mask on the transparency. However, since the highlights of the original are covered by high densities in the highlight mask, these areas come out very light in the principal masks. Specular highlights in the original have almost no density at all in the principal masks.

After the principal masks have been prepared, the highlight mask is removed from the transparency and the appropriate principal mask is registered on the transparency. With the principal mask in place, the transparency appears to have very bright and contrasty highlights, because the principal mask reduces the contrast of the middle tones and shadows but not that of the highlights. Highlights on a face may even have a greasy appearance.

The color-separation negatives are made in the normal manner. As a result of the highlight masking procedure, the highlight tones of the original are printed at relatively higher contrast than the middle tones or shadows. When the color reproduction is made, however, the exaggerated contrast of the highlights is reduced by the toe characteristics of the printing process. Only enough contrast is left to insure the desired brilliant rendering of highlight areas.

(Above) A highlight mask was used in making this Dye Transfer print from a Kodak Ektachrome transparency. Note the sparkling highlights in the face, hair, and sleeves. (Below) Print made from the same original without highlight masking. Photograph by Muray-Grif.

MASKING DIRECT SEPARATION NEGATIVES

When color-separation negatives are made directly from the original subject, masking is less often required than it is when the negatives are made from a color transparency. However, if greens and blues are to be reproduced along with reds and other warm colors, the results are definitely improved by masking to compensate for the undesirable absorptions of the printing dyes. A relatively simple and effective procedure is to make two low-contrast positive masks from the red-filter separation negative and one low-contrast positive mask from the green-filter separation negative. These masks are used over the separation negatives during the exposure of the matrices, as described in the section *Registering the Masks* on the following page.

Highlight masking is seldom necessary with direct separation negatives which have been properly exposed. The highlights have sufficient contrast in the final print even though they are reproduced on the relatively low-contrast toe region of the matrix film.

MASK MATERIALS

Although any blue-sensitive material of moderate contrast and a good exposure scale will provide satisfactory masks for color-separation negatives, Kodak Commercial Film is suggested if the separation negatives are on film, and Kodak 33 Plates are suggested if the separation negatives are on plates. In case these materials are not readily available, the masks can be made on the same type of film or plate as was used for the separation negatives, or, in the case of negatives on film, they can be made on Kodak Pan Masking Film.

ARRANGEMENTS FOR EXPOSURE AND DIFFUSION

When the color-separation negatives and the masks are on film, register of the masks is simplified by the use of Kodapak Diffusion Sheet, as described in the single-mask procedure for transparencies. When plates are used, however, no difficulty should be encountered in registering sharp masks, and it is usually unnecessary to introduce diffusion. Sharp masks made on plates must be exposed with the emulsion of the negative in contact with the emulsion of the mask material.

Exposure. White light (unfiltered tungsten or fluorescent) is used in exposing the masks. The exposure should be sufficient to retain the full highlight detail of the color-separation negatives, and should be the same for all three masks.

Development. The masks should have a density range about one-third that of the color-separation negatives. With correct exposure, this density range can be obtained by developing masks on Kodak Commercial Film for about 2½ minutes at 68 F (20 C) in a tray of Fresh Kodak Developer DK-50, diluted one part developer to 4 parts water. Discard the developer after use. Under the same conditions, the development time for Kodak 33 Plates is about 3 minutes. In order to preserve the balance of the color-separation negatives, it is essential to develop all three masks to exactly the same gray-scale gamma.

Registering the Masks

After processing, the two masks from the red-filter separation negative are taped in register with the red-filter and green-filter separation negatives and left there during the exposure of the cyan and magenta matrices. The mask from the green-filter separation negative is taped in register with the blue-filter separation negative and left there while the yellow matrix is being exposed.

Diffused masks on film should be registered on the base side of the color-separation negatives, whether the matrices are to be exposed by enlarging or by contact. Sharp masks on plates should be registered on the emulsion side, and in this case the matrices should be exposed only by enlarging.

MAKING THE MATRICES

When matrices are made from masked direct color-separation negatives, it will in most cases be necessary to adjust the composition of the matrix film developer as recommended in order to compensate for the contrast-reducing effect of the masks. Information is given in the instructions packed with the Kodak Matrix Film and in the Color Data Book, *Kodak Dye Transfer Process.* This Data Book is available from Kodak dealers for insertion in the *Kodak Color Handbook.*

NOTE: This method of masking is primarily suited to use with direct separation negatives and is not recommended in making Dye Transfer prints from Kodachrome or Kodak Ektachrome transparencies.

KODAK SUPER-XX PANCHROMATIC SHEET FILM

Code Notch

A high-speed, Type B panchromatic, antihalation film of moderate contrast and low enough graininess to permit reasonable enlargement.

Safelight: *Total darkness required.* A Kodak Safelight Filter, Wratten Series 3 (dark green), in a suitable safelight lamp with a 15-watt bulb can be used for a few seconds *only,* at 4 feet, after development is half completed.

COLOR-SEPARATION NEGATIVES

The following data are accurate for laboratory conditions; under actual working conditions, exposure and development times should be modified, if necessary, to produce color-separation negatives of the desired density and contrast.

Exposure

Exposure Indexes* (For color-separation work):

White Flame Arc—**20** *Tungsten*—**25**

*These settings are based on exposure through a Kodak Wratten Filter No. 25.

These settings are recommended for meters marked for American Standard Exposure Indexes and are based on the use of a Kodak Wratten Filter No. 25 over the camera lens. When these meter settings are used in conjunction with the filter ratios in the following table, they are useful in determining exposure times. The exposure time when using various filters is calculated by multiplying the *exposure time* for the No. 25 filter by the appropriate *filter ratio.* If an exposure meter is not used, the exposure with the No. 25 filter can be determined by trial.

For Example: With tungsten illumination, the filter ratio is 1.0 for the No. 25 filter and 1.5 for the No. 58 filter. If the exposure through the No. 25 filter, as determined by the use of the appropriate exposure index or by trial, is 20 seconds, the exposure through the No. 58 filter will be approximately 30 seconds.

Filter Ratios:

Light Source	Kodak Wratten Filters — These filter ratios are based on an exposure of approximately 15 seconds through a No. 25 filter					
	No. 25	No. 58	No. 47	No. 29	No. 61	No. 47B
Tungsten*	1.0	1.5	2.5	2.0	2.5	4.0
W.F.A.**	1.0	1.0	0.4	2.0	1.2	0.4

*These ratios apply to clear-bulb, high-efficiency lamps used without an optical system. They will vary somewhat when the lamp is used in an enlarger containing heat-absorbing glass.

**For ac or dc. With direct-current arc lamps, the positive carbon should be in the lower position.

Exposure Times: When making separation negatives from color transparencies, use the times in the following table as a basis for trial with the recommended light source. The illumination level is determined from the chart on page 21.

Light Source	Exposure Times for Separation Negatives from Color Transparencies			
	No. 29	No. 61	No. 47B	
Tungsten*	25	15	20	Illumination level of exposing light source determined by shadow (or highlight) density of transparency.
Fluorescent (4500 white)	39	21	13	

*These times apply to the exposing light or enlargers recommended in the text.

KODAK HIGHLIGHT MASKING FILM — *Code Notch*

An orthochromatic film of high contrast, designed for use in making color prints from transparencies containing important highlight detail. After processing, the highlight mask is placed over the transparency during the exposure of the principal mask or masks; its use results in improved reproduction of highlight areas.

Safelight: Use a Kodak Safelight Filter, Wratten Series 1A (light red), in a suitable safelight lamp with a 15-watt bulb at not less than 4 feet.

HIGHLIGHT MASKING FOR THE KODAK DYE TRANSFER PROCESS

Exposure of highlight mask is fairly critical and an exposure test should be made with each transparency. An enlarger equipped with a tungsten light is a suitable source. Set enlarger to give 3 foot-candles of illumination on the exposing plane with the lens set at *f*/4.5. Stop the lens down to *f*/22 and give a 10-second exposure. Mask should have a density of 1.5 to 2.0 in areas corresponding to diffuse highlights in transparency.

Processing

Develop in a tray of Kodak Highlight Mask Developer, full strength, with continuous agitation for 4 minutes at 68 F (20 C). Do not attempt to adjust densities of the mask by changing development time. Adhere to recommended development time and adjust exposure time to obtain a mask of proper characteristics.

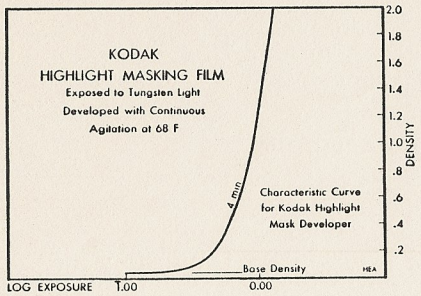
Rinse for about 15 seconds in Kodak Stop Bath SB-1a.

Fix for 2 to 3 minutes in fresh Kodak Fixing Bath F-5 or the solution prepared from Kodak Acid Fixer.

Wash for 10 to 15 minutes in running water.

Dry without heat.

Sensitometric Curve: For average product and average processing.



Summary of Steps

FOR MAKING COLOR-SEPARATION NEGATIVES FROM COLOR TRANSPARENCIES

Read:	Highlight and shadow densities of transparency.
***Position:**	Transparency, step tablet, Kodapak Diffusion Sheet (.003-inch), and unexposed Kodak Pan Masking Film in printing frame.
***Expose:**	100 seconds with Kodak Wratten Filter No. 29; 150 seconds with No. 61 filter.
***Develop:**	In DK-50, 1:4, for 3 minutes at 68 F in tray with continuous agitation. Rinse, fix, wash, and dry.
***Read:**	Step-tablet densities in mask. Density range should be ¼ to ⅓ that of transparency.
***Register:**	Red-light mask on transparency.
Position:	Transparency and step tablet in printing frame or negative carrier of enlarger.
Expose:	Kodak Super-XX Film for 25, 15, and 20 seconds through Kodak Wratten Filters No. 29, 61, and 47B at illumination level given by chart on page 21. (Use red-light mask for red- and green-filter exposures; green-light mask for blue-filter exposure.)
Develop:	In DK-50, 1:1, for 6, 6, 8½ minutes (4, 4, 6 minutes for unmasked negatives) at 68 F in a tray with continuous agitation. Rinse, fix, wash, and dry.
Read:	Step-tablet densities in each of the three negatives. Density range should be approximately 1.4.

*These steps are necessary when the transparency is to be masked.