COLOUR PRINTING FROM COLOUR NEGATIVES

A KODAK PUBLICATION

COLOUR PRINTING FROM COLOUR NEGATIVES

For many years it has been possible to make colour prints on paper by a number of processes. These processes often involved the production of separation negatives, colour-correcting masks and the assembly of three coloured images, in register, upon a paper support. Such complex processes were necessarily the work of a specialist technician rather than the photographer. A direct colour-printing paper, giving prints of comparable quality that could be handled by the photographer himself, was only possible when the integrally-masked negative–positive system of colour photography was evolved. The versatility of the colour negative is shown by the variety of reproductions available from a single negative source – colour prints, colour transparencies, black-and-white prints and photo-mechanical reproductions.

The chief emphasis of this book is on "white-light" exposure with ordinary enlarging equipment and on processing with ordinary darkroom equipment.

In the photo-finishing field Kodak 'Ektacolor' Paper in roll form is used on automatic colour printers. Although this book may be interesting to those employed in this type of work, it is primarily aimed at the professional photographer who wishes to have complete control over the ultimate presentation of his colour prints.

Front cover From a negative on Kodak 'Ektacolor' Film, Type S. Original photograph by Jack Oakley, Kodak Limited.

Hugo Tapia
1.2.67

CONTENTS

NEGATIVE CHARACTERISTICS

When colour negatives can be printed individually, the quality of colour reproduction obtained with Kodak 'Ektacolor' Paper is comparable to that obtained with the 'Kodak' Dye Transfer Process. As in all colour printing, however, the quality of the end result depends to a marked degree on the quality of the starting point. A fine colour print should not be expected from a poor colour negative. In quantity work, production and economic requirements may make it necessary to tolerate some variation from the best obtainable print quality.

Making a good colour negative – for printing on 'Ektacolor' Paper or any other purpose – requires much care in lighting, exposure, and processing. Here we are concerned only with the characteristics of negatives that relate to colour printing. In later sections of this book (pages 48 to 55), there is information on controlling the effective contrast of finished negatives and on the making of intermediate negatives from colour transparencies.

KODAK NEGATIVE MATERIALS

Kodak films for making colour negatives have coloured couplers incorporated in the emulsion layers at the time of manufacture. The unused couplers remaining in the film after development provide automatic masking for colour correction. Thus colour prints and transparencies of excellent quality can be made without the supplementary masking procedures usually required for best results in reproductions from positive colour transparencies.

NOTE: Coloured couplers effectively improve the characteristics of the dyes in the negative. They do not eliminate the need for supplementary masking procedures when a colour negative is used as an intermediate in printing or duplicating a positive transparency.

Kodak 'Ektacolor' Film is available in two types. The Type L (long exposure) film is designed for exposures from $\frac{1}{5}$ second to 60 seconds, whereas the Type S (short exposure) film is intended for exposures of $\frac{1}{10}$ second or shorter. Both are supplied in the most popular sheet-film sizes and both are designed for processing with prepared chemicals (Process C–22). The user can process the negatives himself or he can have them processed by a commercial laboratory. This service is not provided by Kodak Limited.

Kodak 'Ektacolor' Film without a type designation is supplied in rolls 35mm wide for use by school, identification, and portrait photographers. Negatives on this material are essentially similar to negatives on Kodak 'Ektacolor' Film, Type S, and can be printed in the same manner.

'Kodacolor' Film, available in sizes to fit most roll-film and miniature cameras, is supplied in a single type suitable for exposure either in daylight or with clear flash bulbs. Other light sources can be used with suitable filters. The film can be developed to a negative by the user or by a Kodak or other processing laboratory. 'Kodacolor' Prints and Enlargements are only supplied by Kodak Limited on orders placed through dealers; prints and enlargements on Kodak 'Ektacolor' Paper can be made by others.

NEGATIVE EXPOSURE

Kodak 'Ektacolor' Paper can be used satisfactorily for making prints from almost any type of colour negative, either masked or unmasked. However, certain differences in colour balance characterize different types of negative film. Slight differences in colour balance also occur as the result of variations from one emulsion batch to another of the same type of film, as the result of using light sources that differ in colour quality or as the result of processing variations.

Use of Filters: When it is known before the original exposure of colour negatives that they are to be printed on 'Ektacolor' Paper with manual selection of the printing filters, it will be found convenient to make advance compensation for differences in exposing sources. Filter recommendations for 'Kodacolor' and Type S 'Ektacolor' negatives are designed to correct the light source used to a colour quality similar to that of clear flash bulbs. Negatives exposed by other types of illumination are brought to the same balance by using filters over the camera lens.

'Kodacolor' Film, when used professionally, is treated in a similar manner to 'Ektacolor', Type S. This approach entails use of a filter, such as the Kodak 'Wratten' No.85C, for daylight exposures, even though no filter is recommended for general amateur use in daylight. Kodak 'Ektacolor' Film, Type L, is intended primarily for exposure with 3200°K lamps. Filter suggestions for exposures by photoflood, daylight or other types of illumination are given in the film instructions and in the publication "Kodak 'Wratten' Filters".

Exposure: The most important single characteristic of a negative suitable for colour printing is adequate shadow detail. This point can be checked by examining the negative through a green filter such as the Kodak 'Wratten' No.61.

IMPORTANT: Do not expose 'Ektacolor' Films for times longer or shorter than specified in the film instructions. To do so may cause colour-reproduction errors in the negatives that cannot be corrected satisfactorily in the printing operation.

KODAK 'EKTACOLOR' PAPER

Kodak 'Ektacolor' Paper consists essentially of three emulsions – sensitive to blue, green, and red light, respectively – coated on a medium-weight paper base. The emulsion surface has a fairly high gloss, which permits the prints to retain a long tonal range.

The Kodak Professional Catalogue gives the full range of sizes, prices and availability of 'Ektacolor' Paper in roll and sheet forms.

STORAGE

As supplied, the paper is protected by a moisture-proof bag of laminated foil. After removing the paper to be used, fold the foil over on itself to prevent moisture from penetrating to the remaining paper.

As with all photographic colour products for critical professional use, protection against heat should be provided by storing the paper in a refrigerator at 50°F (10°C) or lower. To prevent condensation of moisture on the cold paper, remove it from the refrigerator about half to one hour before use to allow it to come approximately to room temperature. Prolonged exposure of unprocessed paper to temperatures above 50°F (10°C) may cause losses in the photographic quality of the colour prints.

After a package is opened, either heat or humidity may change the printing characteristics of the material. In the event of the contents of a package being used over an extended period of time, it may be necessary to adjust exposure conditions to make allowance for such changes. Storage for indefinite periods is best accomplished by placing unopened packages in a freezing unit operated at 0 to −10°F (−18 to −23°C).

SAFELIGHT

Kodak 'Ektacolor' Paper is very sensitive to light of all colours and requires more care in darkroom handling than most printing materials. As noted on the instruction sheet, it can be handled for a limited time under a safelamp fitted with a 'Kodak' Safelight Filter 'Wratten' Series 10H (dark amber) using a 25-watt bulb. Two layers of 'Wratten' Filter No.72B are suitable for use as a safelight screen in a torch or in a lamp used to illuminate a timer. Safelight filters of different transmission characteristics must not be used, either for working illumination or to illuminate instruments or a timer.

EXPOSURE METHODS

There are two basic methods for exposing Kodak 'Ektacolor' Paper: by a single "white-light" exposure or by three individual exposures through tri-colour (red, green and blue) filters.

Prints of excellent quality can be made by either method. When a difference appears, it generally takes the form of slightly lower contrast

Four-colour halftone blocks from a print on Kodak 'Ektacolor' Paper. Original photograph by John Dixon, F.I.B.P., Studio Graphis.

and slightly lower saturation of yellows and blues in a print made by white-light exposure. Usually these effects can be seen only in a pair of prints that have been made from the same negative and matched as closely as possible in density and colour balance. Even then a difference appears only if the original subject contained highly saturated colours. Most professional and specialist users prefer the white-light exposure method. However, the tri-colour method may be suitable for advanced amateurs, to whom the purchase of a set of CP or CC filters represents a considerable outlay. The prospective user should make a careful appraisal of the comments in the text before deciding which method to adopt.

White-Light Method The term "white-light", usually applied to this single-exposure method, may at first seem somewhat misleading because filters are used as required to adjust the colour quality of the light source. Once a print of satisfactory colour balance has been made from a typical negative, the same group of filters, commonly referred to as a "filter pack", can be used for trial exposures with other negatives. Minor changes in filter requirements are to be expected from one batch of negatives to another, and sometimes even from one negative to another on the same roll of film, unless the negatives were exposed at about the same time and under about the same illumination conditions.

Because of its similarity to black-and-white enlarging procedures, the white-light method is considerably easier for workers with limited experience in handling colour materials. Also, the fact that all three layers of the print are being exposed simultaneously makes it possible to shade or print-in parts of the picture without affecting colour balance. Furthermore, the use of Colour-Compensating Filters in shading or printing-in permits deliberate local changes in colour balance where they are wanted.

Tri-colour Method. This technique involves three separate exposures – one to red, one to green, and one to blue light. To avoid the possibility of colour shifts, successive exposures should always be given in the same order. The relative exposure times are varied as necessary to secure satisfactory colour balance.

Some workers may feel that the tri-colour method offers an advantage over the white-light method in that it requires a smaller investment in filters. Certainly, when filters are to be used next to the enlarging lens, the fact that only one filter is used at a time decreases the danger that definition will be impaired. Losses can occur if several filters are used in the path of image-forming light. However, the optical requirements of the filters are more critical, since any irregularities will produce colour fringing due to image displacement. Gelatine filters are therefore recommended.

KODAK 'EKTACOLOR' PRINT FILM

This film is designed for contact printing or enlarging direct from 'Ektacolor' or 'Kodacolor' negatives. It is intended to be processed by the user and yields brilliant positive transparencies which are well suited for use in displays or as originals or colour guides in the photomechanical reproduction processes.

MAKING TRANSPARENCIES

The suggestions made in this book for making prints on 'Ektacolor' Paper can be followed to make transparencies on 'Ektacolor' Print Film. Merely substitute 'Ektacolor' Print Film for 'Ektacolor' Paper and, as a starting point, use the exposure time and filters suggested in the supplementary instruction sheet packed with the film. This suggested filter pack applies, of course, to specific equipment. Make test prints until a transparency of satisfactory colour balance is obtained. The difference between the filter pack and exposure time used to make this transparency and that suggested on the supplementary instruction sheet can be regarded as a filter correction for the equipment used. This filter correction can be added to the suggestions for other 'Ektacolor' Print Film emulsions to obtain a starting filter pack for new emulsions. This "equipment filter correction" may need modifying when the exposing lamp ages or is changed, or when the filters, the enlarging lens, etc. are changed.

'Ektacolor' Print Film is exposed with its emulsion side facing the exposing lamp and with a sheet of black interleaving paper behind the print film.

After exposing and processing the test transparency, allow it to dry thoroughly before attempting to evaluate it, because a transparency of satisfactory density and colour balance appears somewhat opaqne and too warm when it is wet. As with 'Ektacolor' Paper, wet prints can be judged approximately if they are immersed for one minute in 'Kodak' AM-33 Rapid Liquid Fixer (undiluted – no hardener added) after step 7 of the processing sequence. If the test transparency is to be kept, continue the normal process with the 8-minute wash.

PROCESSING

Kodak 'Ektacolor' Print Film is processed in 'Kodak' Colour Film Processing Chemicals, Process C-22. The development time for 'Ektacolor' Print Film is 12 minutes at 75°F (24°C). The mixing and processing directions are shown in the Process C-22 instructions packed with each kit.

EQUIPMENT

The amount of expenditure required for starting-up in colour printing is not large – often under ten pounds. But to produce colour prints on a commercial basis, a capital outlay of several hundred pounds might be necessary. Most reasonably-equipped darkrooms will contain equipment that is suitable or needs little modification for a start to be made.

AN ENLARGER FOR COLOUR PRINTING

Almost any enlarger having a tungsten lamp and heat-absorbing glass is suitable. Enlargers with fluorescent light sources are not recommended.

A new enlarger lamp should be burned for an hour at its rated voltage before using it to make prints, because changes in lamp characteristics are greatest in this initial period. Because the image in a colour negative is composed of dye, a specular optical system (as given by condensers and a small light source) is unnecessary and a more diffuse optical system is recommended. A specular optical system would merely emphasize any negative scratches or abrasions, on the print. If the enlarger head leaks light, it will have to be hooded with black cloth when exposures are made.

A lens which is colour-corrected is necessary; some older lenses intended for black-and-white work give prints showing colour-fringing.

LAMP VOLTAGE

Changes in the voltage applied to a tungsten lamp affect both the light output and the colour quality of the light. In the normal operating range (200–250 volts), a 10-volt variation changes the output by about fifteen per cent and the colour quality by about the magnitude of a CP10 or CC10 filter. Hence not only will the exposure time be affected, but the change in colour quality will affect the colour balance of the print significantly.

Some voltage variations are characteristic of the time of day; others may arise from the use of electrical equipment within the building or in the immediate neighbourhood. Both slow and sudden changes in the line voltage can be eliminated by installing an automatic constant-voltage transformer.

A less expensive means of controlling the voltage is to use an adjustable voltage transformer in conjunction with an accurate a.c. voltmeter. Alternatively, a variable resistance and voltmeter in circuit with the lamp can be used. These items can be purchased from electrical or radio dealers. Since the voltage may change even during the time an exposure is being made, it is best to apply luminous paint to the voltmeter needle and to the proper mark on the voltage scale. The two luminous points can then be re-aligned in the dark whenever the need arises.

Operation at rated voltage provides a good balance between the higher light output that would result from higher voltage and the longer lamp life that would result from lower voltage. If enough light for exposures of practical length is available at a lower voltage, it will probably be

desirable to standardize on the lower voltage. For example, a 230-volt lamp might be operated at 220 volts, and the basic filter pack determined for 220-volt operation. Not only will the life of the lamp be extended, but any changes in lamp characteristics will be much more gradual.

FILTERS

The white-light exposure method requires the use of a filter pack containing a number of filters. The less-expensive CP Filters may be nsed in the preferred position, which is between the negative and the lamp, but CC filters can be used in a position close to the enlarging lens. Provided that they are free from dust and scratches, as many as three filters used at the lens will not impair quality to a serious degree. Where filters are used above the negative they should be placed as far from the negative as possible in order that dust, scratches or fingerprints are not focused on the print when the enlarging lens is stopped down. To prevent premature fading of the filters a heat-absorbing glass must be placed between them and the lamp (but not too close to the filters as heat-absorbing glasses become extremely hot in use.)

Use of the tri-colour exposure method requires a means of changing filters and of timing three different exposures without disturbing, even slightly, the position of the enlarger or paper. Either a timer that can be read in the dark or one that can be set in the dark to the proper interval will serve.

THE 'KODAK' COLOUR ENLARGER

The 'Kodak' Colour Enlarger is a relatively inexpensive enlarger designed to make enlargements on Kodak 'Ektacolor' Paper from 'Kodacolor' negatives. It can accept all the popular sizes of film negatives from 24×36 mm up to $2\frac{1}{4} \times 3\frac{1}{4}$ in.

The Colour Enlarger employs a unique method of manually varying the colour of the printing light and photo-electrically monitoring the light transmitted by the negative, ensuring correct exposure of the colour print. The sliding filters give continuously variable control of colour balance, so that even very small adjustments can be made, as opposed to definite steps as when using CC or CP filters.

Variations in the colour and intensity of the enlarging lamp output due to 'seasoning' or changes in the mains supply voltage are automatically compensated by movement of the sliding filters.

In addition to this photo-electric monitoring of colonr-balance, the Colour Enlarger features an exposure photocell. This is nsed to make readings of the projected image, thus making automatic allowances for negative density, colour filter densities and magnification.

The rapidity with which assessment of the negative can be carried out, in terms of colour and density, contributes to a high rate of output. Thus the Colour Enlarger offers a means of producing colour prints up to 12×15 in. or larger, without elaborate test strips – in fact a large proportion of results are right first time.

EQUIPMENT NEEDED

The following list gives the minimum amount of equipment needed to print and process Kodak 'Ektacolor' Paper.

1. A tungsten lamp enlarger with a filter drawer for holding CP filters above the negative: alternatively a means of holding tri-colour or CC filters close to the enlarging lens.
2. A set of 'Kodak' Colour-Printing or Colour-Compensating Filters or, if tri-colour printing is envisaged, Kodak 'Wratten' Filters No.70, 98, and 99.
3. A masking frame.
4. Several airtight bottles for storing processing chemicals.
5. Four processing dishes of the appropriate size.
6. An accurate thermometer.
7. A luminous clock or watch with a second hand.

For making colour prints on a commercial scale the above list would have to be extended to include some or all of the following:

8. Darkroom safelights.
9. A voltage stabilizer.
10. An automatic enlarger timer.
11. A thermostatically controlled water supply.

For quantity production of prints up to 8 × 10 inches

12. Seven 'Kodak' No.3 Processing Tanks.
13. Four 'Kodak' No.3 Hard-Rubber Washing Tanks.
14. Several 'Kodak' No.3 Colour Print Processing Baskets.
15. A 'Kodak' No.3 Tempering Coil.
16. A supply of nitrogen gas, pressure reducing valve, and ancillary gas piping.
17. A 'Kodak' No.3 Nitrogen-Gas Distributor.
18. A 'Kodak' Burst-Valve Control Unit and a Valve for the 'Kodak' Burst-Valve Control Unit.
19. A 'Kodak' Drying Cabinet or a 'Kodak' Glazing Machine.
20. An electric processing-solution mixer.

The booklet "Equipment for Professional Colour Printing, Technical Memorandum No.50", available on request, gives much useful information concerning darkroom layout and sources of supply of equipment such as voltage stabilizers, gaseous burst equipment, mixing valves, timers, etc.

FILTERS FOR COLOUR PRINTING

Filters are used when printing 'Ektacolor' Paper from colour negatives, not because the negatives have any shortcomings in their manufacture, exposure or processing, but to compensate for differences between paper batches, exposing equipment and to make fine adjustments to colour balance. The rare negative that needs no colour-printing filters in the light beam is not necessarily any better than a negative needing several filters.

In a typical filter designation, CP20Y, 'CP' stands for 'Colour-Printing', '20' for a density of 0·20, and 'Y' for 'Yellow'. The density designation applies only for light of the colour that the filter is designed to absorb – in this case, blue light.

COLOUR-PRINTING FILTERS

CYAN	MAGENTA	YELLOW
CP025C	CP025M	CP025Y
CP05C	CP05M	CP05Y
CP10C	CP10M	CP10Y
CP20C	CP20M	CP20Y
CP30C	CP30M	CP30Y
CP40C*	CP40M*	CP40Y*
CP50C*	CP50M*	CP50Y*
Also a CP2B (equivalent to a Kodak 'Wratten' No.2B)		

* To ensure greater accuracy in colour printing, each of the nominal values CP40 and CP50 are subdivided into three groups of actual values. The actual value groups for CP40 are 37½, 40, and 42½, and CP50 are 47½, 50, and 52½.
Both 'nominal' and 'actual' values are marked on the filter packets.

For use in enlargers which provide a convenient means for placing the filter pack between the light source and the negative, 'Kodak' Colour-Printing Filters are recommended. These filters are less expensive than Colour-Compensating Filters, but they cannot be used in the path of image-forming light without affecting print definition. The CP Filters are supplied in cyan, magenta, and yellow, and in density values shown in the table opposite.

The range of 22 filters is available as gelatine film 12, 16, and 23 cm square ($4\frac{3}{4}$, $6\frac{7}{8}$, and 9 in. square respectively).

The CP Filters are not supplied in red, green or blue, because the number of filters between the lamp and the negative is not important. Hence, these colours can, if they are needed, be obtained by using the proper combinations of cyan, magenta, and yellow filters.

COLOUR-COMPENSATING FILTERS

For use at the lens, gelatine-film filters are recommended. These are somewhat more expensive than the Colour-Printing Filters, but they can be used in a much smaller size. In order to avoid flare and loss in definition, it is important to use the smallest possible number of filters at the lens. 'Kodak' Colour-Compensating Filters are supplied in red, green, and blue, in addition to the cyan, magenta, and yellow. It is, therefore, possible to obtain with not more than three CC Filters practically any colour and density combination needed. The complete range of Colour-Compensating (CC) Filters is overleaf.

CYAN	MAGENTA	YELLOW	RED	GREEN	BLUE
CC05C	CC05M	CC05Y	CC05R	CC05G	CC05B
CC10C	CC10M	CC10Y	CC10R	CC10G	CC10B
CC20C	CC20M	CC20Y	CC20R	CC20G	CC20B
CC30C	CC30M	CC30Y	CC30R	CC30G	CC30B
CC40C	CC40M	CC40Y	CC40R	CC40G	CC40B
CC50C	CC50M	CC50Y	CC50R	CC50G	CC50B

The ultra-violet absorbing CP2B Filter should, if possible, be placed between the negative and the lamp. This position is advised even with enlargers which have no special provision for accepting filters above the negative, because the CP2B stays in the system and is not involved in any adjustments in the filter pack. If the ultra-violet absorber can only be placed in the path of image-forming light, the Kodak 'Wratten' Filter No.2B should be used. It can be located directly above the lens.

The filters used at the lens, or in any position between the negative and the paper, must be free from dust, scratches or finger marks. The condition of filters should be checked regularly to prevent a gradual increase in definition losses from occurring in the colour prints. Filters which have been damaged by careless handling should be replaced for printing purposes, though they can still be used for viewing test prints to help judge the colour correction needed.

Basically, the CP filters are similar to CC filters but they have improved colour-transmission characteristics so that better neutrality is achieved when similar nominal values of cyan, magenta, and yellow are combined. This means that similar values of CP and CC filters may not produce identical results on a colour print and it is recommended, therefore, that the two types of filters are not used together, or interchanged.

FILTER COMBINATIONS

The combination to be placed in the exposing light beam should always be the simplest combination possible – the combination that uses the fewest filters to produce the desired colour correction.

The determination of filter combinations can be simplified by thinking of all filters in terms of the subtractive colours, as follows. However, for really critical use, a particular red, green, or blue filter may not give exactly the same colour adjustment as the corresponding subtractive pair.

A RED FILTER (absorbs blue and green)	is equivalent to **A YELLOW FILTER** (absorbs blue)	plus **A MAGENTA FILTER** (absorbs green)
A GREEN FILTER (absorbs blue and red)	is equivalent to **A YELLOW FILTER** (absorbs blue)	plus **A CYAN FILTER** (absorbs red)
A BLUE FILTER (absorbs green and red)	is equivalent to **A MAGENTA FILTER** (absorbs green)	plus **A CYAN FILTER** (absorbs red)

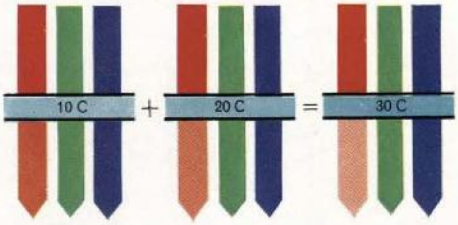
There are two reasons for keeping the number of filters to a minimum: first, when prints are made by projection through the filters, definition

FILTER FUNDAMENTALS

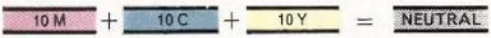
White light is made up of red, green, and blue components. When these components are absorbed differentially by filters, there is a change in both colour and intensity.

A cyan filter transmits almost all of the blue and green components of white light, but absorbs or subtracts part of the red component. The proportion of red light that is subtracted depends on the density of the cyan filter.

The same principle applies to filters of the other two subtractive primary colours. A magenta filter transmits red and blue light, but subtracts green light. A yellow filter transmits red and green light, but subtracts blue light.

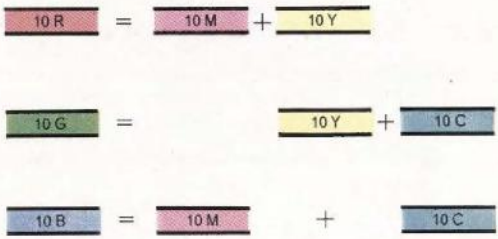


A combination of many filters, expressed in terms of the subtractive primaries, may reveal the absorption of all three components. This absorption is neutral density. Since it reduces the intensity of the light without giving any colour correction, it should be removed.

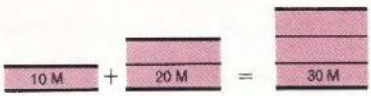


To calculate the neutral density of a filter system, reduce all filter colours to their equivalents in cyan, magenta, and yellow.

Note that the colour density remains the same in the division: 10R becomes 10M and 10Y, not 05M and 05Y. The converse is also true: 20C plus 20Y equals 20G. Similarly, 10C plus 10M plus 10Y equals 0.10 neutral density.



However, when filters of the same colour are combined, the densities add normally. For example, 10M plus 20M equals 30M.



may be impaired by scattered light unless the least number of filters is used; second, if filters of different colours are merely added together, the resulting combination may contain some neutral density, which will serve only to increase the exposure time. Unwanted neutral density is present when all three components of white light – red, green, and blue – are absorbed.

The following procedure is therefore recommended:

1. Convert the filters to their equivalents in the subtractive colours – cyan, magenta, and yellow – if not already of these colours **(for example, 20R = 20M + 20Y).**
2. Add the values for each colour **(for example, 20M + 10M = 30M).**
3. If the resulting filter combination contains all three subtractive colours, take out the neutral density by removing an equal amount of each **(for example, 10C + 20M + 20Y = 10M + 10Y + 0·10 neutral density, which can be removed).**

In many cases, a filter pack may include three or more filters. However, the procedure given above applies in each case and following it carefully will prevent the use of the wrong filters or the use of a filter combiuation heavier than necessary to obtain the desired colour balance.

Particularly when using CP filters, it is *sometimes* desirable, in spite of the foregoing text, to use some neutral density in a filter combination. This situation occurs when a *slight* alteration is to be made to a filter pack made up of many filters; and wheu such a change would mean changing several of the components of the pack. As an example, consider a test print made with a filter pack containing CP30C + CP10M + CP37½M filters. If this test print is very slightly too yellow and a reprint needs a CP025Y filter in tbe pack. It is preferable, and more convenient, to add the CP025Y filter to the above pack (with due exposure time allowance) than to remake the pack as CP025C + CP05C + CP20C + CP025M + CP05M + CP37½M.

TRI-COLOUR FILTERS

The recommended Kodak 'Wratten' Filters are:

Red – No.70
Green – No.99 (equivalent to a No.61 plus a No.16)
Blue – No.98 (equivalent to a No.47B plus a No.2B)

Since each of these tri-colour filters (or combinations) absorbs ultra-violet radiation, it is not necessary to place an ultra-violet absorber in the light beam as is done with white-light printing.

Where filters are used between the negative and the paper, e.g. at the enlarging lens, it is recommended that single gelatine filters mounted in card frames are used. Filters mounted between glass can produce poor registration of the individual images on the paper, unless the filter glasses are optically flat and of the same optical thickness. Furthermore, unless the enlarger is focused with the glass filter in position, an unsharp image will be produced in the actual exposure, due to the thickness of the filter glass. Focusing with the glass filter in position is difficult because the amount of light passing through the filter is so small. When gelatine filters are used the enlarger may be focused without the filter in position.

TEST PRINTING

Because of the number of variables which must be brought under control in the initial set-up of colour-printing conditions, it is highly unlikely that a perfect print will be produced at the first attempt. The first print, therefore, must be considered a test print. The final print, to be acceptable, must be satisfactory in both density and colour balance.

SIGNIFICANCE OF TESTS

It is worth while at this point to consider the relationship between the two objectives, satisfactory density and satisfactory colour balance. When the paper is exposed by white light, the three emulsion layers in effect divide the white light into its three primary components, just as if the paper were being exposed by the tri-colour method. When a print exposed by either method is developed, the cyan dye image in the red-recording layer controls the reflection of red light from the white paper base to the eye. Similarly, the magenta dye image controls the reflection of green light, and the yellow dye image the reflection of blue light. The relationship of the three dye densities at any given point on the print governs the colour synthesized there, and the over-all density relationship of the three dye images governs the colour balance of the print as a whole.

Since the process is a negative-positive one, increasing the exposure in any of the three emulsion layers of the printing material increases the density in that layer. Conversely, decreasing the exposure decreases the dye density. Suppose, for example, that everything in a test print appears too yellowish. Since less yellow dye is wanted, a decrease in the exposure of the blue-sensitive layer is needed. In tri-colour printing, this result is obtained by shortening the exposure through the blue filter. In white-light printing, it is obtained by adding a yellow (blue-absorbing) filter to the exposing filter combination, thus making the light yellower. The added yellow filter decreases the exposure in the blue-sensitive layer of the paper and hence decreases the amount of yellow dye formed.

The same type of reasoning applies when a print is too dark or too light. Perhaps the exposure in all three layers is too great or too little; perhaps one layer is correctly exposed and the other two are not. The important thing to remember is that the real objective is correct exposure in each of the three layers of the print material. In tri-colour printing, this goal is achieved by determining the correct exposure time through each of three filters. In white-light printing, there are two determinations to be made: exposure time and filter combination.

TEST CONDITIONS

First select a properly exposed colour negative that is as nearly as possible typical of those to be printed. The subject should preferably include some neutral or near-neutral areas. The fact that more pictures than not

include people should also be considered. Note, however, that when the most pleasing reproduction of flesh tones is obtained in a print, true neutrals (such as the grey side of the 'Kodak' Neutral Test Card or the 'Kodak' Grey Scale of the 'Kodak' Colour Separation Guides) may be reproduced with a slight cast of colour.

The emulsion side of a 'Kodacolor' negative is toward you when the arrow along the edge is pointing in a clockwise direction around the negative. The emulsion side of an 'Ektacolor' sheet-film negative is toward you when you are holding the film with the long edge vertical and the code notch in the upper right-hand corner.

Make sure the negative is free from dust and place it in the enlarger so that its emulsion side is down (toward the lens). Elimination of stray light around the edges of the negative image is absolutely essential. Stray light can be reduced with the sliding masks built into some enlarger heads or with a black-paper mask having an opening about the same size as the image area to be printed.

White-light Trial: An enlarger with tungsten illumination used for exposing 'Ektacolor' Paper must be equipped with heat-absorbing glass. For white-light exposures, an ultra-violet absorber, such as the Kodak 'Wratten' Filter No.2B or CP2B must always be included in the light beam preferably above the negative (see page 12). As a starting point for the first trial, with an average enlarger having a lamp operated at rated voltage, use no Colour-Printing Filters in the light beam. Make a stepped exposure-time series at a lens aperture that you would use for the normal printing of an average black-and-white negative at the same magnification. This recommendation assumes the use of a colour negative of normal balance; i.e. 'Kodacolor' or 'Ektacolor' Film, Type S exposed to light of 3800°K with an exposure time of about $\frac{1}{50}$ sec. or 'Ektacolor' Film, Type L exposed to light of 3200°K with an exposure time of about $\frac{1}{2}$ sec.

One of these exposures should be approximately correct in density and this will indicate the direction of any colour correction required. A second test should then be made with a range of densities of the estimated CP or CC filter or filters, giving the exposure indicated by the first test.

NOTE: In making test exposures, the use of a 'Kodak' Enlarging Exposure Scale, as in black-and-white work, is not recommended. Because of variations in sensitivity of the emulsion layers with illumination level and exposure time, use of a device of this type is not likely to lead to reliable exposure predictions.

Tri-colour Trial: For tri-colour printing, it is easier to give one set of filtered exposures to the whole area of a test strip rather than attempting to make a stepped test print. If necessary, two or three test strips can be exposed and processed. The exposures through the red, green, and blue filters, even on test strips, must be made without disturbing the position of the negative or paper. It may be worthwhile to make stepped test exposures through each of the tri-colour filters on separate pieces of colour print paper for the initial setting-up.

With a tungsten light-source enlarger set to give an 8×10 in. enlargement from a $2\frac{1}{4}\times3\frac{1}{4}$ in. negative, try red, green, and blue exposures in the ratio 1 : 2 : 3, e.g. 15, 30, and 45 seconds at, say, *f*/8. Use the filters recommended on page 14.

MULTIPLE TEST EXPOSURES

Once the basic filter pack or tri-colour exposure ratio has been determined for a typical negative, the same exposure conditions can be used when tests are made on the same paper batch from other negatives. If the negatives are small, a convenient procedure is to tape several to a sheet of plate glass, with the base side of the film in contact with the glass. Adjust the enlarger to give the same degree of enlargement that is later to be used in printing the negatives, using a negative mask or negative carrier of the proper size in the enlarger head. If an 8×10 in. enlargement is to be made from each negative, the cone of light from the enlarger should be large enough to cover an 8×10 in. sheet of glass with all the negatives taped to it. If the size of the final prints is to be other than 8×10 in., adjust the lens opening to compensate for the difference.

Now lay a sheet of the 'Ektacolor' Paper on the enlarger baseboard and cover it with the negatives. Expose the sheet as indicated by previous test: then process and dry it.

Assuming the exposure level for the contact test prints proves to be correct, exposures will be about the same when the negatives are placed in the negative carrier and enlarged. Allowance must be made, however, for changes to improve colour balance or density, based on the evaluation of the contact test prints.

If the negative previously enlarged is included among those from which contact prints are made, it forms a standard of comparison or "master negative" (see page 38). Each of the other contact prints can then be compared with the reproduction of the master negative. In this way, only the differences characterizing the individual negatives will enter into the comparison. Other variables, such as a departure of the test-print process from normal colour balance, will be eliminated.

Incidentally, do not discard test prints. Instead, write on them the actual exposure conditions and the predictions made from the test results. Such records will enable the greatest practical value to be gained from past work. Properly applied, they will help develop the judgment needed for easier colour printing in the future.

PRINT ASSESSMENT

As the incidence of partial or complete colour blindness is higher than is generally realized, particularly in men, it is most desirable that any person who will be concerned with assessing or checkiug of colour prints should have his colour vision tested by one of the recognized methods.

When examining a print to determine colour balance and density, beware of taking too long over the assessment, as fatigue in your eye will upset your colour judgment.

VIEWING CONDITIONS

Try to evaluate prints under illumination of the same colour quality as that by which they will finally be viewed. Where this is not possible 'Kolor-rite' or 'Colour Matching' fluorescent tubes are recommended.

While wet, prints on 'Ektacolor' Paper appear slightly too dark and much too cyan in colour balance. However, wet prints can be judged approximately if they are immersed for 1 minute in 'Kodak' AM-33 Rapid Liquid Fixer (undiluted – no hardener added) directly after the second hardener fixing bath, step 7. After evaluating the test print, complete the remaining processing steps as usual. If the test print is to be kept, double the wash time in step 8. It is just as important to pre-view wet prints under the final viewing conditions as it is with finished prints.

There are two ways of assessing prints or tests. The assessment of colour balance and density is not an easy skill to acquire quickly and in the initial stages of colour printing it is useful to assess prints by both methods. With increasing experience these aids to judgement will become unnecessary.

Method No.1 – Comparison: In this method the test print is compared with one of a "ring-around" set of colour prints. Such a set is obtained by printing the same master negative (see page 38) first "on balance" and then purposely off balance in steps of 10CP or CC filter units in tbe red, green, blue, cyan, magenta, and yellow directions. Three or four such steps in the direction of each colour will be sufficient. In each case compensation of the exposure times to allow for the changes in filtration relative to the "zero" print is necessary (see page 20).

A supplementary set of prints with changes in density obtained by opening and closing the lens aperture by $\frac{1}{3}$, $\frac{2}{3}$, and 1 stop (or other choseu values) from the value used to make the "zero" print will also be useful.

Method No.2 – Use of Viewing Filters: If a test print is reasonably close in colour balance, viewing it through 'Kodak' Colour-Compensating or Colour-Printing Filters provides a means of determining what colour correction is needed. Since a filter used in this way tends to over-correct highlights and under-correct shadows it should be selected on the basis of correcting the lighter middle tones to the desired colour balance. Be sure to view the print under proper lighting conditions, and hold the filter neither

so close to the print that the light falling on the print passes through the filter first nor so close to the eye that the filter influences general colour perception by allowing the eye to become "adapted" to that colour.*

Since the contrast of the print material is fairly high, a filter used in exposing a print tends to produce a greater change in colour balance than might be expected from the effect of a filter of the same strength used in viewing. *In general, the filter added to the filter pack, for white-light printing, should be half the strength of, and complementary to, the filter that makes the lighter middle tones of the test print appear best.*

Suppose, for example, that the test print is too green – that is, the magenta dye image is too light relative to the cyan and yellow dye images. The print will look best through a magenta filter, but to achieve relatively more exposure in the green-sensitive layer where magenta dye is formed it is necessary to add green filtration to the pack or to remove magenta filtration. If a 20M filter was best for viewing, removing a 10M filter from the pack (or adding 10Y+10C) should accomplish the desired correction.

When modifying a filter pack, particularly when using CC filters, the old filter pack should be noted mentally or written down in its component yellow, magenta, and cyan parts. The print assessment in terms of Y.M.C. (yellow–magenta–cyan) is then added to these subtractive equivalents. The total of this addition is then simplified to give the minimum number of the filters available. An example of filter pack modification, broken down to its simplest terms, is given in the next chapter.

* An alternative method of using viewing filters is to place a sheet of white paper next to the print requiring assessment. A combination of filters is chosen so that when the white paper viewed through them has the same colour as the cast in the print, then these viewing filters are added to the filter pack.
NOTE: *In this method the values and colours of the viewing filters are the same as those used to modify the filter pack.*

MODIFYING FILTERS AND EXPOSURE TIMES

When it has been decided which colour predominates in the test print, a filter of that same colour can be added to the pack. However, it is more desirable to subtract a complementary filter, and this procedure should be adopted whenever possible.

The following table may be useful in determining what filter adjustment should be made in white-light printing.

IF THE COLOUR BALANCE IS	SUBTRACT THESE FILTERS	OR ADD THESE FILTERS
YELLOW	MAGENTA AND CYAN (OR BLUE)	YELLOW
MAGENTA	CYAN AND YELLOW (OR GREEN)	MAGENTA
CYAN	YELLOW AND MAGENTA (OR RED)	CYAN
BLUE	YELLOW	MAGENTA AND CYAN (OR BLUE)
GREEN	MAGENTA	CYAN AND YELLOW (OR GREEN)
RED	CYAN	YELLOW AND MAGENTA (OR RED)
ADD FILTERS OF THE SAME COLOUR AS THE CAST ON THE PRINT		

For example, if the print is too red, remove a cyan filter from the filter pack. If there is no cyan filter present in the filter pack, add yellow and magenta filters (or the equivalent red filter).

The following rough guide may also be helpful: When a slight shift in colour balance is needed, use an 05 or 10 filter change; when a moderate shift is needed, use a 15 (05 plus 10) or 20 change; and when the shift required is too large to estimate, try a 30 change. The 025 filters are useful for making very snbtle changes in colour balance.

TRI-LINEAR FILTER CHANGE CHART

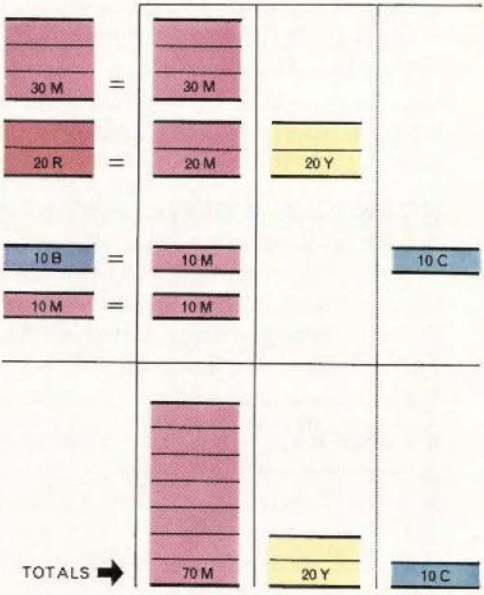
The tri-linear filter change chart inside the back cover of this book, is designed to minimize the "arithmetic" of the filter changing explained opposite. It will be particularly useful to users of CP filters.

To determine a new filter pack, start at the point which represents the filters used to make the test print. Move away from this point on a line parallel to, and in the direction of, the excess colour in the print. Thus, if CP30Y+CP40M filters were used to make the test print then, if this test is assessed as requiring a 20B filter moving ↗ two steps along the

EXAMPLE OF FILTER-PACK MODIFICATION

Suppose that a test print was exposed with 30M and 20R filters in the light beam.

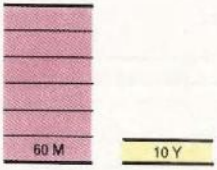
In subtractive terms, the 20R is equivalent to a 20M plus a 20Y. The 30M is already subtractive.



Now suppose that the print looked best when viewed through a 20Y plus a 20G. It follows that half of these values of the complementary colours (10B plus 10M) should be added to the filters in the enlarger.

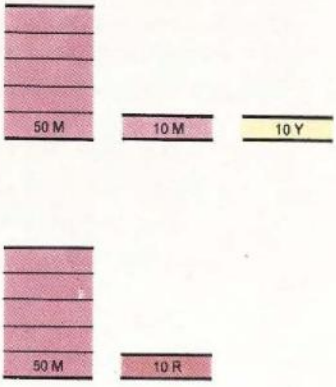
In subtractive terms, the 10B is equivalent to a 10C plus a 10M. The 10M is already subtractive.

The sum of all the filters to be used in exposing the final print is 70M plus 20Y plus 10C. However, since equal densities of all three subtractive filter colours are equivalent to a neutral density, a density equal to that of the lightest filter can be eliminated from each of the three colours in the total. The result of cancelling out 10C plus 10Y plus 10M is to leave 60M plus 10Y.



Since 0.50 is the highest density available in a single filter, a slightly different combination of actual filters is needed. With CP filters it will be 50M plus 10M plus 10Y. With CC filters it will be 50M plus 10R.

If the filters are used in the path of image-forming light, they must be CC rather than CP Filters. The 50M plus 10R combination gives the required correction with the smallest number of filter surfaces.



line parallel to the blue line the new filter pack will be CP10Y+CP40M.

Where a CP05 correction is necessary, interpolate the value which is halfway between the adjacent CP10 step values. For example, consider a test print made nsing CP20Y+CP10M filters. If this is assessed as requiring a CP15C+CP10G correction then move 1½ steps parallel to the cyan line and then 1 step parallel to the green line; the new filter pack is interpolated directly as CP20Y+CP10C+CP05C.

MODIFYING WHITE-LIGHT EXPOSURE TIMES

Whenever the filter pack is changed, allowance must be made for the change in exposure introduced by (1) the change in filtering action, and (2) the change, if any, in the number of filter surfaces. In practice, the values of filter factors and densities have been modified to allow for both these effects simultaneously.

Method No.1 – Use of the Nomogram: It is possible to calculate exposure time changes by using the table of filter densities in conjunction with the nomogram given on the folding flap of the back cover of this book.

The nomogram is used in the following manner:

1. Find the densities of the filters used for the test print from the appropriate table on page 64.
2. Add their densities and select the corresponding number on the scale A.
3. Locate the point on scale C which represents the exposure time (in seconds) used for the test print.
4. Lay a straight-edge across the nomogram between these points.
5. Note the point where the straight-edge intersects scale B (the arbitrary figures on this scale can be used).
6. Add the densities of the new filter combination and locate the number corresponding to this total on scale A.
7. Now lay the straight edge across from this new point to the point previously noted on the reference scale B (as found in step 5).
8. The intersection of the straight-edge with the scale C then gives the exposure time required for the new filter combination.

NOTE: If an exposure time is greater than 64 seconds, all the figures on scale C can be multiplied by, for example, a factor of 10 so that the scale then extends from 20 to 640 seconds.

Example: Filter combination used for the test print:

CP10M+CP05C

Densities=0·11+0·09=total of 0·20

Exposure was 13 seconds

This test print was too red

Assessed filter combination for final print:

CP10Y+CP05Y+CP20M+CP05M

Densities=0·07+0·07+0·16+0·09=total of 0·39

From nomogram exposure for the new filter combination=20 seconds.

Method No.2: Alternatively, the 'Kodak' Colour Print Exposure Time Calculator for use with 'Kodak' Colour Printing Filters is a rotating dial calculator designed to provide a very quick and simple means of determining the new exposure time necessitated by changes in the filter pack.

MODIFYING TRI-COLOUR EXPOSURES

Since printing with 'Ektacolor' Paper is a negative-positive process, exposures through the tri-colour filters must be changed by a relative increase in the direction that the test print is off balance. For example, if the test print is too blue, correction can be made by increasing the blue-filter exposure relative to the green-filter and red-filter exposures. Relatively more exposure will then be given to the blue-sensitive emulsion layer of the next print, thus causing more yellow dye to be formed.

If the test print is off balance in the cyan (blue-green) direction, giving relatively more blue and more green exposure will cause relatively more yellow and more magenta dye to be formed. The two dyes together form red, which is complementary to the excess of cyan in the test print and will counteract it. To state the same thing in a different way, decreasing the red exposure relative to the green and blue exposures will decrease the relative amount of cyan dye formed, thus shifting the colour balance in the desired direction.

IF THE PRINT IS TOO	INCREASE THE EXPOSURE OF	OR DECREASE THE EXPOSURE OF
RED	RED	GREEN AND BLUE
GREEN	GREEN	RED AND BLUE
BLUE	BLUE	RED AND GREEN
CYAN	GREEN AND BLUE	RED
MAGENTA	RED AND BLUE	GREEN
YELLOW	RED AND GREEN	BLUE

The choice as to whether colour balance is going to be corrected by increasing one (or two) of the three exposures or, alternatively, by decreasing the other two (or one) will depend on whether the test print is too light or too dark. Practical experience with the tri-colour method is the best guide to estimating exposure adjustments.

PROCESSING

The purpose of this section is to supplement the instructions packaged with the 'Kodak' Colour Print Processing Chemicals, Process P-122.

The instructions should be consulted for details of the processing steps.

Colour print processing is quite different in many respects from black-and-white print processing. Development times, temperature, and agitation are much more critical and must be standardized. There is no chance of correcting even small errors in exposure by altering the development conditions and prints cannot be assessed until at least thirty minutes after exposure. In other words, more care in working and a systematic approach are needed to prevent waste of time and materials.

Three basic types of equipment – dish, tank and continuous machine – can be used in processing Kodak 'Ektacolor' Paper. The choice depends on the size and quantity of prints to be handled.

Dish processing is described here in some detail because this method offers the possibility of getting started in colour printing with a minimum outlay for equipment. Tank processing is recommended for a wide variety of production requirements, and tank equipment is also discussed in some detail. For processing large quantities of prints on paper in rolls the 'Kodak' Continuous Colour Paper Processor is available. This machine can process several hundred average-size prints per hour and is principally for use in photo-finishing establishments.

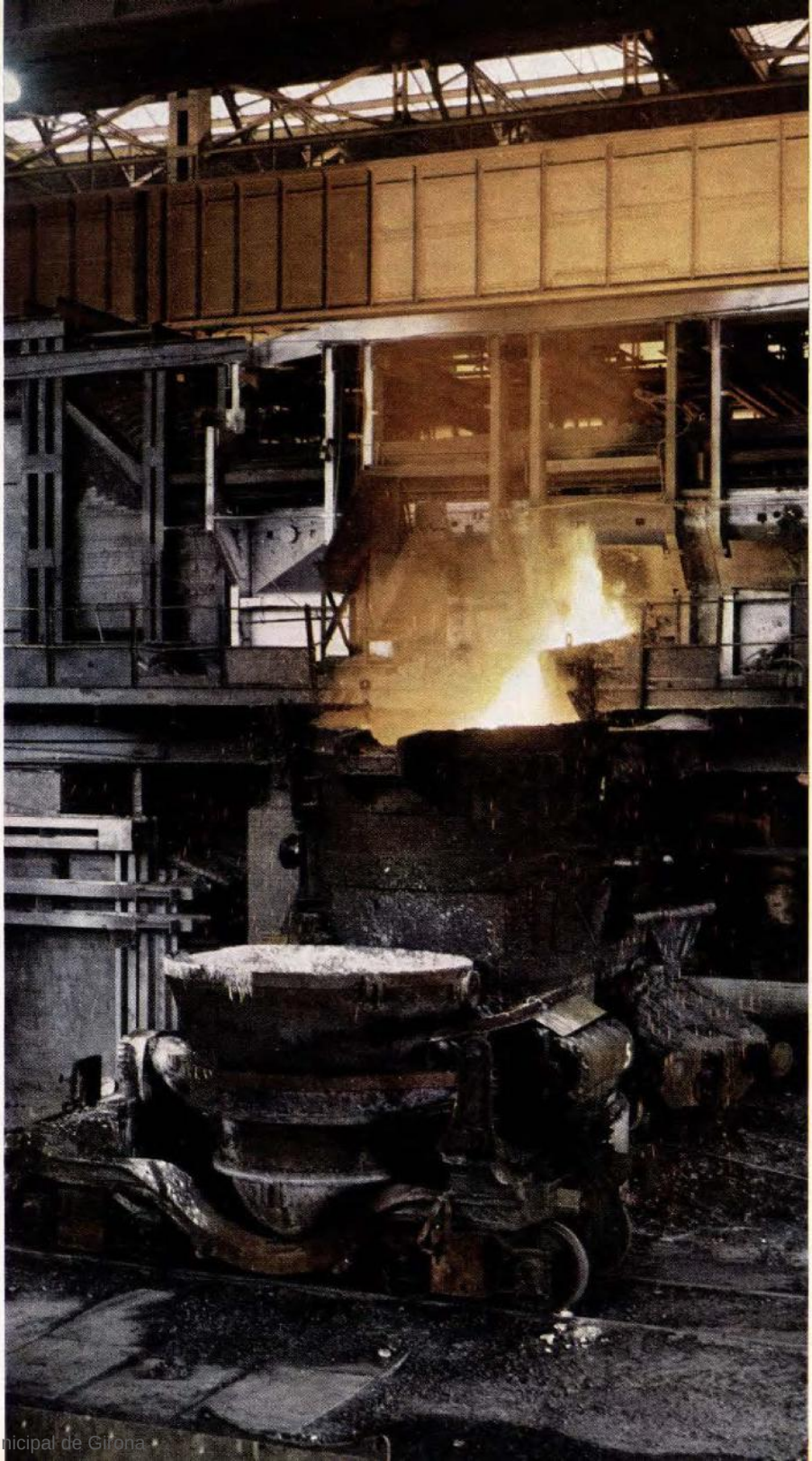
SOLUTIONS

All the chemicals necessary to mix processing solutions for Kodak 'Ektacolor' Paper are supplied in packaged form as the 'Kodak' Colour Print Processing Kit, Process P-122, or as individual components in several sizes. Processing instructions and a summary of the steps are included. A separate Developer Replenisher is available and replenishers for the other solutions can be prepared by dissolving the regular chemicals in the amount of water specified on the package label for use as replenishers.

Mixing: The directions for mixing the processing solutions are given in the instructions packed with the chemicals. Follow these directions carefully – be sure to use the full volume of water at the proper temperature; add chemicals in the order specified; and make sure that each is completely dissolved before adding the next. The chemical mixing area should be separate from the printing area, because chemical dust on unprocessed paper may cause contamination spots.

It is advisable not to mix the solutions in the actual processing tanks. Where an electric stirrer is used to dissolve chemicals, make sure that air is not sucked into the solution, as this may cause oxidation of the developing agents.

Tapping an open furnace at the Corby works of Stewart and Lloyds Limited. Four-colour halftone blocks from a print on Kodak 'Ektacolor' Paper. Photograph by Alan S. Marshall, A.I.B.P., A.R.P.S. on Kodak 'Ektacolor' Film, Type S.



Capacity: When used in a shallow dish, the developer should be discarded after being used once. Otherwise it will be very difficult to achieve consistent print quality. The other solutions can be used in dishes up to the normal exhaustion point.

When processing is carried on in tanks, there are two alternative ways of compensating for the normal exhaustion of solutions: without replenishment, but increasing the development time after processing each basketload of thirty prints *or*, with replenishment, keeping the development time constant. It is better to replenish after using the processing solutions each time, on a pro-rata basis, than to replenish solutions once or twice a day. Full details are given in the instruction sheet packed with the chemicals.

Handling Chemicals: Particularly when processing is done in dishes it is essential that clean rubber gloves be worn to avoid skin irritation. Gloves should be flexible and cover the wrist. Fingertip grips are useful, but thin, surgical-type gloves afford a maximum of fingertip sensitivity. Sprinkling ordinary talcum powder in the gloves will make them more comfortable to wear. Be sure to read the section 'Precautions in Handling Chemicals' in the instructions for Process P-122.

TIME AND TEMPERATURE

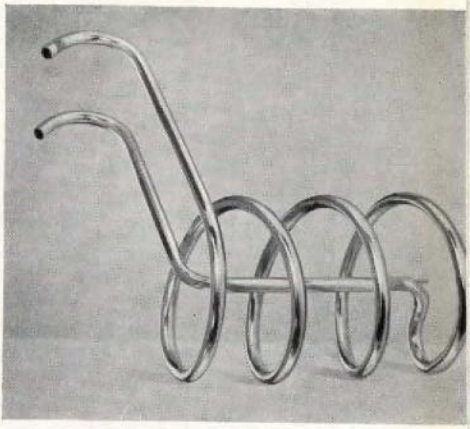
Timing: Either dish or tank processing requires a timer with a sweep second hand which can be followed in the dark. The dial can be phosphorescent or it can be illuminated with a safelight lamp fitted with a Kodak Safelight Filter, 'Wratten' Series 10H (see page 4).

The time required for each processing step includes the draining time. In each case, start draining in time to end the processing step (and start the next one) on schedule.

Temperature Control: An advantage of using 75°F as the nominal processing temperature is the fact that in temperate climates, such as that of Great Britain, solution temperatures tend to fall due to the somewhat cooler air of the darkroom. Temperature control thus becomes a simple problem of heating rather than heating *and* cooling which might be necessary at a lower processing temperature. One way of holding solution temperatures at the proper level is by immersing the dishes or tanks in a water bath at the correct temperature. A thermostatic regulator can be used to control a mixing valve. Thus, when the temperature of the water bath drops, the valve automatically opens to allow a jet of hot water to enter the bath through one or more proportioning valves.

As a substitute means of temperature control for dish or tank processing, an ordinary mixing tap can be used. With such an arrangement, a thermometer placed in the water flow near the developer tank must be watched constantly to make sure that varying loads on the water supply lines do not change the temperature of the mixture.

One convenient arrangement for small-scale operation is to connect the mixing tap through a rubber hose to a wide-mouthed flask or bottle fitted with a three-hole stopper. The incoming water mixture is led to the bottom of the flask with copper or glass tubing. The outlet tube, on the other hand, projects only slightly below the bottom of the stopper. The third hole serves to hold the thermometer, which should be an accurate one.



'Kodak' No. 3 Tempering Coil

The relatively slow rate of heat exchange through the walls of a hard rubber tank is advantageous for maintaining the proper temperature of a solution. For rapid adjustment of temperature at the beginning of a processing run, the 'Kodak' No.3 Tempering Coil (for 'Kodak' No.3 Processing Tank) is available. This device, a spiral coil of stainless steel tubing, is submerged in the solution. Hot or cold water reaches the coil via a hose, passes through it, and is discharged outside the tank. In this way, the solution is heated or cooled quickly.

WASH WATER

Washing: A convenient way of supplying temperature-controlled wash water is to use a thermostatic mixing valve which compensates for temperature variations in the hot and cold water lines and can deliver about three gallons of water per minute.

It is permissible to use wash water in the temperature range 50–77°F (10–25°C). But when the temperature is below the 73–77°F (23–25°C) range a 50 per cent increase in wash times is necessary. Note, however, that the mains water in winter months may be well below 50°F in which case some form of heating will be required.

The 'Kodak' No.3 Hard Rubber Washing Tank provides a convenient means of washing prints in baskets. The minimum flow rate in this tank should be two gallons per minute.

Eliminating Wash Bubbles: When hot water is mixed with cold water containing large amounts of dissolved air, an effervescent wash water results. The prints become covered with a layer of air bubbles which prevents adequate washing. If an aspirator (a common laboratory filter pump) is installed in the water line and adjusted to permit a steady flow of air into the wash water, the small bubbles will not form.

DISH PROCESSING

Only three processing dishes plus a washing dish are required, because the room lights can be turned on after the paper is placed in the wash after

the First Hardener-Fixing Bath. The three solution dishes can then be emptied, rinsed thoroughly, and used for other processing solutions. Do not use chipped or cracked dishes, because they may give rise to iron contamination.

The paper is slippery when wet, and care must be exercised to avoid scratching the emulsion of one sheet with the corner of another. With experience, up to six prints can be processed in dishes at one time. For best results, however, not more than three prints should be processed at a time. The procedure is as follows:

1. Place in the sink three dishes filled, respectively, with Developer, Stop Bath and First Hardener-Fixing Bath. To decrease the risk of contamination, the dishes should be well separated. About one litre of each of the processing solutions is necessary for 8×10-in. prints in 8×10-in. dishes; correspondingly larger volumes of solution are needed when larger prints are processed in larger dishes.

2. Adjust the Developer to 75°F (24°C). If a water bath is used to maintain the temperature within the required tolerance of $\pm\frac{1}{2}$°F ($\pm\frac{1}{4}$°C), make sure there is no danger that the water level will rise too high during processing.

3. Turn out the white lights. Mark the first print by notching or cutting off the corner of one of the sheets of paper to be processed (the notch or cut should be just large enough for positive identification in the dark).

4. Start the timer and simultaneously immerse the first print, emulsion side down, in the Developer. Push the print to the bottom of the dish to make certain it is thoroughly wet with solution. Start the second and third sheets in the same way, at 20-second intervals. Take care to prevent the sheets from adhering to one another.

5. During the development, agitate the prints once a minute by pulling the bottom sheet out, placing it on top without draining, and re-immersing it completely. Follow quickly with the second and third sheets. One interleaving cycle takes about 15 seconds. Each sheet is handled once a minute, and at the end of each cycle the first print is on the bottom. Try to keep the agitation cycle as smooth as possible, to avoid damaging the soft emulsion surfaces.

If only one sheet of paper is being processed, dish-tilt agitation is recommended. Raise the left side of the dish about 2 ins. and lower it smoothly; then raise and lower the near side; next the right side, then again the near side, then the left side, and so on.

6. After it has been in the Developer for 11 minutes and 40 seconds, pick up the first print, drain it for 20 seconds, and place it in the Stop Bath. Repeat with the other two sheets at 20-second intervals. Give interleaving agitation at the end of 1 minute.

7. After it has been in the Stop Bath for 1 minute and 40 seconds, lift the first print out of the dish, drain it for 20 seconds, and place it in the First Hardener-Fixing Bath. Repeat with the other two sheets at 20-second intervals, continuing the same agitation cycle. After the last

print has been placed in the First Hardener-Fixing Bath, turn on the white lights and continue processing as outlined in the Process P-122 instructions.

TANK PROCESSING

When a number of prints are to be processed, the use of tanks is recommended. The usual size of tank capable of accepting 8×10-in. sheets of paper holds about three gallons of solution. Stainless-steel tanks fabricated with ordinary tin solder must be avoided; see page 32.

There are several different ways in which the colour-print material can be suspended. A fundamental consideration is the fact that the paper base expands somewhat when wet. One possibility is the use of clip-type hangers, each of which holds one sheet of paper or two sheets back to back.

Fewer clip-type hangers can be handled at one time than if they were loaded with film. The reason is that the expansion of the paper causes a tendency for sheets to bow outward and come in contact with each other. Spring loading of the clips relieves the situation somewhat, but the tension must not be great enough to tear the paper.

The lowered tensile strength of the wet paper must also be considered in agitating the sheets. The recommended technique is gentle jiggling action for the first 30 seconds of development, then for 5 seconds at 1-minute intervals during the remainder of the process.

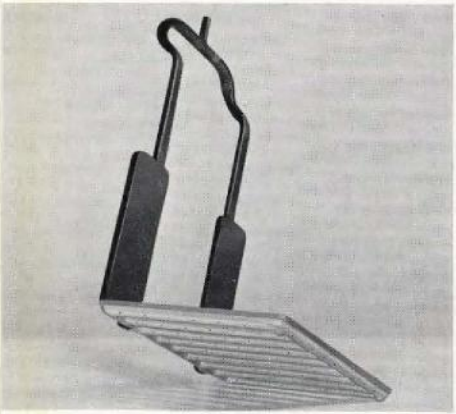
Channel-type hangers are not very satisfactory for processing paper because the sheets tend to slip out of the channels. With care, however, they can be used by loading two sheets back to back in each hanger, with a sheet of 0·010-in. or 0·015-in. thick cellulose acetate between them. Agitation is the same as with clip-type hangers.

Basket Equipment: The most convenient way of handling 8×10-in. prints in quantity is with a device such as the 'Kodak' No.3 Colour Print Processing Basket, which has compartments formed of mesh, supported by a stainless-steel frame designed to fit in the 'Kodak' No.3 Processing Tank. Two sheets of paper can be loaded back to back in each of the fifteen compartments. A stainless-steel cover is supplied with each basket to prevent prints floating out of the compartments during processing.

Basket processing of prints smaller than 5×7 ins. is not recommended. Prints of this size should be placed vertically in the compartments to facilitate their removal.

'Kodak' No. 3 Colour Print Processing Basket

'Kodak' Burst-Valve Control Unit



'Kodak' No. 3 Nitrogen-Gas Distributor

Gaseous-Burst Agitation: The ideal type of agitation with baskets or reels, especially during development, is by bursts of nitrogen gas bubbles which work their way up through the processing solutions. Equipment available for this purpose includes the 'Kodak' Burst-valve Control Unit and the 'Kodak' No.3 Nitrogen-Gas Distributor (for 'Kodak' No.3 Processing Tank), which divides the gas distribution evenly over the bottom of the tank. For processing 'Ektacolor' Paper a 1-second burst at 12-second intervals is recommended. For processing 'Ektacolor' Print Film a 1-second burst at 60-second intervals is recommended. Gaseous agitation can also be provided for the other solutions, to help standardize the process and to enable two or more batches of prints to be processed in sequence at the same time.

DRYING

The simplest method of drying is to squeegee prints and hang them up in pairs fastened back to back with film clips or spring clothes-pegs. Prints can also be laid, emulsion side up, on frames covered with plastic screening or muslin or on sheets of 'Fotonic' Photographic Paper. *Never* leave a print between blotters or face down on a glazing machine blanket, because the soft emulsion will adhere to any such surface.

If the number of prints is not large, gummed brown paper strip or decorator's masking tape can be used to fasten the wet prints temporarily to a sheet of hardboard which may then be placed in a film drying cabinet, using hot air at 110–118°F (43–47°C) to dry the prints. The prints will then lie reasonably flat when they are dry.

Glazing Surfaces: High-quality chromium-plated or stainless-steel sheets or drums are recommended for glazing colour prints. The surface must be free from scratches or pinholes. Black japanned glazing plates are not suitable, because colour prints tend to stick to them.

The glazing surface must be thoroughly cleaned just before use. 'Silvo' is a suitable cleaning agent. It can be applied with a cellulose sponge and polished off with a clean, soft, lintless cloth.

Cold Glazing: The recommended method of cold glazing is to squeegee 'Ektacolor' prints on to sheets of glass. To prevent prints sticking, the glass should be treated with a 3 per cent solution in carbon tetrachloride* of the silicone fluid M441 (marketed by I.C.I. Ltd). This solution should be applied with a cotton wool pad to both sides of each sheet of glass, following this by vigorous polishing with a soft cloth. Glass thus treated may be used about 100 times before a new silicone treatment is needed.

To promote rapid drying, and at the same time prevent premature lifting of the prints from the glass, it is necessary to use absorbent pulp boards or pads of felt at least $\frac{1}{4}$ in. thick. These boards or felts should be impregnated in a 20 per cent. aqueous solution of calcium chloride and subsequently dried in a heated cabinet. They must be allowed to cool before placing them in contact with the back of the prints, otherwise ferrotyping mottle may result. Once impregnated these boards need no further chemical treatment, but they must be dried and cooled before use each time.

Prints may be squeegeed on both sides of each sheet of glass and a "stack" can be built up with a board sandwiched between every two sheets of glass. Complete the stack with a sheet of glass with prints on its lower side only. The time needed to complete glazing will be 1–1½ hours.

An alternative method of cold glazing is to remove prints directly from the wash (step 10 in the Process P-122 instructions) and place them in a dish containing 900 cc (31½ fl. oz) of buffer and 100 cc (3½ fl. oz) of glycerine. Interleave paper in this solution for three minutes, then squeegee on to stainless-steel or chromium-plated glazing sheets. Discard this solution after use.

Prints can also be put through the normal process, dried to determine whether the results are satisfactory, and glazed later. In this case, they should be agitated for three minutes in the modified buffer solution just before glazing.

Hot Glazing: Prints can be hot glazed on clean, chromium-plated or stainless-steel drums or sheets by either of the following methods. The choice will depend on individual preference, operation, and equipment.

1. Prints can be air-dried after complete processing, then re-wetted in Buffer for half to one minute, and hot glazed at 180°F (82°C).

2. Prints can be hot glazed directly after processing if the time in the Hardener (Step 9) is extended to nine minutes. The other processing steps are normal, and the prints are glazed directly after the Buffer, without washing.

---

* Care should be taken when making up the silicone fluid to avoid contact with the skin or clothes. Goggles and rubber gloves are recommended for handling the silicone preparation but do not allow carbon tetrachloride to come into contact with rubber. When using carbon tetrachloride there must be plenty of ventilation and no-smoking rules must be observed, because a lighted cigarette will decompose carbon tetrachloride into the toxic gas phosgene.

MOUNTING PRINTS

'Ademco' Dry-Mounting Tissue can be used for mounting prints if the cover sheet used over the face of the print has been pre-heated to remove residual moisture and if the temperature of the mounting press is no higher than is necessary to secure a satisfactory bond. The actual temperature across the heating plate should range between 200 and 220°F (93–104°C).

'Kodak' Photographic Rapid Mounting Cement is satisfactory with colour prints, providing that the instructions for its use are followed carefully. NOTE: If prints are mounted behind glass, a slight separation should be maintained between the print surface and the glass.

PROCESSING FAULTS

Several variables in processing can affect the quality of colour prints adversely. Some of the more common causes underlying quality losses are: lack of cleanliness, incorrect mixing of solutions, incorrect use of solutions, contamination of solutions, and lack of adequate control in the processing procedure.

The master negative system, page 38, provides a simple check on processing. This type of control is useful both to those who make colour prints occasionally and to those who produce them in quantity.

For photo-finishers using 'Kodak' Colour Printers or 'Kodak' Colour Enlargers the booklet "Quality Control-Process P-122" gives recommendations for maintaining a high level of photographic quality.

The following list will help to check specific errors associated with processing.

WHITE-LIGHT FOG: A print made on paper which has been fogged by white light will show yellow, or in extreme cases, orange areas.

OVER-DEVELOPMENT: The result of over-development (excessive development time, temperature, agitation, or replenishment rate) is a print that is darker and slightly more contrasty than a normally developed print. There is also danger of staining and of hue shifts over parts of the tone scale as a result of contrast differences between the dye images.

UNDER-DEVELOPMENT: An under-developed print (insufficient development time, temperature, or agitation) is lighter and lower in contrast than a normal print and usually tends toward a yellowish-green colour balance.

SAFELIGHT FOG: Prints fogged by use of the safelight too close, for too long a time, or with a lamp of higher than recommended wattage, usually show a cyan fog. The degree depends on the amount of fogging exposure.

DEVELOPER CONTAMINATION: If the developer becomes contaminated with one of the fixing baths, a print will show cyan fog.

Cyan fog, especially noticeable in highlight areas, may be caused by tin contamination of the developer as a result of the use of ordinary tin solder in the manufacture of a stainless-steel tank. Such tanks should be welded.

Contamination with acid from the stop bath or buffer retards development and causes a pink stain, most noticeable in the highlights. Therefore print baskets and dishes should be *washed* and dried after they have been used for processing.

DEVELOPER EXHAUSTION: With exhaustion of the developer, the density level of prints becomes lighter and the highlights go pink.

IRON CONTAMINATION: Iron or rust particles in the wash water or iron salts on the glazing surface will cause red spots. Iron particles in the bleach will cause blue spots.

OMISSION OF BUFFER: Failure to give this treatment may cause higher-than-normal stain in the white areas and may impair print stability. It may also cause blue stains on the backs of prints.

HARDENING DIFFICULTIES: Inadequate hardening may lead to a lacy or blotchy blue-cyan pattern which becomes visible several days or weeks after processing. The effect of Hardener exhaustion or insufficient agitation may be aggravated by excessive drying or mounting temperatures.

HIGH-TEMPERATURE DRYING: Prints dried at temperatures above 180–200°F (82–92°C) may show a yellow stain in unexposed areas.

INSUFFICIENT WASHING: Some time after processing, prints which have been poorly washed will exhibit blue stains which are most noticeable on the base side of the prints.

LARGE COLOUR PRINTS

Making large colour prints, in sizes 16×20 in. up to 30×40 in. and multi-section murals, requires the same general procedures as those used for preparing smaller prints. Differences due solely to the size of the prints mainly concern handling techniques and equipment.

Generally, dish processing is sufficiently economical, but details of a tank system, capable of handling large numbers of 30×40 in. or 40×60 iu. prints, are available on request.

PAPER CUTTING, HANDLING AND EXPOSING

Kodak 'Ektacolor' Paper is available in standard sheet sizes and rolls up to 40 ins. wide.

When planning large prints or multi-section murals that are to be wet mounted, it is useful to know the effect of expansion of 'Ektacolor' Paper due to wetting. When wet the paper expands about three per cent in the crosswise dimension of roll stock and it expands about 0·5 per cent in the lengthwise dimension.

Generally, a horizontal enlarger is more suitable for exposing large prints, because its movement is less restricted.

DISH PROCESSING

There are two alternative methods of dish processing. The choice will depend on the volume of work to be handled. Where there is a small number of large prints (up to about eight per day), it is possible to process, for example, 30×40 in. 'Ektacolor' prints individually, each in one gallon of solution. In this method the developer is used for one print and then discarded, but the other solutions are used to capacity or replenished.

The second method utilizes deep dishes to process up to four 30×40 in. prints simultaneously. The developer and other solutions are replenished in the normal manner for use over an extended period. For processing 16×20 in. prints, dishes 20×24×6 in. are suitable. Proportionately larger deep dishes are necessary for larger prints. When not in use, the developer must be covered by a floating lid of suitable material to prevent developer oxidation. In addition, a lid for the hardener, to minimize vapours of formaldehyde, is desirable.

Either method needs a minimum of three dishes and a washing tank, although with large prints a separate dish for each solution makes for easier working.

It is possible to have the dishes in a sink with temperature control as described on page 26, but an alternative method of maintaining temperature is to have a grid of copper tubing underneath each dish. A closed-circuit, thermostatically controlled system can be used to circulate hot

water, at a suitable temperature, throngh the grid to maintain each solution within the specified temperature limits.

For critical work, nsing the single print method, some slight differences between results from different mixes of developer may be found. Mixing two 3-gallon sizes of developer chemicals in a large crock and using six separate gallons to process one set of test prints and five 30×40 in. prints will give consistent results. The developer can conveniently be stored in 1-gallon stoppered bottles until required for use.

Wetting evenly and the agitation of prints mnst he tackled consistently particularly when working in large sizes. To immerse a large print in the developer, roll it up, hold the corners and draw the leading edge, emulsion down, through the solntion pulling the body of the print behind it. When it is thoroughly wetted, tnrn the print emulsion side up. For the single print method, agitate each solution by lifting three adjacent sides of the dish in turn. This can be used to create an even, rolling motion of the liquid. In multiple-print dish processing, immerse prints at 30-second intervals and interleave the prints without draining at about 1-minute intervals. Be sure not to expose prints to the air unnecessarily during this agitation cycle. Remove the prints from the developer in the correct order – at 30-seconds intervals.

Try to adhere as closely as possible to the processing recommended in the instruction sheet packaged with P-122 chemicals. The development time may have to be increased in order to match the results of tank processing of 8×10 in. prints when the recommended time is used. Check processing as described on page 39. The washing times in the P-122 process should be increased by two minutes if the efficiency of the water circulation in the dish is poor. When washing several prints, the washing efficiency is improved by interleaving all the prints, emptying out all the water from the dish and allowing it to refill.

When processing 'Ektacolor' Prints in dishes, clean rubber gloves must be worn to avoid skin irritation. The gloves must be kept clean and should be rinsed between processing steps to avoid solution contamination.

DRYING

Prints may be dried by pinning them to racks and attaching weighted film clips to the bottom of each to minimize curl. Drying between muslin frames or by taping to hardboard can be accomplished as explained on page 30.

MOUNTING

Large prints up to about 30×40 in. can be dry mounted on hardboard using 'Ademco' Dry-Mounting Tissue and a large press ('Fibrox' hardboard obtainable from Rex Bousfields Ltd, 77 Carter Lane, London EC4, is suitable). It may be necessary to take several "bites" to cover the complete area of the print.

Sectional mural prints should be wet mounted by using an adhesive such as Tub Paste (Obtainable from A. Sanderson and Sons Ltd, 52 Berners Street, London, W1, or wallpaper shops). Many adhesives

From a print on Kodak 'Ektacolor' Paper. Both the print and the original photograph were made by Raymond Wilson.

are unsuitable for 'Ektacolor' Paper because they affect the dyes in the emulsion and cause a colour-balance shift. Other adhesives therefore, should be thoroughly tested before they are used on valuable large prints.

Prints may be mounted directly on to plaster walls, using wallpaper techniques, but such a wall must first be sealed with emulsion paint to prevent chemical and moisture staining. Hardboard or stout cardboard used as a support for wet-mounted prints must be similarly sealed. After the print has been mounted, cover its entire surface with muslin damped with buffer solution. This will retard the paper's drying until the adhesive has partially set; the use of buffer solution will ensure maximum dye permanence.

THE MASTER NEGATIVE

There are several potential causes of variation in both the negative and positive stages of colour printing. The most important of these are unavoidable manufacturing variations from one emulsion number to another, variations in storage conditions both before and after exposure, variations in colour quality of illumination, variations in sensitivity with differences in illumination level and exposure time (reciprocity effect), and variations in processing. Fortunately, a wide range of adjustment is available during the positive stage, so that these variations seldom prevent the making of a good print.

Making a good print and doing it easily may, however, prove to be two quite different matters. To get consistently good results with as little testing, balancing, and time wasting as possible requires careful attention to instructions, good workmanship and maximum utilization of experience. The master-negative system, in essence, is a means of getting the greatest practical value out of experience. It is particularly well suited to white-light printing, although it can be adapted to tri-colour printing.

Briefly defined, a master control negative is an average, normal negative which has been properly exposed under known conditions and which is known from actual trial to make an excellent print. In other words, it has been printed previously and an accurate record of the filter pack required for a particular paper emulsion is available. Here, then, is a standard which can be used for comparison purposes. The master negative can be useful in at least three different ways:

(a) for comparing printing characteristics with those of other colour negatives;

(b) for comparing a new paper emulsion with the old;

(c) for checking processing.

MASTER-NEGATIVE CHARACTERISTICS

The master negative should be typical of the majority of negatives to be printed. If most of them are outdoor shots on 'Ektacolor' Film, the master negative should obviously be an outdoor shot on 'Ektacolor' Film. Further, it should be normally exposed with the correct filter, it should be normally processed, and it should be of a typical subject with typical lighting. That is, the lighting ratio and light direction should be similar to most of the negatives that are to be printed.

It will help considerably if the master negative contains some areas that are relatively sensitive to minor colour-balance changes. For example, sunsets or flowers are *not* good test objects, because they can be printed over a wide range of colour balance and still be pleasing. However, the face in a portrait is a sensitive area, as is any near-neutral, such as a sunlit concrete surface. Surprising as it may seem, a prominent sunlit

tree trunk may be helpful in judging small colour differences in middle tones and shadow areas. Best of all is a 'Kodak' Neutral Test Card placed in the scene. The grey side, of eighteen per cent reflectance, lends itself to exact and reproducible measurement.

On the other hand, landscapes may not be the only typical subject material. In this case, it will be advantageous to have a "primary" master negative for the most usual film-subject-lighting situation, plus one or more "secondary" negatives representing other situations. The basic enlarger filter pack should be determined for each negative, but the differences between these packs will remain constant when the paper batches are changed.

CHECKING PROCESSING

For trouble shooting or simply as a routine check on processing, the master negative is invaluable. A small print made carefully with controlled voltage from the master negative and processed in the same batch with other prints, will tell at a glance if there is any abnormality in the processing solutions or procedure.

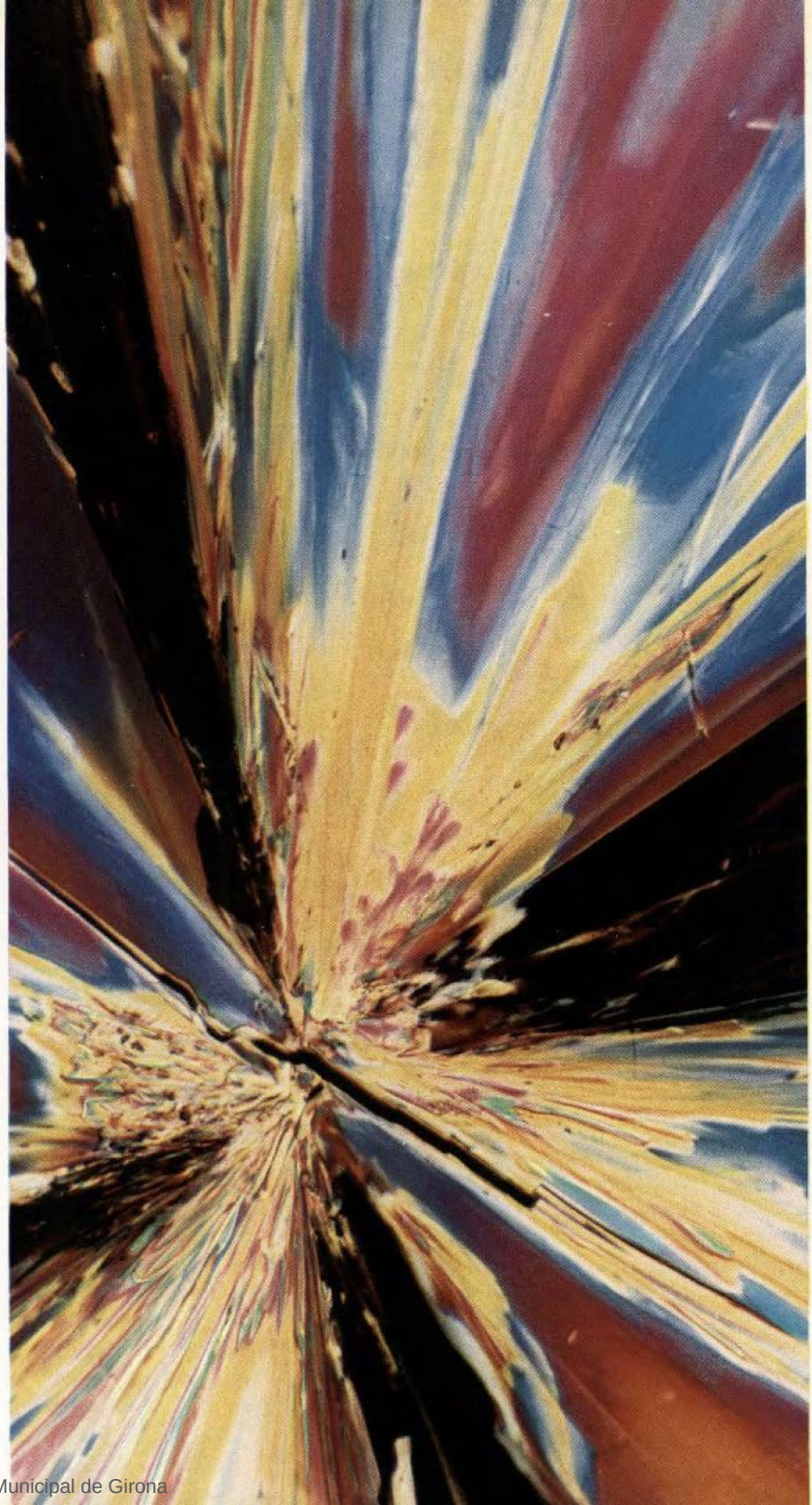
A supply of these master-negative or control prints sufficient to last up to six months can be pre-exposed if the exposed prints are held at room temperature for forty-eight hours. After this stabilization period, wrap the prints individually in aluminium foil to protect them against water vapour, and store them in a freezer operated between 0 and −10°F (−18 to −23°C). Before processing a batch of prints from other negatives, take one of the control prints out of the freezer and let it come to room temperature while it is still wrapped. The warm-up time for single prints is only a few minntes; keep this time as consistent as possible to minimize colour-balance changes.

NOTE: Unless advance compensation for latent-image keeping is made in exposing the control prints, their colour balance will usually differ from that of prints processed soon after exposure. Such a characteristic departure from normal balance does not matter. However, a control print used to check processing should be compared only with other control prints exposed at the same time on the same batch of paper.

COMPARING NEW PAPER WITH OLD

Kodak 'Ektacolor' Paper varies slightly from one emulsion to another. Consequently, a re-balancing problem arises when one batch of paper is used up and a new batch is started. The problem is solved by finding the new basic filter pack for the primary master negative.

To obtain some guidance in deciding the filter pack for the new batch of paper refer to the label on each box or packet of 'Ektacolor' paper, on which are given two sets of *exposure factors*. These have been determined by both sensitometric and practical tests for each batch of paper. Due to unpredictable conditions of storage and use, time of exposure and other variables, **these factors are necessarily only an approximate guide to filter changes in the right direction.** They cannot give help in setting-up a process.



Exposure Factors for Tri-Colour Printing: The first set of factors represent the speeds of each of the three emulsion layers relative to a manufacturing standard of 100. These factors (labelled "Arithmetical Factors") can be applied to tri-colour printing, to 'Kodak' Colour Printers, Types S1 and S3, and to 'Kodak' Colour Enlargers. Instructions for use of arithmetical exposure factors with these printers are given in the appropriate instruction manuals. Their application to tri-colour printing is quite simple; new exposure times are derived from the formulae.

$$\frac{\text{New Red printing time}}{\text{Old Red printing time}} = \frac{\text{New Red exposure factor}}{\text{Old Red exposure factor}}$$

$$\frac{\text{New Green printing time}}{\text{Old Green printing time}} = \frac{\text{New Green exposure factor}}{\text{Old Green exposure factor}}$$

$$\frac{\text{New Blue printing time}}{\text{Old Blue printing time}} = \frac{\text{New Blue exposure factor}}{\text{Old Blue exposure factor}}$$

Note that the *higher* the arithmetical factor, the *lower* the speed of the paper to light of that colour.

As an example:

Old exposure times	Red 11 sec.	Green 25 sec.	Blue 38 sec.
Old exposure factors	90	80	100
New exposure factors	70	80	110

New exposure times

$$\text{Red} = \frac{11 \times 70}{90} = 8\tfrac{1}{2} \text{ sec.}$$

$$\text{Green} = \frac{25 \times 80}{80} = 25 \text{ sec.}$$

$$\text{Blue} = \frac{38 \times 110}{100} = 42 \text{ sec.}$$

Exposure Factors for White-light Printing: The second set of exposure factors is provided for those using CP or CC filter packs in the white-light exposure method. The determination and use of these factors is not as simple as with tri-colour factors because filters of only two colours are used in a filter pack.

In this system the speeds of the blue-sensitive and green-sensitive

Photomicrograph of salicyn crystals viewed by cross-polarized light. 200× magnification. 16 mm apochromat objective, 12·5× compensating eyepiece. From a print on Kodak 'Ektacolor' Paper. Original photograph on Kodak 'Ektacolor' Film, Type L, by Eric Freeborn, F.I.B.P., F.R.P.S.

layers are rated relative to the red-sensitive layer, in terms of CP or CC filter units. Where these blue and green layers are faster than the red layer, they are given plns values and where they are slower they are given minus values. Thus, the first two figures (labelled "Filter Pack Adjustment") are used to modify the filter pack. The third figure (labelled "Speed Factor") is derived from the absolute speed of the red-sensitive layer and is used to calculate an exposure time for the new batch of paper. Note that the higher the value of this figure the lower the speed of the paper. The speed factor can be thought of as representing units of exposure time: so that, for example, a paper labelled 140 needs twice the exposure of one labelled 70.

Calculating the values of filters for a new emulsion is not difficult when the principles involved are understood.

The basic filter pack (i.e. that used to produce a successful print from the master negative, on a given batch of paper) consists basically of two component parts: a part which is contributed by the master negative, exposing equipment and processing conditions and a second part which is due to the batch of 'Ektacolor' Paper in use. The first part may be determined by subtracting the "old" paper exposure factors from the basic filter pack. The "new" factors are added to this value to obtain the basic filter pack, for the master negative, for the new batch of paper. This procedure is equivalent to subtracting the old factors from the new factors and adding the results to the original basic filter pack, which in practice, is the usual method of working.

Where the new filter pack has a cyan filtration different from that used in the basic filter pack for the old paper then an effective neutral density will have been added to or subtracted from the filter pack. This may be allowed for in altering the exposure time but it is usually more convenient to adjust the lens aperture on the basis that 0·10 neutral density (i.e. 10Y+10M+10C) equals $\frac{1}{3}$ of a stop.

A change in exposure time, due to differences between the two batches of paper, is usually necessary. This is calculated using the speed factors for each batch of paper.

The two following examples illustrate the use of exposure factors for filter pack adjustment and calculation of the new exposure times.

EXAMPLE 1:

Old paper: White-light exposure factors = +05Y—10M speed factor 110

New paper: White-light exposure factors = 00Y+05M speed factor 90

Old paper: Basic filter pack = (CP20Y+CP05Y+CP30M)
Exposure time = 15 sec.

Required: Basic filter pack for the new batch of paper and the new exposure time

First subtract the "old" from the "new" factors.

	Y	M	C	
	00	+05	00	New exposure factors
Subtract	+05	−10	00	Old exposure factors
	−05	+15	00	

This result is used to modify the basic filter pack for the master negative on the old batch of paper.

Y	M	C	
25	30	00	Old basic filter pack (CP20Y+CP05Y+CP30M)
Add −05	+15	00	Result of previous calculation
+20	+45	00	

This result contains no minus values nor do filters of the three colours occur together so that the new basic filter pack for the master negative will be CP20Y+CP40M+CP05M

The new exposure time, incorporating the speed factors of the old and new batches of papers is calculated from:

$$\frac{\text{New exposure time}}{\text{Old exposure time}} = \frac{\text{New speed factor}}{\text{Old speed factor}}$$

If the exposure time for the master negative was 15 sec. then:

$$\text{New exposure time} = \frac{15 \times 90}{110} = 12{\cdot}3 = 12\tfrac{1}{2} \text{ sec.}$$

Thus, the first *trial* print from the master negative on the new batch of paper is made with

CP20Y+CP40M+CP05M filters with $12\frac{1}{2}$ sec. exposure.

EXAMPLE 2:

Old paper: White-light exposure factors = −10Y −10M speed factor 80.

New paper: White-light exposure factors = +10Y −10M speed factor 115.

Old paper: Basic filter pack = CP30M+CP10C Exposure time = 16 sec.

Required: Basic filter pack and exposure time for the new batch of paper.

Subtracting "old" from "new" factors:

Y	M	C	
+10	−10	00	New factors
Subtract −10	−10	00	Old factors
+20	00	00	

Adding this result to the basic filter pack for the old paper:

Y	M	C	
00	+30	+10	Old basic filter pack (CP30M+CP10C)
+20	00	00	Result of previous calculation
+20	+30	+10	

Because this combination contains filters of three colours the neutral density must be eliminated by subtracting the value of the lowest filter in the combination from each value in the row.

Y	M	C
+20	+30	+10
−10	−10	−10
+10	+20	00

Thus the new *trial* basic filter pack will be CP10Y+CP20M.

Less exposure will be required because ten filter units of density were subtracted from the calculated filter combination to eliminate neutral density. In this case the lens aperture is closed by $\frac{1}{3}$ stop.

$$\text{New exposure time} = \frac{16 \times 115}{80} = 23 \text{ sec.}$$

Note that the filter factors for the filters actually used in the filter packs do not enter into the calculation of the new exposure time.

Just before the first batch of paper is used up, make test prints from the master negative on both the old and the new emulsions. Using the established and the estimated printing techniques respectively. Process these two prints – which can be small prints to save paper – together in unexhausted solutions with a normal processing technique.

The print on the old paper should give a processing check, assuming the paper has been stored properly. If the printing and processing were standard, the picture will look as it did when printed before, and estimates of any filter changes required by the new paper will be valid.

COMPARING PRINTING CHARACTERISTICS

Most colour negatives of the same type of subject exposed under similar conditions will print similarly, but not identically. Differences may result from variations in lighting (time of day, sky condition, etc), variations in film emulsion, film processing, or other factors. These differences are normal and should be expected. However, the important thing is to think of these balance variations in terms of filter differences between each negative and the master negative.

Thus, for making a normal print from the master negative, suppose the filter pack consists of 40M plus 20Y, and the best print density is attained at an exposure time of ten seconds. These filters remain in the optical system as an excellent starting point for similar negatives as long as the same emulsion number of 'Ektacolor' Paper is being used. For a particular negative, perhaps it will be necessary to add a 10M filter to the pack and adjust the printing time to, say, twelve seconds in order to compensate for the differences between the new negative and the master negative. In other words, the new negative prints differently from the master negative by a 10M filter and a twenty per cent increase in printing time.

Record these data with the new negative, because the relative difference will remain constant, regardless of the characteristics of the paper emulsions which might be used in the future. For example, six months from now a re-print of this negative might be needed. But now a different 'Ektacolor' Paper emulsion is in use, and the basic filter pack in the enlarger (to print the master negative satisfactorily) has become a 20M. It is necessary only to increase the exposure by twenty per cent and add a 10M filter to the pack to make a balanced print without further test.

In some establishments individnal colour negatives are likely to be printed several times on different batches of paper. In such cases it is useful to note the working filter pack, the exposure time, the batch number of the paper and its appropriate exposure factors on the negative envelope, when the first correct colour print has been made. This will minimize testing stages on subsequent printings.

NEGATIVE EVALUATION

When negatives of varying density and colour-balance characteristics must be printed on a production basis, the cost in time and materials of making a test print from each negative may be prohibitive. Some means of analysing the characteristics of each negative is needed, and the analytical data must lead to practical exposure information for a satisfactory print. For white-light printing, the evaluation procedure must yield the exposure time and the specific filter pack. For tri-colour printing, it must yield exposure times through the red, green, and blue filters.

When the negative contains an image which can be used as a reference area, an obvious possibility is to evaluate the negative as a whole in terms of the reproduction in this area. The usual practice is to select an area corresponding to a flesh tone or a neutral and correlate densitometer readings with printing exposures determined for a master negative of the same type of subject material. The readings are made through narrow-cut red, green, and blue filters, but the data can be used to calculate exposure conditions for either white-light or tri-colour printing. An electronic densitometer, rather than a visual one, is usually preferable.

Negative Evaluation in White-light Printing: The principle of negative evaluation is to take the three-colour density readings of the reference area of the master negative and add these to the densities of the filters in the basic filter pack. The filters for any other negative are chosen so that their densities plus those of the reference area of that negative come to these same totals.

As an example, consider a master negative requiring a basic filter pack of CP20Y+CP30M+CP05M and its red, green, and blue measured densities are R0·96, G1·08, B1·24. These values are added thus:

	R	G	B	
	0·96	1·08	1·24	Negative densities
add	0·00	0·35	0·20	Filter densities
	0·96	1·43	1·44	

These figures represent the total amount of cyan, magenta, and yellow in the standard negative plus its filter pack.

The densities of the reference area in the production negative are measured under the same conditions and subtracted from the total above. For example, consider a production negative with densities R1·08 G1·06 B1·12. Subtracting these from the total in the first calculation.

	0·96	1·43	1·44	Master Neg.+filter densities
Subtract	1·08	1·06	1·12	Production negative densities
	−0·12	+0·37	+0·32	
Cancel out neutral density				
	+0·12	+0·12	+0·12	
	0·00	+0·49	+0·44	
Rounding off figures to the nearest filter value		·50	·45	

The filter pack for the production negative becomes:

CP40Y+CP05Y+CP50M

The 0·12 neutral density represents the amount by which the production negative is denser than the master negative. Suppose that the exposure time for the master negative is seventeen seconds; then, the increase in exposure time for the production negative can be determined by using the nomogram on the folding flap of the back cover of this book. Remember it is *differences* in density that are used to calculate the exposure time of the production negative.

To use the nomogram, place a straight edge to pass through zero on scale A and the master negative exposure time (i.e. seventeen seconds) on scale C, note the reference point on scale B. Now place the straight edge through the difference figure (i.e. 0·12) on scale A and the reference point on scale B and read off the exposure time (twenty-two seconds) for the production negative on scale C.

Because some production negatives will be lighter than the standard, both negative and positive neutral density differences need to be accommodated on the A scale. To do this, either extend the lower end, or use 1·0 as a zero for scale A and add or subtract differences to this 1·0 value.

Negative Evaluation in Tri-Colour Printing: Three-colour negative densities are taken of reference areas in the master and production negatives. These are used in a simple equation to calculate red, green and blue printing times for the production negative.

In each colour

$$\frac{\text{Production negative exposure time}}{\text{Master negative exposure time}} = \text{Antilog}\left(\begin{matrix}\text{production}\\ \text{negative}\\ \text{density}\end{matrix}\right) - \left(\begin{matrix}\text{master}\\ \text{negative}\\ \text{density}\end{matrix}\right)$$

As an example:

Master negative exposure time	Red=8 sec.	Green=18 sec.	Blue=30 sec.
Master negative densities	Red=1·00	Green=1·12	Blue=1·34
Production negative densities	Red=1·04	Green=1·26	Blue=1·22

It is required to find the red, green and blue exposure times for the production negative using the above equation:

Red exposure time=8 × antilog 0·04=8 × 1·096=8·75 sec.

Green exposure time=18 × antilog 0·14=18 × 1·380=25 sec.

Blue exposure time=30 × antilog(−0·12)=30 × 0·7586=23 sec.

SHADING AND PRINTING-IN

For many purposes, the ease with which reproduction in a local area of the print can be controlled is a tremendous advantage of the white-light exposure method. The area can be shaded to lighten it or printed-in to darken it. For example, a heavy shadow can be lightened by shading it during a portion of the exposure time, or a sky area can be darkened by giving it more exposure time than the rest of the picture.

The basic tool for shading is an opaque card, of appropriate size and shape, fastened to the end of a stiff wire; for printing-in, it is a larger opaque card containing an opening of appropriate size and shape. In either case, the tool is held in the light beam, between lens and paper, and it is kept in motion to avoid producing a sharp line of demarcation in the print. For best results, it is generally advisable to practice the control measure in advance of making an actual exposure on paper.

As in monochrome enlarging, colour-print control can be overdone. Take, for example, a shadow area that is to be held back in order to make subject detail in that area more discernible. How far shading can be carried depends largely on the amount of detail available. Shadows containing little detail should not be held back at all – it is better to let them go dark in the print than to make them smoky and unreal.

CC (not CP) Filters cut to the proper shape add a valuable dimension to colour-printing control. A common instance of their need is excessive blue in the shadow under a tree or along the side of a building. The remedy is to keep a blue filter in motion over that area during part of the print exposure. Similarly, a brickish face tone can be corrected by use of a red filter. In general, a CC30 to CC50 density is suggested – a weaker filter may not have enough affect; and if the filter is too strong, it can simply be used for a smaller part of the exposure time.

Filters are equally helpful in printing in. For example, a white highlight might have a tendency to pick up too much colour when darkened by extra exposure. A filter of the same colour over the hole in the card will restore the area to neutral.

There are numerous other situations in which local print control is desirable, not necessarily because of any fault in the colour reproduction but perhaps to show a product to best advantage or compensate for uneven lighting of the original scene. Then too, the colour of faces, dresses, buildings, and many other areas can be shifted, intensified, lightened, or darkened so easily that local control should often be considered simply as a means of producing a more pleasing picture.

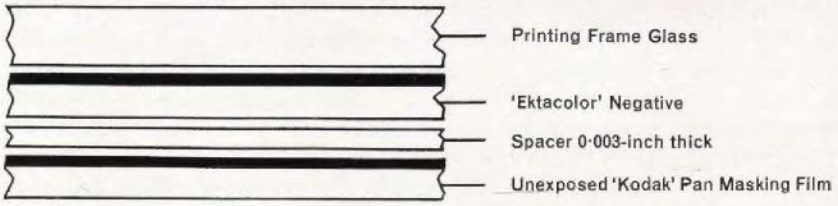
CONTRAST CONTROL

Kodak 'Ektacolor' Paper is matched to the normal contrast characteristics of colour negatives. Occasionally, however, a subject is encountered that would reproduce better at a contrast level different from that afforded by the film-and-paper system. Since the paper is available in only one contrast grade, the best remedy is a supplementary mask to modify the printing characteristics of the negative. Masking is not often necessary, but in the comparatively rare instances that it is needed at all, it is usually able to produce a significant improvement.

CONTRAST REDUCTION

Sometimes a negative contains too great a range of densities to print satisfactorily on 'Ektacolor' Paper. A typical subject is a back-lighted outdoor portrait in which no fill-in flash or reflector was used. In such cases, local control in printing may not solve the problem completely or even passably. However, a positive mask can be superimposed over the negative to compress its density range to a suitable level.

The positive mask is made by contact printing the colour negative on a sheet of 'Kodak' Pan Masking Film. It is convenient to use an enlarger with a tungsten light source and to make the exposure in a printing frame on the baseboard of the enlarger. To facilitate registering the mask on the negative after it has been developed, it is preferable to make the mask image slightly unsharp by placing a spacer between the negative and masking film as shown in the diagram.

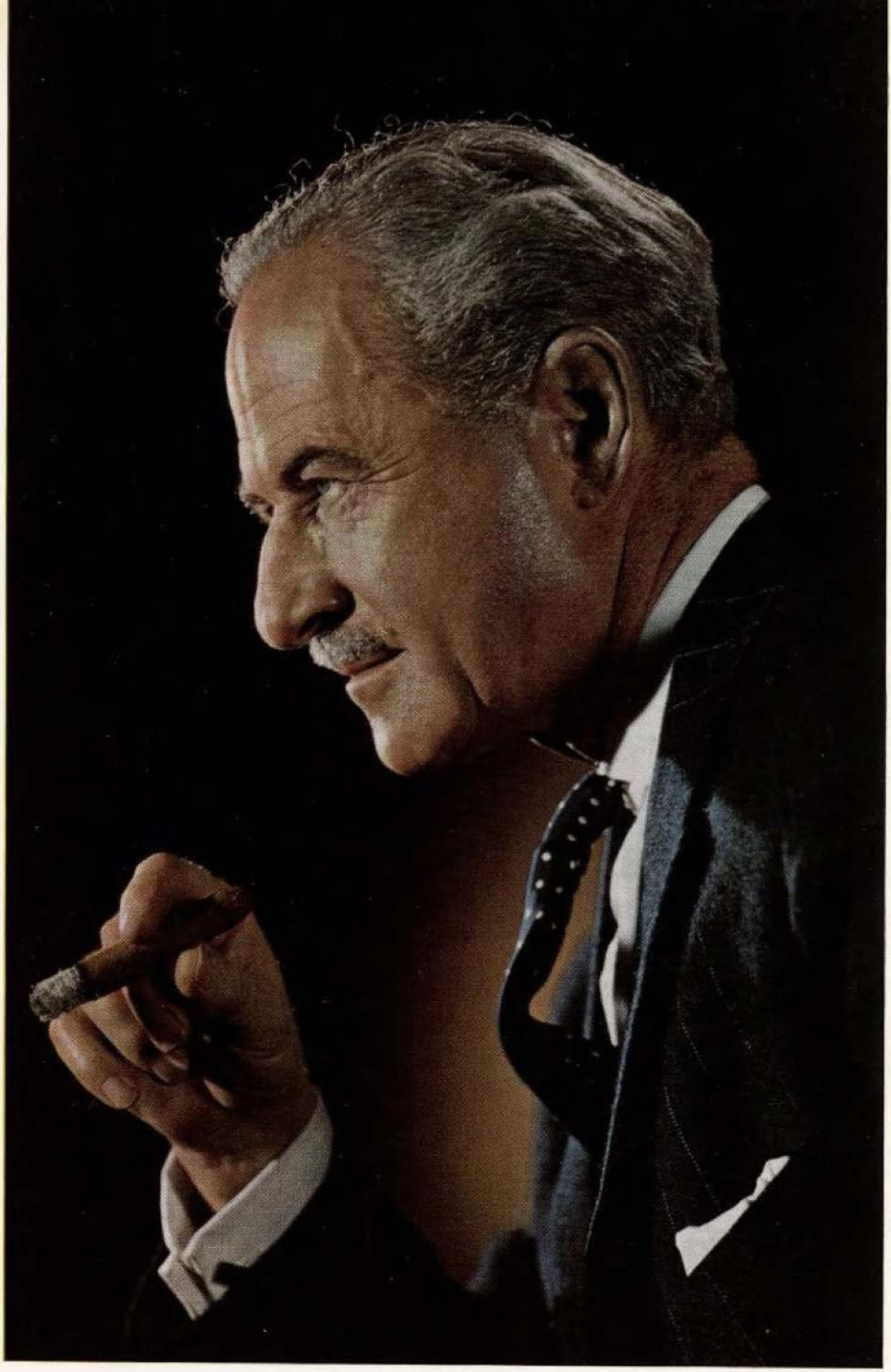


To counteract the effect of the coloured couplers in the negative, filtering equivalent to 200B is used in the light beam.

The exposure varies with negative density, but with the enlarger adjusted to give three foot-candles at the exposing plane (measured without the filters), a negative of average density requires about fifteen seconds. The exposure should be adjusted, if necessary, to give a full-scale image having a slight density even in extreme highlight areas.

Suggested development is three minutes at 68°F (20°C) in a dish of fresh 'Kodak' DK-50 Developer, diluted one part developer to four parts water. Other processing details are the same as given in the instruction sheet packaged with 'Kodak' Pan Masking Film.

After it is dry, the mask is taped in register on the base side of the original. When the combination is placed in the negative carrier of the



From a print on Kodak 'Ektacolor' Paper. Print and original 'Ektacolor' negative by E. Johnson, Kodak Limited.

enlarger, the emulsion side of the negative should be down, as usual. Printing the combination requires about twice the exposure for the unmasked negative but no change in filtration.

Shadow Masking: When a contrast-reducing mask is used, it sometimes makes the shadows come out smoky in the print. This effect can be eliminated by a mask that removes the shadows from the principal mask, thus preventing their contrast from being lowered. The action is similar to that of a highlight mask on a transparency.

To make the shadow mask, use 'Kodalith' Pan Film and develop it in undiluted D-11 developer for 2 minutes at 68°F (20°C). Adjust the exposure to record only the deepest shadows – those devoid of any useful detail. In all other respects, follow the recommendations given on the film instruction sheet.

Register the developed shadow mask on the emulsion side of the colour negative and, from the combination, make the contrast-reducing mask on 'Kodak' Pan Masking Film. Use only the contrast-reducing mask with the colour negative in exposing the colour print.

CONTRAST INCREASE

On rare occasions, a negative may be encountered that is too low in contrast to make use of the full density range of the print material. The cause may be slight under-exposure of the negative, camera flare, an unusually low lighting ratio in the illumination of the original scene, an unusually low reflectance ratio on the part of the subject material, or a combination of these factors. In such cases, a negative silver mask can be added to the colour negative to increase its effective density range and improve print quality.

An interpositive is first made by contact printing the colour negative on 'Kodak' Pan Masking Film, emulsion to emulsion. As in the case of a contrast-reducing mask, it is convenient to use an enlarger with a tungsten light source and to make the exposure in a printing frame on the baseboard. Filtering equivalent to 200B should be used in the light beam. With three foot-candles at the exposing plane (measured without the filters), the exposure required to give a full-scale image is usually about ten seconds. The suggested development time is 4½ minutes at 68°F (20°C) in a dish of fresh 'Kodak' DK-50 Developer, diluted one part developer to four parts water.

The interpositive is printed on 'Kodak' Commercial Fine Grain Film with a spacer between the two films. The base side of the interpositive and emulsion side of the Commercial Fine Grain Film should face the light source. Again, the exposure should be sufficient to give a full-scale image. Suggested development for the negative mask is four minutes at 68°F (20°C) in a dish of full-strength 'Kodak' DK-50 Developer. However, the development time can be varied, depending on subject requirements. After the contrast-increasing negative mask is dry, it is taped in register on the base side of the colonr negative, and the combination is ready for printing.

HIGHLIGHT MASKING

This correction is useful with any subject which requires increased highlight contrast, but is of particular value in securing clean whites in reproductions of flat copy, such as charts or wash drawings.

Making the Mask in the Camera: In reproducing flat copy, a highlight mask can be exposed in the camera at the time the colour negative is made. To ensure good register, the mask exposure must be made on precision equipment at the same lens opening as the colour negative.

With a tungsten light source, a CC40B filter is needed over the lens to put equal densities into the three colour scales. Also needed are Kodak 'Wratten' Neutral-Density Filters to a total density of 1·5 to make the exposure time for 'Kodak' Pan Masking Film approximately the same as for the colour negative. If necessary, the exposure should be adjusted (by changing neutral density filters) to give a maximnm density between 0·20 and 0·25 when the mask is developed for two minutes at 68°F (20°C) in a dish of 'Kodak' D-163 Developer. After it is dry, the mask is registered on the base side of the developed colour negative.

Making the Mask from the Negative: In considering the possibility of masking a colour negative that has already been made, the fact that highlight masking increases negative density range shonld be borne in miud. The negative density range may become too great to print properly without using a contrast-reducing mask as well.

The first step in making a highlight mask is to make a full-scale interpositive by contact printing the negative on a sheet of Kodak 'Plus-X' Pan Film, emulsion to emulsion, with filtering equivalent to 200B in the beam of light from a tungsten light source enlarger. The interpositive is developed for three minutes at 68°F (20°C) in a dish of 'Kodak' D-163 Developer.

After it is dry, the interpositive is contact printed on 'Kodalith' Pan Film, emulsion to emulsion, with the exposure adjusted to give a maximum density between 0·15 and 0·25 wheu the mask is developed in a dish of undiluted D-11 developer for two minutes at 68°F (20°C). Since the highlight mask has a short scale, no diffusion should be necessary. After it is dry, the highlight mask is taped in register on the base side of the colour negative.

COLOUR PRINTS FROM TRANSPARENCIES

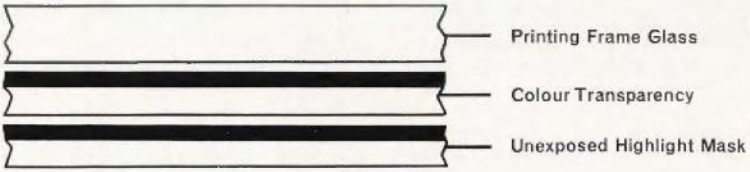
To print an 'Ektachrome' or 'Kodachrome' transparency on Kodak 'Ektacolor' Paper, it is necessary to make an internegative. For this purpose, Kodak 'Ektacolor' Film, Type L, is recommended. Since the coloured couplers in the internegative film provide no correction for the dyes in the transparency, masking of the transparency is recommended.

This section presents, in outline form, some suggestions that may prove helpful. They are intended mainly to guide the experienced colour worker in developing procedures adapted to his own conditions.

MASKING THE TRANSPARENCY

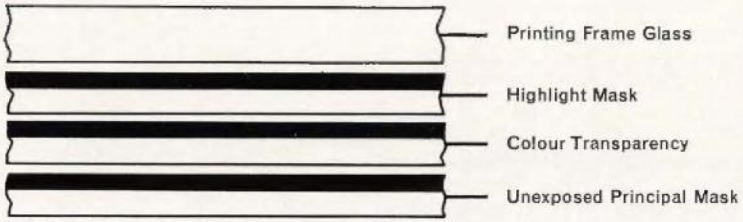
In general, the recommended masking procedures are very similar to those for printing transparencies by the 'Kodak' Dye Transfer Process. For the purposes of this outline, the function of masks on a transparency may be summarized as follows: A single mask corrects relative brightness and saturation errors. To correct for hue shift errors, two masks are necessary. If the subject contains important highlight detail, a highlight mask is necessary in addition to the principal mask or masks.

Highlight Mask: If a highlight mask is needed, it is made first on 'Kodalith' Ortho Film, Type 3, and used over the transparency during exposure of the principal mask or masks. 'Kodalith' Ortho Film may be developed in undiluted D-11 developer for two minutes at 68°F (20°C). The mask differs from a highlight mask for Dye Transfer printing only in



density level. As a starting point, adjustment of the exposure to give a density of 0·30 to 0·45 in an area corresponding to a diffuse white highlight is suggested. The mask requirements of a particular transparency can be judged more effectively after some experience with internegatives has been gained. Ordinarily, a density of 0·50 is about the maximum ever needed, and some transparencies need no highlight masking at all.

Principal Masks: For printing most transparencies, a single mask exposed with white light is recommended. If it is desirable to lighten the blues and greens somewhat in relation to the reds, red light can be used to expose the mask. If it is important to prevent reds from shifting toward orange, and greens from shifting toward blue, two principal masks are needed, one exposed by red and one by green light. In any case, 'Kodak'



Pan Masking Film is used, and it is developed for two and a half minutes at 68°F (20°C) in 'Kodak' DK-50 Developer, diluted one part developer to four parts water. The rest of the processing is the same as described in the instruction packaged with the film.

With three foot-candles at the exposure plane (measured without a filter), the times shown below will be approximately correct.

Colour of Exposing Light	'Wratten' Filter	Exposure Time
White	Neutral density totalling 1·2	12 sec.
Red	No.29	12 sec.
Green	No.61	18 sec.

If necessary, adjust the exposure time to give just discernible detail in the mask from the darkest shadow area. If two masks are made, maintain the green-light exposure at 1½ times the red-light exposure.

Use of two principal masks involves a register problem that does not occur with a single mask. The recommended procedure is to use oversize masking film and oversize Type L film with the 'Kodak' Register Punch and the 'Kodak' Register Printing Frame.

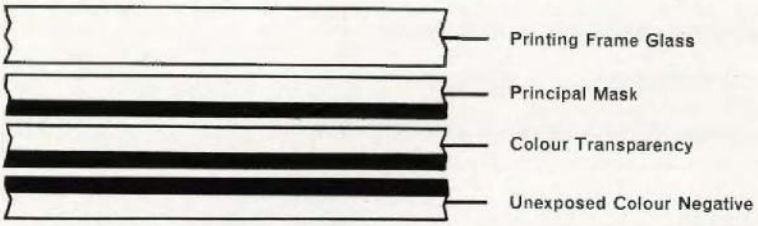
EXPOSING THE INTERNEGATIVE

The light source for printing the transparency on Kodak 'Ektacolor' Film, Type L, should have a colour temperature of approximately 3200°K. The exposure should be adjusted to record adequately the shadow detail of the masked transparency, but excessive exposure should be avoided. Whether the internegative is to be exposed by contact or by projection, the principal mask (or masks) must be registered on the base side of the transparency.

Single-Masked Transparency: Projection printing with a diffusion-type enlarger is recommended, because it tends to give an internegative of desirably low contrast. A typical exposure condition for a full-scale transparency can be worked out as follows: Without a transparency in the

negative carrier, open the enlarger lens to *f*/4·5 and adjust the magnification to give three foot-candles at the exposure plane. Change the lens opening to *f*/16. If a magnification different from the one that yields three foot-candles is to be used, set the enlarger to give the desired magnification and adjust the *f*/16 value to make appropriate compensation. Put the masked transparency in the enlarger and expose for five seconds.

If it is necessary to print the transparency by contact, simply expose



in a printing frame on the baseboard for five seconds at *f*/16, with the enlarger set at the magnification which gave three foot-candles at *f*/4·5.

Double-Masked Transparency: With two principal masks, contact printing is usually necessary. Using an enlarger as the light source, adjust the magnification to give three foot-candles at *f*/4·5. Close the lens down to *f*/16 and add a CC10C filter to the beam.

Place in order in a 'Kodak' Register Printing Frame a punched sheet of Type L 'Ektacolor' Film, the transparency, and the red-light mask. Make a 2-sec. exposure with the Kodak 'Wratten' Filters No.12 and 2B in the beam.

Now replace the red-light mask with the green-light mask, and remove the No.12 plus 2B filter combination. Expose as follows:

Type of Transparency	Kodak 'Wratten' Filter	Exposure Time
'Ektachrome' (Process E-2 or E-3)	No.98	9 sec.
'Ektachrome' (Process E-1)	No.49B+2B	35 sec.
'Kodachrome'	No.49B+2B	35 sec.

CONTRAST REDUCTION

The contrast level of many internegatives exposed by projection is satisfactory. Internegatives with deep shadows or those made by contact may require contrast reduction beyond that obtained by masking the transparency. Three different controls are available. In most cases one should be sufficient, but two can be used with additive effect.

Positive Mask: This type of mask is the same as that described on page 48, except that the suggested development time is two minutes. The exposure time can be adjusted over the range of about 1½ to 15 sec., according to the amount of density reduction desired. A longer time will open up the shadows more than a shorter time.

Flashing: At the expense of some loss of shadow contrast in the print, the density range of the internegative can be reduced by giving it an overall flash exposure after the image exposure. Remove the transparency and mask from the printing frame and with neutral-density filters totalling about 2·5 in the beam, flash the internegative film for the same time used for the image exposure. (In the double-mask procedure, use the neutral-density filters with the colour filters in turn, and give two flash exposures.)

If desired, the colour of the deep shadows in the print can be adjusted at the same time. Add to the beam a filter of the same colour as that to which the shadows are to be changed. To make the shadows greener, for example, try a CC50G filter.

Processing Adjustment: In case of necessity, some contrast reduction can be obtained by reducing the development time for the internegative in Process C-22. If the development time is reduced to twelve minutes, increase the internegative exposure by ½ stop. If the development time is reduced to ten minutes increase the exposure by 1 stop.

RETOUCHING COLOUR NEGATIVES AND PRINTS

Retouching of a colour negative or print is often necessary, especially in portraiture, to produce a pleasing print. The information in this chapter is intended to supplement the knowledge of a proficient black-and-white retoucher, and explain the similarities, as well as the differences, between colour and black-and-white retouching techniques. In general, colour negatives do not need as much retouching as do black-and-white materials. Retouching cannot be regarded as a substitute for good make-up.

Where a number of prints are planned from one negative, correcting the negative rather than the prints will save time and afford more consistent results. Furthermore, even in cases where only one print is wanted from a negative, certain defects are easier to correct on the negative than the print.

It is essential to realise that colour negatives and papers have three superimposed dye layers and that an etching knife cannot be used for lightening densities on any of these materials. The work that is normally done with a knife on black-and-white negatives or prints must be done by *adding* colour or neutral density, by means of dyes or pencil, to the colour print or negative.

If the worker has little previous experience of retouching colour negatives or prints, experimenting with discarded materials is suggested. It is also recommended that 'Ektacolor' prints are made before and after retouching of practice colour negatives.

RETOUCHING 'KODACOLOR' AND 'EKTACOLOR' NEGATIVES

In addition to the usual materials required for black-and-white negative retouching some colour pencils and colour dyes are necessary. The following may be used, but other similar materials may also give satisfactory results.

Pencils: Eberhard Faber 'Mongol' 860 Red and Blue combination, or Eberhard Faber 'Colorama' 8056 – Crimson and 8025 Indigo, or Eagle Turquoise 'Prismacolor' 922 – Scarlet and 901 Indigo. These are the most useful colours for portrait negatives, other colonrs may be necessary for other types of negatives.

Dyes: Kodak 'Flexichrome' Replacement Colours or 'Kodak' Dye Transfer Dyes or 'Pelikan' Albumen Dyes (sold by Rudowsky, 63 Spencer St. EC1.).

Some colour retouchers find it helpful to check their work by viewing it through colour filters such as the Kodak 'Wratten' Filters No.29, 61, and 47B.

PREPARATION

Assessment of a colour proof (not a black-and-white print) will enable the retoucher to determine the areas to be corrected for a more satisfactory colour print.

In areas requiring heavy correction the retouching fluid should be applied to both sides of the film. Pencils can then be used to add a considerable amount of colour or density. Since 'Kodacolor' negatives do not have as much surface tooth as 'Ektacolor' negatives additional retouching fluid should be left on the negative. An alternative is to retouch 'Kodacolor' negatives with dyes. It is also possible to bind a "fixed-out" piece of black-and-white cut film to a negative and to carry out the retouching on this supplementary surface.

RETOUCHING TECHNIQUES

There are three points which the retoucher must remember in viewing 'Ektacolor' and 'Kodacolor' negatives:

1. As in black-and-white negatives the densest portions of these negatives represent the highlights in the original subject.

2. The colours in these negatives are approximately complementary to the colours in the original subject. Thus a yellow object appears blue on the negative.

3. The orange colour of the coloured-coupler masks is superimposed on the subject colour in these negatives making precise colours difficult to identify.

Pencil Work The major proportion of the retouching required by a colour negative is done with the same black lead as is used in black-and-white negative retouching. In areas where colour must be neutralized, used coloured pencils before black leads.

Blemishes, lines and wrinkles. In a portrait negative, inspect the flesh areas for green spots or lines (often faint) which represent red blemishes and wrinkles on the subject. Apply the red pencil until the green is no longer visible. If additional density is needed after this colour correction, use the black lead to build up extra density.

Veins. Blue veins in the original subject will appear yellowish red on the negative. They may be removed or subdued by careful use of the blue pencil.

Highlights. It is possible to enlarge highlight areas or to work adjacent ones smoothly together with a black lead. Where the eyes are in shadow, the catchlights will be small or may not appear at all. They can be restored or enlarged with black pencil lead or liquid opaque.

Pinholes and dust spots. Dark spots on the colour print result from dust or other foreign matter on the film during exposure. Correct these spots in the negative with neutral-grey dye or liquid opaque applied with a brush. The resulting light spot on the print can be retouched to match the surrounding area.

DYE RETOUCHING

Colour-negative retouching which has been accomplished with dyes shows less grain than pencil retouching and may therefore be desirable when large prints are to be made from small negatives. Dye retouching is usually preferable to pencil retouching on 'Kodacolor' negatives, since the lack of sufficient tooth prevents application of much pencil work.

Large areas of 'Kodacolor' negatives can be dyed on the base side. This eliminates the possibility of wet dyes or water turning the emulsion surface opalescent and the inconvenience of waiting for the surface to dry before continuing the retouching. On the other hand, applying dye for fine or critical retouching on to the emulsion side will minimize dye bleeding.

The technique of applying dye is generally similar to black-and-white work. Apply coloured dye first to remove unwanted colour in the negative; then apply neutral dye until the density is built up satisfactorily. As with pencil, much retouching can be accomplished using neutral dye only.

If too much dye is applied, some of it can be removed by sponging the area with slightly damp cotton wool. To remove the dye completely, wash the negative in water for several minutes.

RETOUCHING 'EKTACOLOR' PRINTS

Also required, in addition to the materials usually used for black-and-white print retouching, are a set of Kodak 'Flexichrome' Replacement Colours and some water-free denatured ethyl alcohol, which can only be purchased when a licence from a local Customs and Excise officer has been obtained. It is also possible to use rectified spirit which may be purchased from a dispensing chemist. 'Kodak' Dye Transfer Dyes or artists' water colours may be used in place of, but not in the same manner as, the 'Flexichrome' Colours.

Spotting Prints: Much of the spotting of colour prints can be undertaken using black pencil in the same manner as for black-and-white work. Application of retouching medium may be necessary to give the print surface some tooth. After the retouching, apply some form of lacquer to preserve the pencil work. It is only in strongly coloured areas that this method is unsatisfactory.

The nature of various retouching dyes and water colours requires different techniques for their application and removal. An advantage of using 'Flexichrome' Colours is that if they are applied with pure alcohol in place of water, any excess can be wiped away with a cotton rag dipped in alcohol. When the desired effect has been obtained, steaming the print will render the 'Flexichrome' Colours permanent.

'Flexichrome' colours should be picked up from the dry cake with a brush moistened in alcohol. Two or more dyes can be mixed until the desired colour is obtained but it may be necessary to subdue this colour by adding "Flexichrome" Neutral. Spotting is best carried out by the "dry-brush" technique. The brush is slightly moistened by wiping lightly

over a piece of clean cotton rag that has been 'wetted' in alcohol. After picking up some of the dye solution from the palette the brush is stroked over blotting paper to remove excess dye and liquid before it is applied to the print.

Dye Transfer dyes and water colours are diluted with water and mixed on a palette. They can be applied with the dry-brush technique described above. Because these colours dry rapidly and are absorbed by the emulsion, they are difficult to remove. Nevertheless where an excess of colour is deposited on a print, it can sometimes be removed with a tuft of cotton wool moistened with undiluted Kodak 'Photo-Flo' Solution. Within one minute of applying the 'Photo-Flo' Solution, blot the print area with clean newsprint.

KNIFING. Not only is it difficult to remove dark spots on a colour print with an etching knife accurately, but the resulting hole is difficult to retouch satisfactorily. Adding dyes to the etched area will not fill the holes. Generally etching is not recommended.

PINHOLES. Pinholes in the negative, caused by dust on the film during the camera exposure, become black spots on the colour print. Apply white opaque to the spot on the print and when it dries, apply coloured pencils to match the surrounding area. Alternatively, apply dye to the opaque with the dry-brush technique or, before applying the opaque, tint it with the proper colour. It is, of course, preferable to spot the negative, as previously described.

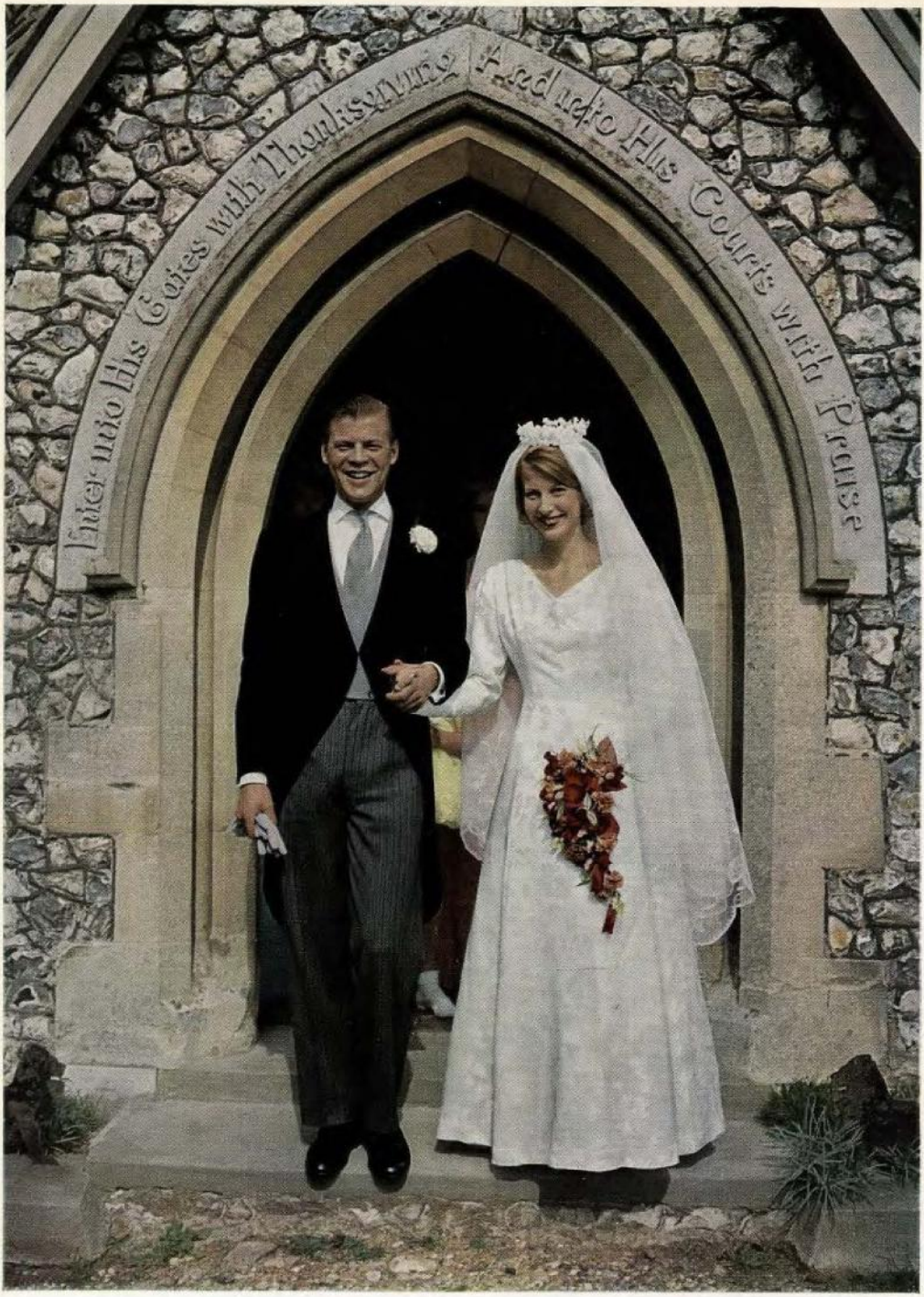
If opaque colour is used to retouch a print from which colour separation negatives are required, the engraver should not apply petroleum jelly or other oily substances to the print. These would cause the opaque colour to photograph dark. An alternative is to spray the print with a lacquer: although this will also make the opaque darker, with experience, the retouching can be lighter to compensate for this density change.

DUST SPOTS. Prepare a weak solution of dye by mixing small amounts of colour in water or alcohol on a palette. Using the dry-brush technique, stipple the spot with the tip of the brush to build up the dye gradually.

HAIRLINE DEFECTS. It is difficult to brush the hairline several times with weak dye solution and keep the dye within the hairline borders. Rather, prepare a concentrated solution of dye of the desired colour and apply it with one smooth stroke of the brush.

SCRATCHES. Surface scratches on a print may remove one or more of the three dye layers. If the scratch has removed the cyan and mageuta dye layers, for example, prepare a blue dye solution and apply carefully to cover up the defect. Print scuffs which do not penetrate through the gelatine supercoat layer can usually be removed by rubbing the area with cotton dampened with water.

SKIN BLEMISHES. To subdue skin blemishes, build np a dye deposit around the blemish by light stippling with the tip of the brnsh to blend the spot into the surrounding skin areas. To subdue a dark blemish the dye colour should be slightly darker than the skin tone but lighter than the blemish.



DYE TINTING

The colour in a specific area of a print can be changed by applying *dry* 'Flexichrome' Colour with a tuft of cotton wool. This treatment is useful in warming bluish shadows; changing or enhancing the colours of skin or clothing and generally modifying the colour of specific areas. The technique has two major advantages; the retoucher can experiment until the desired effect is achieved before making the retouching permanent, and glazed colour prints can be retouched without spoiling the surface.

To apply the colours in dry tinting, breathe moisture on to the 'Flexichrome' cake and rub a tuft of dry cotton wool over the cake surface to pick up dye. Apply the colour with a light brushing motion. More colour may be deposited by a swabbing motion and even more by patting the cotton wool tuft on the print. Smooth out the dye with a clean tuft of dry cotton wool. Two or more dyes can be mixed directly on the surface which is being treated. To remove the dye completely, to clean up surrounding areas or to introduce high-lights, wipe the area with cotton dampened with denatured alcohol.

To make the dye retouching permanent, subject the retouched area to steam for a few seconds. Avoid applying too much steam. When the surface marks caused by the dye application disappear, the surface has been steamed sufficiently.

It is important that the 'Flexichrome' Colours should not have been moistened at any time with water. The 'Ektacolor' print and the cotton wool must be thoroughly dry. The source of steam should not be in the retouching room.

If 'Kodak' Dye Transfer Dyes or water colours are to be used for tinting, they are best diluted with a mixture of nine parts of alcohol and one part of water. The use of water alone causes the print emulsions to turn opalescent and bluish; the print must be allowed to dry before retouching can be continued in that area. The above alcohol and water mixture will still cause this opalescing effect but it dries out quicker.

OPAQUE RETOUCHING

Opaque colours can easily be applied to a colour print with sable spotting brushes to outline and accentuate objects, introduce specular highlights, retouch spots, etc. Also, opaque colours can be applied with an airbrush. In the hands of an expert, an airbrush is useful in changing larger areas of colour prints which need a change in density or colour.

A grey base which approximately matches the tone of the paper emulsion can be prepared by mixing white opaque water colour with small amounts of black and orange (yellow plus red) water colour in water.

This grey-white base material can be mixed with any of the chromatic water colours to obtain the desired retouching colour. The base material alone is often sprayed on the print area being retouched to cover dark colours before the final colour is applied. In areas where bright colours are desired, the pure chromatic water colours mixed only with water can be applied to an area opaqued with the base colour.

Colours should be mixed with enough water to let them flow easily

through the airbrush. Colours which are too dry tend to produce rough textures, such as "orange peel", on a print. Wet colours adhere better to the print and blend more satisfactorily with the print texture.

Airbrush colours should be applied in successive coats to build up the density gradually. Also, the colours should be feathered out to blend into the surrounding areas. A frisket or other mask can be used to prevent opaque colours from being sprayed on any but the desired areas.

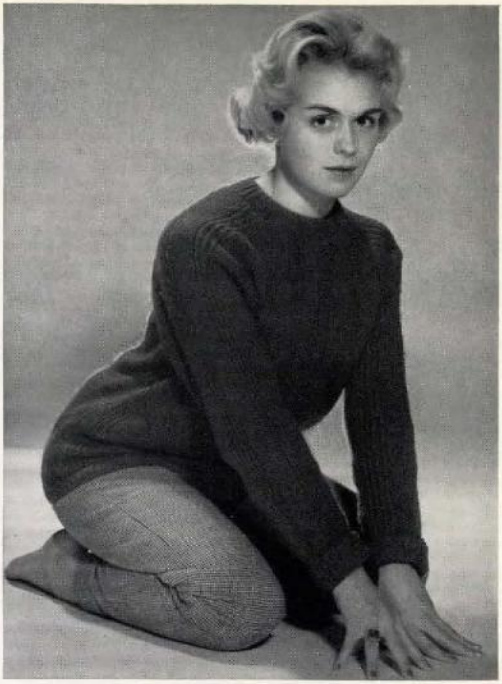
The water colours recommended for airbrush retouching are not absorbed by the print emulsion and, therefore, can be removed by wiping the retouched area with damp cotton.

Considerable judgement is necessary to select the proper density of opaque colours for a print that will be lacquered, since the lacquer will render opaque colours appreciably darker.

LACQUERING

Various lacquers and other coating materials are available to give matt or glossy protective surfaces to colour prints and cover the change in surface-reflective qualities caused by retouching. Since some matt lacquers reduce print contrast and brilliance considerably, they should be tried on a test to make sure the effect is satisfactory.

White shellac mixed with denatured alcohol provides a glossy, textured surface. The texture obtained depends on the amount of dilution of the shellac with alcohol; less alcohol gives greater texture.



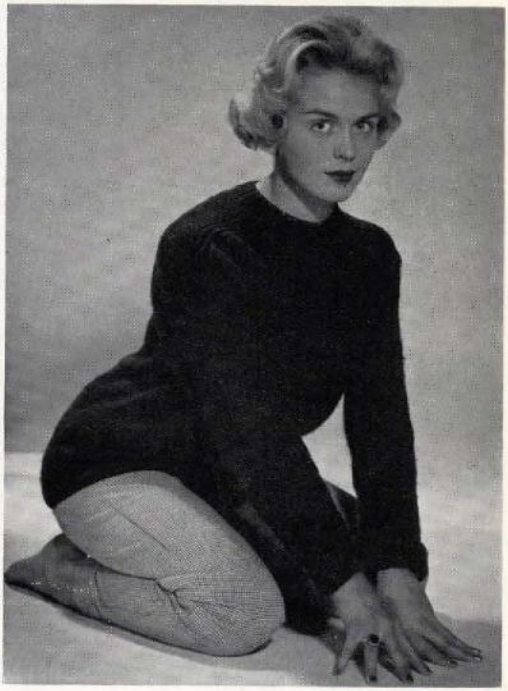
Kodak 'Panalure' Print

BLACK-AND-WHITE PRINTS FROM COLOUR NEGATIVES

Colour negatives can be printed on Kodak 'Bromesko' or Bromide Paper, but the resulting pictures have distorted tonal relationships.

Kodak 'Panalure' Paper has a panchromatic emulsion, so it may be used to make black-and-white prints from colour negatives similar to prints from normal black-and-white panchromatic negatives.

The colours of important parts of the subject, such as the lips and skin, reproduce in their correct tones on 'Panalure' Paper. So now you can use 'Ektacolor' or 'Kodacolor' Films and offer either colour or black-and-white prints as required.



Kodak Bromide Print

DENSITIES OF CP FILTERS

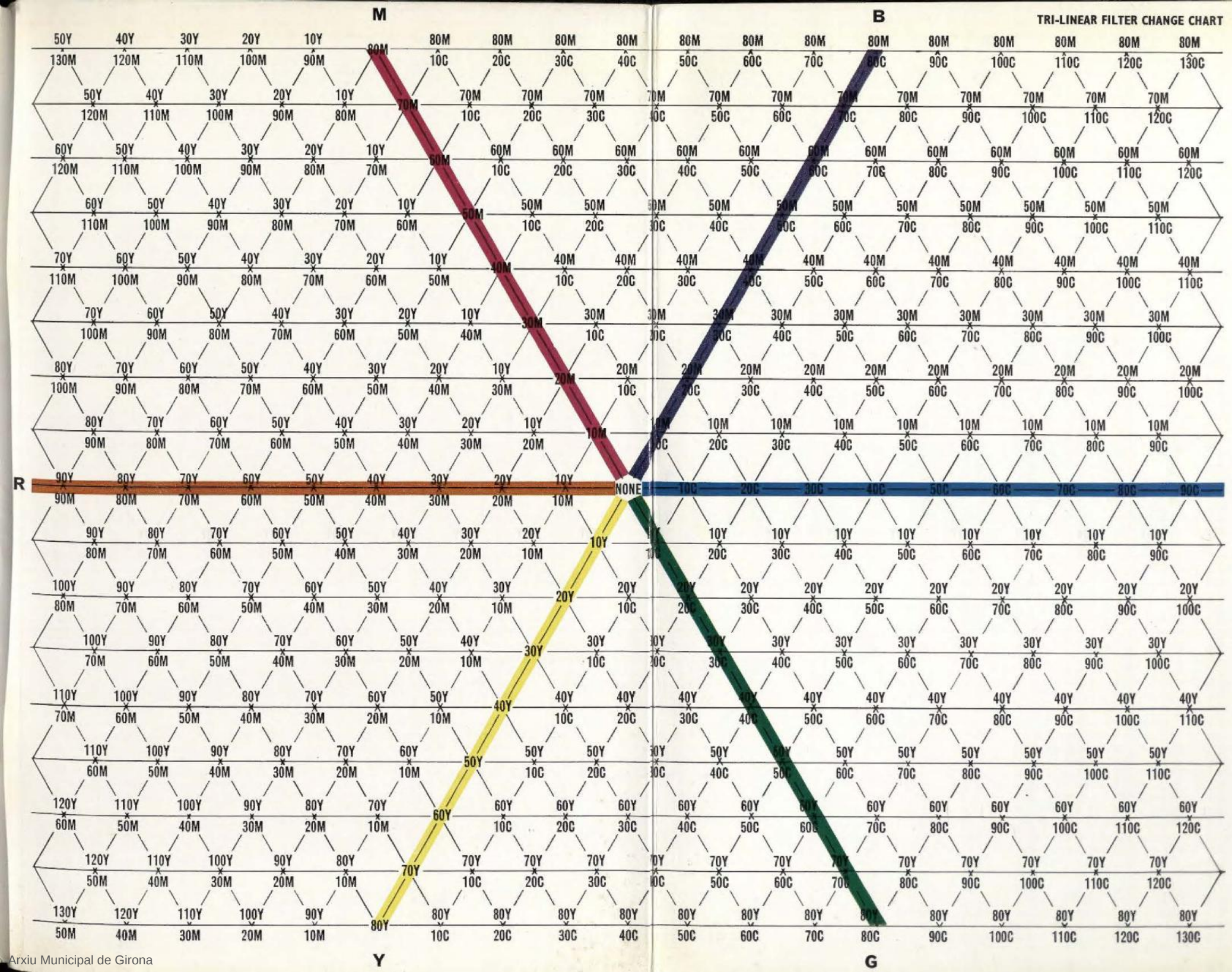
Filter	Density	Filter	Density	Filter	Density
CP025Y	0·07	CP025M	0·08	CP025C	0·08
CP05Y	0·07	CP05M	0·09	CP05C	0·09
CP10Y	0·07	CP10M	0·11	CP10C	0·11
CP20Y	0·07	CP20M	0·16	CP20C	0·15
CP30Y	0·08	CP30M	0·21	CP30C	0·18
CP37½Y	0·08	CP37½M	0·26	CP37½C	0·21
CP40Y	0·08	CP40M	0·26	CP40C	0·21
CP42½Y	0·08	CP42½M	0·26	CP42½C	0·21
CP47½Y	0·08	CP47½M	0·30	CP47½C	0·24
CP50Y	0·08	CP50M	0·30	CP50C	0·24
CP52½Y	0·08	CP52½M	0·30	CP52½C	0·24

DENSITIES OF CC FILTERS

Filter	Density	Filter	Density	Filter	Density
CC05Y	0·04	CC05M	0·07	CC05C	0·06
CC10Y	0·04	CC10M	0·10	CC10C	0·08
CC20Y	0·04	CC20M	0·16	CC20C	0·12
CC30Y	0·05	CC30M	0·22	CC30C	0·15
CC40Y	0·05	CC40M	0·27	CC40C	0·18
CC50Y	0·05	CC50M	0·32	CC50C	0·21
CC05R	0·07	CC05G	0·06	CC05B	0·04
CC10R	0·10	CC10G	0·08	CC10B	0·12
CC20R	0·17	CC20G	0·12	CC20B	0·21
CC30R	0·23	CC30G	0·15	CC30B	0·29
CC40R	0·29	CC40G	0·18	CC40B	0·38
CC50R	0·34	CC50G	0·22	CC50B	0·47

Kodak Limited London

11TP 1601/b PLH 18½ 462



DENSITIES OF CP FILTERS

Filter	Density	Filter	Density	Filter	Density
CP025Y	0·07	CP025M	0·08	CP025C	0·08
CP05Y	0·07	CP05M	0·09	CP05C	0·09
CP10Y	0·07	CP10M	0·11	CP10C	0·11
CP20Y	0·07	CP20M	0·16	CP20C	0·15
CP30Y	0·08	CP30M	0·21	CP30C	0·18
CP37½Y	0·08	CP37½M	0·26	CP37½C	0·21
CP40Y	0·08	CP40M	0·26	CP40C	0·21
CP42½Y	0·08	CP42½M	0·26	CP42½C	0·21
CP47½Y	0·08	CP47½M	0·30	CP47½C	0·24
CP50Y	0·08	CP50M	0·30	CP50C	0·24
CP52½Y	0·08	CP52½M	0·30	CP52½C	0·24

DENSITIES OF CC FILTERS

Filter	Density	Filter	Density	Filter	Density
CC05Y	0·04	CC05M	0·07	CC05C	0·06
CC10Y	0·04	CC10M	0·10	CC10C	0·08
CC20Y	0·04	CC20M	0·16	CC20C	0·12
CC30Y	0·05	CC30M	0·22	CC30C	0·15
CC40Y	0·05	CC40M	0·27	CC40C	0·18
CC50Y	0·05	CC50M	0·32	CC50C	0·21
CC05R	0·07	CC05G	0·06	CC05B	0·04
CC10R	0·10	CC10G	0·08	CC10B	0·12
CC20R	0·17	CC20G	0·12	CC20B	0·21
CC30R	0·23	CC30G	0·15	CC30B	0·29
CC40R	0·29	CC40G	0·18	CC40B	0·38
CC50R	0·34	CC50G	0·22	CC50B	0·47

Kodak Limited London

11TP 1601/b PLH 18½ 462