THE PHOTOGRAPHY OF GROSS SPECIMENS

A KODAK MEDICAL PUBLICATION

$1.00

This booklet
is intended
to provide
basic information
rather than
to advocate
the use of
a particular
photographic
outfit,
other than
to show
typical setups.
For that reason,
the technic
presented
can be used
by anyone
who is familiar
with the demands
of ordinary
close-up
photography.
Those who have
special problems
are invited to send
queries to the
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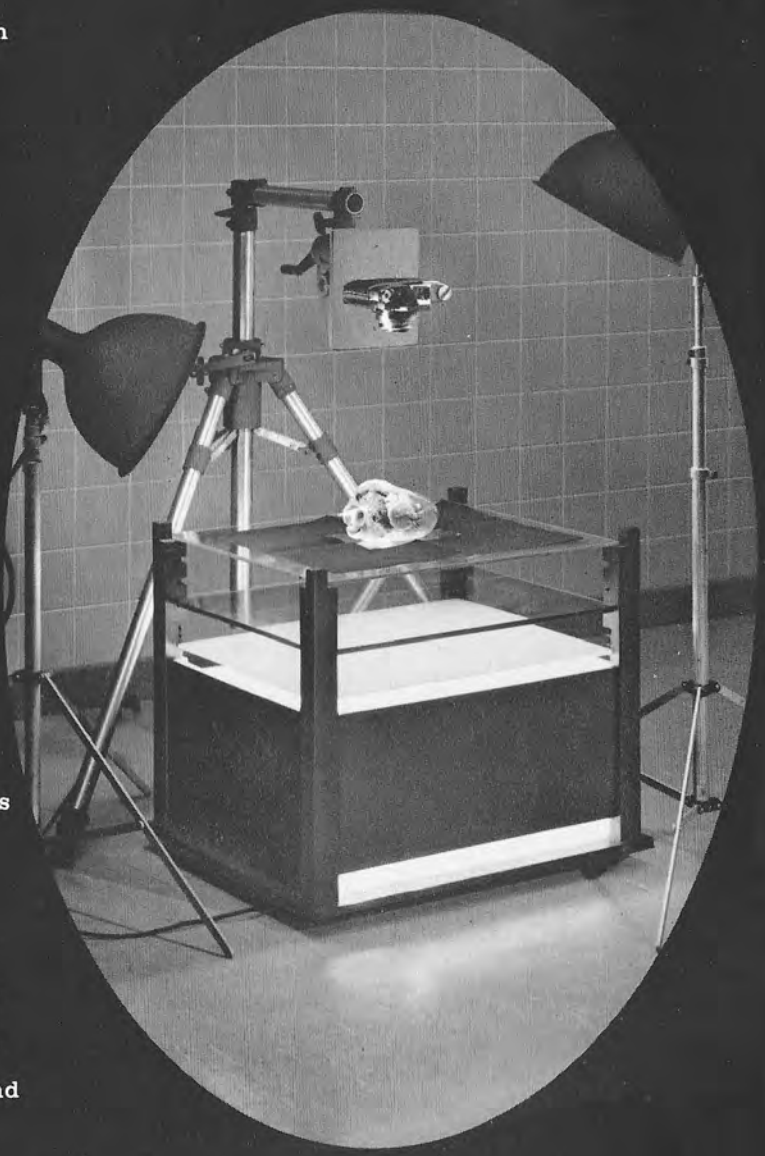

THE PHOTOGRAPHY OF GROSS SPECIMENS

Revised Edition 1966

EASTMAN KODAK COMPANY, Rochester, N.Y. 14650

◀ KODAK RETINA *Reflex IV Camera set up for photographing gross specimens. With its close-up lenses this camera can be focused, in stages, down to an image scale of 1⅛ to 1 for recording small specimens.*

TODAY physicians take photography so much for granted that its value in medicine need only be mentioned to win a nod of agreement. Among its familiar applications is photography of gross specimens . . . in use daily for teaching, for illustrating technical papers, at staff conferences, for exhibition before professional and lay groups, and to supplement case histories. Indeed, color photography of specimens has practically reached the point of outmoding the medical museum. Since preserved specimens soon lose their color, the single purpose of keeping them may eventually be to provide an assortment of representative examples so that their weight, consistency, and structure can be studied.

What makes photographs so important in this field? To begin with, they are a convenient, economical means of "describing" size, shape, and structure. If made in color, they are particularly valuable in recording the appearance of freshly dissected specimens. Their many forms give them unique value: Transparencies and slides can be exhibited before large audiences. Prints and duplicates can easily be made in suitable sizes for filing in any system of case recording. Negatives, prints, and transparencies can be compactly filed, and are easy to care for and transport.

So much for its usefulness—what are the special requirements of gross-specimen photography? There are several: Since the technic is essentially close-up photography, it needs more care in lighting, focusing, and exposure than snapshot photography does. As a rule, a permanent setup is desirable, with the camera attached to a rigid support. (If you are a beginner or have need for the technic only occasionally, you may prefer an outfit that is compact and portable.) Special thought must be given to the choice of films and filters. Lastly, the specimen must be arranged with great care. All of these points are discussed in this booklet.

Equipment and sensitized material

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Types of background

b

Preliminary planning

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Camera technic

d

Equipment and Sensitized Materials

Camera

The camera requirements depend upon how permanent the setup is to be and how much work is planned. To start, you could use a roll-film camera having a good quality lens, and adapt it for close-ups by attaching the appropriate KODAK PORTRA Lens. More efficient and versatile is the camera that has a ground glass for focusing, and long bellows extension that allows making photographs up to actual size (1/1).

It is often necessary to make use of a suitable filter; the proper ones are obtainable in sizes to fit the matched lens accessories known as KODAK Combination Lens Attachments. A KODAK Lens Hood, to shade the lens from extraneous light, also will be found useful in some types of this work. This item is also one of the attachments just mentioned.

Films

Little need be said about the value of full color in recording conditions in which the color of the tissue provides vital information. And because such color variations can be recorded realistically by color films, their use increases daily.

There are some instances, however, where black-and-white photography will provide a useful record if handled properly. They fall into three main groups: 1. To record dark-red areas with light or normal bordering tissue. This requires panchromatic film. 2. To record brightness values in about the actual tones of the specimen. This calls for panchromatic film plus a correction filter. 3. To record subtle variations of red tones with enhanced contrast. This requires an orthochromatic film, or panchromatic film plus a green filter. The films and filters with which to obtain these results are listed in the table on page 23.

In regard to color films, there are two general classifications: 1. Films processed by reversal to produce positive color transparencies that are mounted as slides for projection or viewed directly on an illuminator, depending on their size. 2. Films processed to produce color negatives from which color or black-and-white prints or positive color slides or display transparencies can be made. Technical data with respect to color films are also given on page 23.

Lighting Equipment

Flood lighting is generally used for specimen photography. The reason is this: The subject will not move during the exposure interval, so time exposures can be made, which allows the use of small apertures to provide adequate depth of field* for over-all sharpness of the image. (Occasionally, flash technics can be used when vibration in the floor

*Depth of field means the distance from the nearest to the farthest portion of the subject that will be sharp in the photograph.

of a building would cause unsharpness in pictures made with time exposures.

There are suitable flood-lighting units on the market that are adjustable in direction and height, and accept the lamps mentioned below. Two such units are usually adequate to light the subject, although a third is sometimes needed for background illumination.

Lamps—A small light source such as the No. 1 photoflood lamp is desirable to keep specular reflections small in size. (The reasons for the choice are discussed on page 15.) However, when reflections on the subject must be kept to a minimum, a lamp with clear glass† is recommended.

To protect the photographer's eyes from glare the lamps should be covered by some sort of blackened guard. The conventional type of reflector can be painted black, although its flaring shape may not completely eliminate glare.

Supplementary Equipment

An important accessory is an appropriate base on which to arrange the specimen. A piece of quarter-inch, flawless, polished plate glass, about 18 by 24 inches, will serve the purpose well. This glass should be supported on standards or wooden blocks 6 to 12 inches high, so that a suitable background can be placed below it. If a large volume of work is to be done, it is better to construct an illuminator, as described on page 10. The glass can be separated from the background material, or placed directly above and in contact with it if the background is opaque.

When a black background is used, reflections of the camera unit in the glass support must be prevented. This can be done by suspending a stiff black card between the lens and the subject. A piece about 13 by 15 inches will do, with a hole cut in the center for the lens.

Props are also needed to support the specimen on the glass so that the desired aspect will be displayed to best advantage. Little blocks of wood, wads of cotton, modeling clay, and curved strips of $\frac{1}{16}$-inch lead of various lengths and widths are practical.

When the size of the specimen is important, a ruler should be included in the picture. Its use gives the viewer a quick grasp of the subject's size regardless of whether the picture is projected on a screen or published in a journal. A dull, light-toned ruler with black indices photographs more legibly than a shiny white one. A clear plastic ruler with contrasting indices is unobtrusive. Some workers prefer to include an object of familiar size. Both means of identifying image size are illustrated on page 14.

†Such as the General Electric 500-watt, 3200K, projection lamp, DMS/115/120. It has a medium screw base and it is practical to burn it in various positions for short periods of photography.

Types of Background

The background is of considerable importance in this type of photography, because it can often contribute much to the clarity of the picture. Attention must be given to such factors as its color, tone, and texture, as well as to shadows that appear on the background, because they all affect the scientific and artistic value of the picture. In general, backgrounds fall into two classes – opaque and transilluminated. How they can best be used is discussed in this section.

Opaque Backgrounds

For black-and-white photography, either a black or a light (gray or white) background can be used, the choice depending on the color of the specimen (Figures 1 and 2). A light-colored subject will be shown to best advantage against a dark background, and vice versa. Matte-surfaced paper or cardboard is suitable.

The types of background commonly used for black-and-white photography have been and still are used for photography in color. However, in some instances they tend to obscure details of the subject, a white background having

FIGURE 1–*This medium-toned specimen is shown to best advantage against a light gray background. Note how the translucent plastic ruler serves its purpose without distracting the attention from the specimen.*

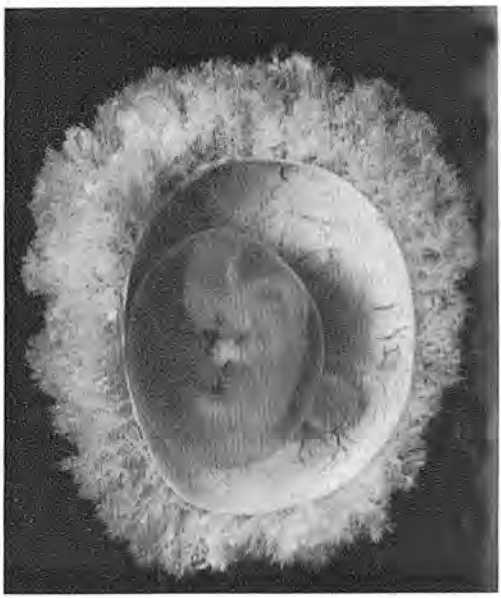


FIGURE 2–*The delicacy of this light-toned specimen is brought out by the black background.*

the added disadvantage of producing glare. These faults are particularly noticeable in transparencies, but are also apparent in color prints. For these reasons, colored backgrounds have come into favor.

Colored Backgrounds—The greatest single advantage in the use of colored backgrounds is in recording subjects that have important areas with both very light and very dark tones. For instance, an almost black anthracotic lung adjacent to a heart with light tones; a brain with its grayish-white surface broken up by dark red—almost black—hemorrhagic areas extending to the edge of the specimen; or multicolored tumors. In such cases, neither a white nor a black background would give sufficient contrast to light or dark areas in the subject, and a gray background would tend to subdue intermediate tones. A carefully selected colored background eliminates these faults by introducing color contrast and emphasizing the subject.

It is interesting to observe the varied reactions of people who see gross-specimen pictures having suitably chosen colored backgrounds. While such pictures will impress a photographer as striking, the average physician notices the vividness and clarity of the subject itself rather than the background. He is apt to comment on it only as an afterthought, indicating that the background is unobtrusive. Lay persons, who are prone to consider all medical photographs as gruesome, seem to find such pictures less distasteful when colored backgrounds have been used.

Choosing color—The choice of background color depends not only upon the subject but often upon a particular feature of it that requires emphasis. Usually, colors complementary to those in the subject are preferable. For most clinical and pathologic subjects in which reds and yellows predominate, blue-green is the best choice (see Figure 3). Some specimens, such as transparent or translucent crystalline stones or greenish icteric organs, are most effectively pictured against warm red backgrounds. Almost black subjects with a small amount of red—anthracotic lungs, for example—or specimens of a yellowish color, such as a fixed brain section, photograph well against a light green background.

Best results are obtained when tone contrast is not too great. Light-colored subjects call for a background tone that is slightly darker than their own; dark specimens require a lighter tone. An exception to this general rule is that pale, thin, translucent membranes are depicted to best advantage against a dark background as may be seen in Figure 6, page 10. Colored cards or other reflecting surfaces have been found to provide pleasing background contrast.

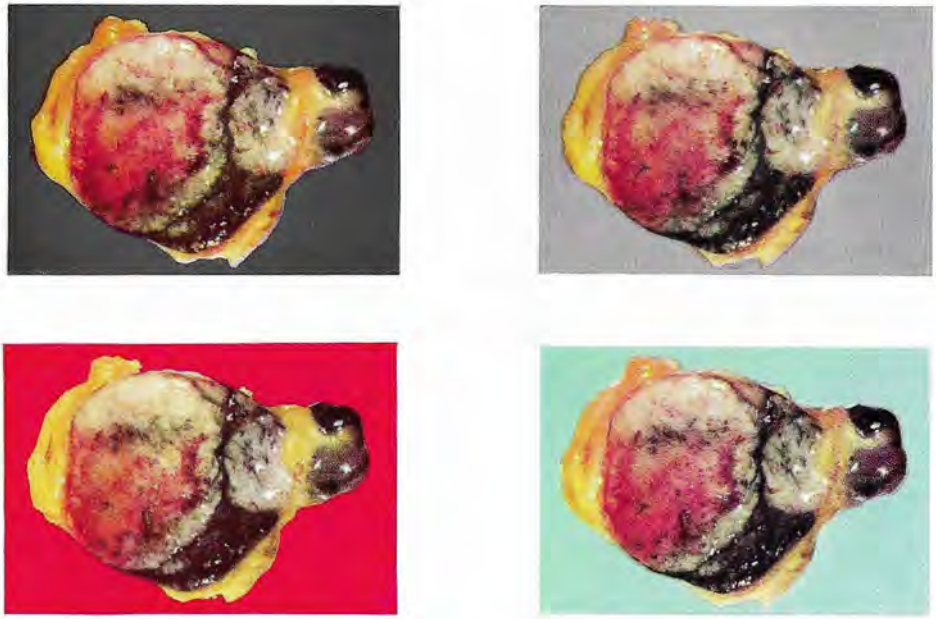


FIGURE 3—*This series of six pictures illustrates the value of background color and the effects obtained by various backgrounds. Gray is better than either white or black but does not bring out all details to greatest advantage. Of the colored backgrounds, the blue-green provides the best effect because the color is not prominent in the specimen itself—a point that should be kept in mind when selecting the background for a subject that comprises many colors.*

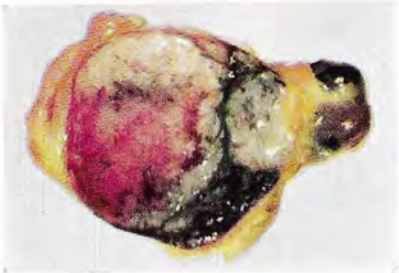
Lighting the Opaque Background—There is no problem of background lighting when a black material is used. On the other hand, shadows sometimes are noticeable on a light background, and, under such circumstances, it should be illuminated by an additional lamp. Take care to shield the specimen from this supplementary illumination with a piece of cardboard. A white card can be arranged so as to serve as a reflector as well as a shield if more illumination is needed on a dark area of the specimen. If the reflected lighting is not necessary, use a black card as a shield.

Transilluminated Backgrounds

Still more effective than colored cards is the use of transilluminated colored glass.* Such backgrounds have greater over-all uniformity and softness, and transillumination eliminates undesirable shadows about the subject. By varying the intensity of the transmitted light, the most suitable tone of the color chosen can be obtained quite readily. See page 20.

Transilluminated colored backgrounds give striking results in the photography of translucent subjects, including some

*Availability is discussed on the inside back cover.



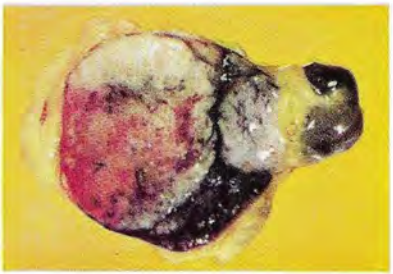


FIGURE 4—*This blue background was chosen to delineate the white tumor and sclera, the almost black choroid, and the translucent cornea and lens of this fixed specimen of an eye. It was photographed under alcohol.*

sacs and cysts, intestines, and thin membranes. The transmitted light emphasizes the important characteristics of thinness and translucency, and even reveals a contained fluid (Figure 11, page 17). An opaque neutral background, on the contrary, almost obliterates such a specimen as an embryonic sac. A very dark background is no better, since it creates the appearance of a single membrane rather than a filled sac.

Special Illuminator—In general, a transilluminated colored background can be obtained through the use of any contrivance that provides a soft, fairly even

FIGURE 5—*The greenish yellow of this fixed specimen is well shown against the red background.*

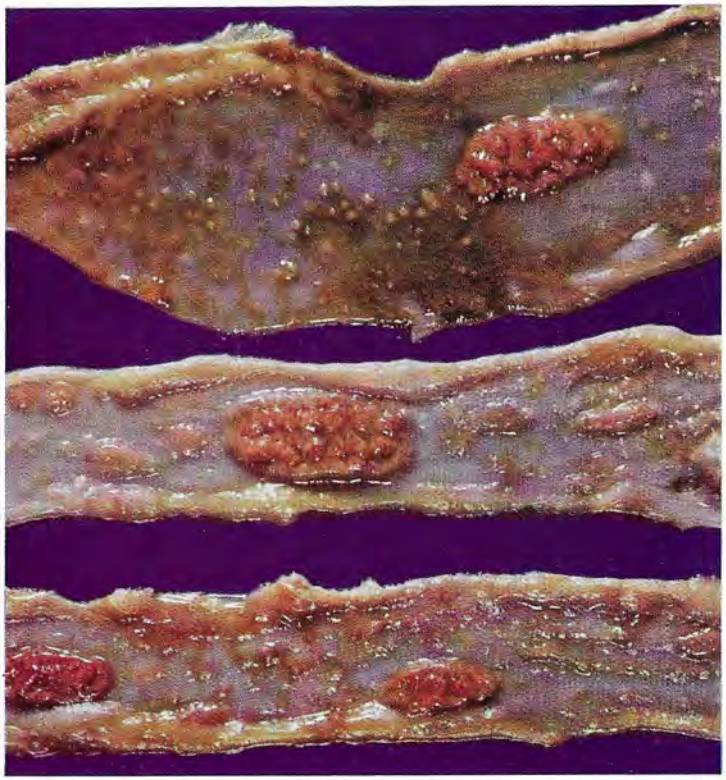


FIGURE 6—*The rich, dark-colored background brings out the thinness and translucency of the intestinal wall.*

source of light shining through a sheet of transparent colored glass. A simple and practical device for the purpose consists of a boxlike wooden frame which rests on the floor, as shown on the inside front cover and in Figure 7. Its base is partly enclosed, and its sides are built up to a height of about 9 inches and slotted for ventilation of the lamps. The inner surfaces of the sides and bottom are painted white to diffuse the light.

Two porcelain lamp receptacles (bolted under the base to save height, with sockets projecting through bored holes) accept No. 1 photofloods. An electrician can wire a switch from an electric stove, and two toggle switches, to permit lighting of the lamps singly or together in series or parallel. In this way the intensity is under some control and so is the shape of the "hot spot." Specimens should be centered over the latter; in the photographs there is very slight grading of tone away from the center, holding interest on the subject. Color temperature of these lights is of little consequence, since the color of the glass predominates. If it is desired, background brightness can also be varied with a voltage control.

A sheet of double-flashed opal glass rests on brackets just above the enclosed

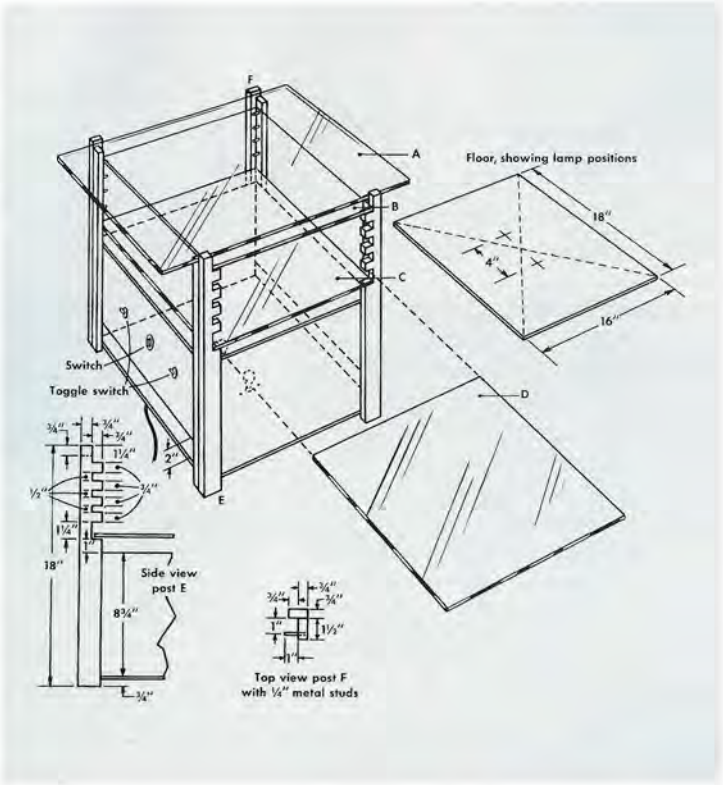


FIGURE 7—*Diagram of wooden illuminator used for transilluminated colored backgrounds.*

Key: (A) *Clear glass plate, 18 x 24 inches, for holding large specimens.*

(B) *Clear glass plate, 16 x 18 inches, for supporting average-sized specimens.*

(C) *Double-flashed opal glass to diffuse illumination from below.*

(D) *Colored transparent glass, 16 x 18 inches, to give desired background effect.*

section of the frame. Directly over this level, slots cut into the corner posts allow the insertion of one or more sheets of colored glass, ⅛- or ¼-inch thick, and cut to 16 by 18 inches.

A 16 by 18-inch sheet of clear plate glass located on brackets about 6 to 8 inches above the colored glass will be adequate to hold most specimens. The distance between the two levels (which must be varied to meet the requirements of the camera lens employed) is great enough to ensure that the colored glass is beyond the depth of field at the smallest aperture used. In this way, any dust specks on the colored glass will always be out of focus.

For large specimens, which naturally require more background area to be included, an 18 by 24-inch sheet of clear plate glass is used. It is laid on the frame with its long dimension projecting beyond the sides of the box toward the light sources illuminating the subject. This arrangement prevents the shadows of the ends of the plate glass from falling within the pictured area. These shadows can be ignored in photographing a small specimen, because in such a case they are not encompassed in the field of view.

Preliminary Steps

Before placing the specimen in position, it is wise to have the film and filter ready and to have an idea of the size of image desired, the subject-film distance, the illumination, and the number of exposures to be made.

With careful planning in advance, the technic can be carried out efficiently and promptly, and there is less likelihood that the specimen will be dried out by long exposure to the heat of the lamps during lighting, composing, and focusing.

Image Size

As a rule, the image size (called scale or magnification) is determined by the relation of the size of the specimen to the negative size. For example, at 1/1 scale, only a very tiny object or a small portion of a larger one can be photographed on 35mm film. On the other hand, 5 by 7-inch film can accommodate a much wider range of specimens at 1/1 or at least 1/2 scale. Whatever the scale, it should be definitely known, because this information makes the photographs more comprehensible to anyone who views them. As we have mentioned before, the scale can be automatically established in the photograph by including a ruler or a familiar object of known size. Whenever feasible, adopt definite scales such as 1/2, 1/5, 1/10, etc.

Subject-film distances for any desired scale can be readily determined for cameras with long bellows extension or extension tubes, by using the following simple formula:

$$\text{Subject-film distance} = \frac{(\text{Magnification} + 1)^2 \times \text{Focal length}}{\text{Magnification}}$$

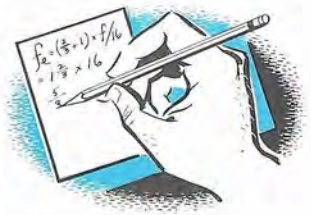
For example: Suppose you wish to make a picture at 1/2 (.5) scale, using a lens of 4-inch focal length. What subject-film distance is necessary?

$$\frac{(.5 + 1)^2 \times 4}{.5} = \frac{2.25 \times 4}{.5} = \frac{9}{.5} = 18 \text{ inches}$$

(If the focal length of the lens is expressed in millimeters, the answer will be in millimeters; if it is in inches, the answer will be in inches.)

For those who may want to use a roll-film camera, the necessary information is included in the table, "Subject Distance and Field Size for Roll-Film Cameras with Supplementary Lenses." These subject-lens distances apply to all cameras and must be measured accurately from the supplementary lens to the subject.

In working with long bellows extension or extension tubes, when a scale size larger than 1/5 is obtained, or the subject is closer than 8 times the focal length of the lens, the f-number at which the lens opening is set (indicated f-value) is no longer effective, and an increase in exposure must be made. The KODAK Master Photoguide, available from your



photographic dealer, contains an Effective Aperture Computer which gives the effective aperture at a glance. (Important: When *supplementary lenses* are used for close-up photography, it is not necessary to make an adjustment in exposure.)

The effective f-value can also be found by substituting the values in the following formula–the distance and focal length should *both* be in either inches or millimeters:

$$\text{Effective f-value} = \frac{\text{Indicated f-value} \times \text{lens-to-film distance}}{\text{focal length of the lens}}$$

For example, a 4-inch lens racked out 8 inches from the film and set at f16 would have an effective aperture of f32, thus:

$$\text{Effective f-value} = \frac{16 \times 8}{4} = 32 = \text{f32}$$

In this case, then, if the lens is set at f16, compute the correct exposure as if it were set at f32, or two openings smaller.

Another method of making the required correction is to increase the exposure time by:

$$\frac{\text{lens-to-film distance}^2}{\text{focal length}^2}$$

Subject Distance* and Field Size for Roll-Film Cameras with Supplementary Lenses

Camera Size		KODAK PORTRA Lens 1+		KODAK PORTRA Lens 2+		KODAK PORTRA Lens 3+	
Approximate Negative Size	Average Focal Length	Camera focused at infinity Subject Distance 38¾ in.	Camera focused at 3½ feet Subject Distance 20⅜ in.	Camera focused at infinity Subject Distance 19½ in.	Camera focused at 3½ feet Subject Distance 13⅜ in.	Camera focused at infinity Subject Distance 13 in.	Camera focused at 3½ feet Subject Distance 10 in.
		Approximate Field Sizes in Inches					
1 x 1½ in. 24 x36 mm	50 mm	18⅝x28	9¼x14	9⅜x14	6⅛x 9¼	6¼x 9⅜	4½x6⅞
1⅛x 1⅞ in. 28 x40 mm	50 mm	21⅞x31¼	10¾x15⅜	10⅞x15½	7⅛x10⅛	7¼x10⅜	5¼x7½
1⅝x 2¼ in. 4.0 x 6.0 cm	75 mm	21⅝x30	10⅜x14⅜	10⅝x14¾	6⅜x 8⅞	7⅛x 9⅞	5 x7
2¼x 2¼ in. 6.0 x 6.0 cm	75 mm	30 x30	14⅜x14⅜	14¾x14¾	8⅞x 8⅞	9⅞x 9⅞	7 x7
2¼x 3¼ in. 6.0 x 9.0 cm	100 mm	22⅛x32	10½x15¼	11⅛x16⅛	6⅞x10	7½x10¾	5¼x7½

*Subject distance measured in inches from front of supplementary lens.

Lighting the Specimen

Important factors in lighting a gross specimen are proper light distribution, control of reflections, and—in color photography—the color quality of the light source. (The last mentioned is automatically taken care of by using the recommended lamps—and a filter, when one is necessary.)

It is a good idea to adopt a "basic" lighting arrangement at first, and then make any adjustments that are necessary for "optimum" lighting after the specimen has been arranged. By "basic" we mean the arrangement of lamps indicated in the table and diagram, which can be used even by a novice with acceptable results. As you gain experience, you will find that you can modify this lighting setup to suit a particular subject, and thus obtain "optimum" lighting.

Two precautions must be kept in mind: First, be sure that no direct light from the lamps falls on the lens. Second locate the lamps in such a way that their images will not be reflected by the glass support, within the field of view. The table, "Lighting and Exposure Data for Photography of Gross Specimens," page 24, has been prepared with these points in mind. The lamp arrangement is illustrated in the figure below the table.

In most instances a certain amount of specular highlighting is desirable to preserve the appearance of roundness and texture. Since a specular highlight (or reflection) is an image of the light source, the important point is to keep these high-

FIGURE 8—*Image size may be identified by a carefully placed ruler, or by including a familiar object. The common pin shown in the picture at the top provides a dramatic comparison of size.*

FIGURE 9—*These pictures demonstrate the relative size of specular reflections created by various light sources.* Left, *Using No. 1 photoflood lamps in reflectors.* Center, *Using No. 1 photoflood lamps without reflectors.* Right, *Using clear bulb lamps without reflectors.*

lights small and properly located. In the past, various lighting devices have been used to diffuse or remove them, and occasionally this is desirable. However, the general consensus among photographers and physicians is that highlights serve a useful purpose. The lighting arrangement illustrated is designed to provide small specular highlights rather than to remove them altogether. It also has the additional advantage of avoiding the slight loss of detail and contrast that results from the use of extremely diffuse illumination.

The results of using different light sources are shown in Figure 9. This series of pictures demonstrates that as smaller sources are used, specular highlights are correspondingly smaller, and that lamps with clear-glass bulbs, used without reflectors, create the least noticeable highlights compatible with an appearance of roundness in the specimen. You will notice that the results obtained with No. 1 photoflood lamps (without reflectors or with blackened ones) closely approach those obtained with the clear-glass lamps. Hence, it is well to try the No. 1 photofloods first and resort to the clear lamps when smaller highlights would be more effective.

The size of specular highlights produced by any given set of lamps can be decreased by moving the lamps farther from the specimen.

Lighting for Color Film—The inexperienced worker will do well to locate both lamps at the same distance from the specimen to provide "basic" low-contrast lighting. Surface texture will be enhanced by placing one of the lamps farther from the subject-lens axis than the other to afford a more oblique illumination. Since the effective intensity of the lighting on the specimen is the same from each lamp, the illumination is not so unbalanced as to produce dense shadows that would be undesirable in color photography.

The lighting angles should be about 60 degrees and 45 degrees, measured from the subject-lens axis.

Lighting for Black-and-White Films—The lighting angles for black-and-white photography are about the same as those for color. Additional modeling can be introduced by placing the lamp that is closer to the subject-lens axis at about 1½ times the distance of the other lamp from the specimen.

FIGURE 10—*Effective use of background color is shown in this pair of specimens. The blue background emphasizes the red tissue of the larger tumor while the small translucent cysts removed from it are well delineated against the black background.*

Preparing the Specimen

Before the specimen is placed on the sheet of glass, make sure that significant features have been exposed by skillful dissection, and that irrelevant tissue has been trimmed away. Only the area of interest and sufficient identifying tissue should be included in the photograph, so that the result can convey the desired information effectively. If the photographer is untrained in this matter, the physician should be asked to do it.

This preparation should be done in a tray in which a sheet of blotting paper has been placed to absorb excess fluids. (For protection against infection, wear rubber gloves while handling a fresh specimen.) The next step is to transfer the subject to the sheet of glass and arrange it so that the area of interest will show to best advantage. If the specimen is a tissue section, its arrangement is relatively easy. For other types, however, it is usually necessary to use concealed props so that important areas will lie as nearly as possible in one plane.

Do not move the specimen over the glass, because the resulting smears would show in the photographic background. If the glass should become smeared, you have no choice but to remove the specimen, wash the glass, and start over. Several layers of blotting paper, torn to a shape slightly smaller than the specimen, can be placed under it to absorb liquid.

Since a specimen usually tends to dry out during the final steps of arrangement, apply liquid sparingly during the procedure, and especially just before the exposure is made. A fresh specimen can be kept moist by swabbing it with a 10 per cent aqueous solution of glycerin or a normal saline solution; a fixed specimen, by applying the fluid that had been used

FIGURE 11—*Contour, transparency, and the color of the sac are clearly shown against this transilluminated blue background.*

for preserving it. A specimen mounted in a museum jar needs no preparation.

As a general rule, fresh specimens are preferable to fixed ones. There are occasions, however, when specimens are received just after being placed in a fixing solution. In such instances it is better to permit the fixing process to run its course rather than attempt to "rescue" the specimen, because a partially fixed subject would yield only nondescript results.

In certain cases, a fixed and restored specimen is easier to prepare for photography than one in a fresh state. For example, it is very difficult to produce a satisfactory cross-section of a fresh eye or other fragile or brittle specimens.

A careful technic in preparing specimens that are to be photographed in the fixed state gives results comparable to those that can be obtained with fresh specimens. Briefly, it consists of fixation in 10 per cent formalin for the shortest possible time—usually about 24 hours; cutting, if necessary; washing; and restoration of the color in 80 to 95 per cent ethyl alcohol. Details of the method have been published elsewhere.*

*Bohrod, M. G., and Beiter, J. J.: Photography in Color of Fixed Pathologic Specimens. J. Lab. & Clin. Med., *29*:944-7, 1944.

Camera Technic

The general recommendations regarding lighting and exposure given below apply alike to mounted and unmounted specimens. There are, however, some individual problems to be met with each type.

Unmounted Specimen

At this point we will assume that the preliminary arrangement under the general illumination of the overhead room lights has been done. Now, take a look at the specimen from the position to be occupied by the lens and make any necessary additional adjustments. Next, swing the camera unit into place and adjust it for the correct subject-film distance. With the lamps in their respective locations, turn them on and focus the camera. Then make the final lighting adjustments for a "basic" or an "optimum" setup. Look at the image carefully from the lens position (or on the ground glass, if the camera has one), and make any slight changes that may be necessary in the position of the lamps and the glass bearing the specimen. The main points to be checked are that significant textures are visible in sufficient relief; that highlights from the lamps do not obliterate important details; and that there are no reflections of the lamps on the glass within the field of view.

Occasionally, a deep fissure or depression near the edge of the specimen needs illumination. This can be done by placing small pieces of shiny metal foil near it—outside the field of view, of course—at such an angle that extra light is reflected into the dark area. To direct the light accurately, take a piece of black cardboard and intercept the reflected light; watch the effect and then, if necessary, move the metal foil until the reflected light is located to best advantage.

In order to preclude lens flare (and edge glare on the specimen) from transillumination and from specular reflections off the glass, the unused outside areas of the illuminator must be masked. This is done with pieces of black paper laid down all around the specimen, just outside the camera field.

The next step is to place the ruler in position. It should be included in the field of view, supported on small wooden blocks *in the plane being focused upon*, to furnish a permanent key to the dimensions of the specimen. Check its position and height to be sure that it is level with the area of interest—and thus in accurate focus—and within the field of view.

Finally, swab the specimen lightly with liquid just prior to the exposure.

Exposure — Photography of specimens does not, of course, present any problems in "stopping" movement, so time exposures are practical. This permits you to stop down the lens to a small aperture—usually f16 or f22—in order to provide a satisfactory depth of field.

When making a time exposure, avoid jarring the setup. Otherwise, a blurred image will result. It is advisable to make the exposure by using a cable release, with the shutter set on Time or Bulb. When this is not practical, the exposure can be made by turning the lamps on and off with a switch rather than by manipulating the shutter.

In the table, "Lighting and Exposure Data for Photography of Gross Specimens," page 24, the lamp distances for both color and black-and-white film, and the exposures at f22 are given. (If you are using an aperture of f16, the exposure time should be cut in half.) The lighting provided by the recommended arrangement will be satisfactory for nearly all specimens.

As indicated in the footnote in the table, the exposure data do not include the factor due to long bellows extension or the use of extension tubes. You can readily work out this factor by using the formula given on page 12.

This is important to remember: the exposure data given are based on the use of *new* lamps operated at their rated voltage. Since lamps of this type darken with use, it is usually necessary to increase the exposure for color film by about one half after the lamps have been burned for about half their rated life. It is seldom necessary, however, to make such an exposure correction for black-and-white film in using the technic described. Another adjustment in exposures for color is sometimes desirable—dark specimens might require 50 per cent more exposure than that recommended in the table.

Use of Exposure Meter—The information on exposure given in the table on page 24 applies to the "basic" setup. For "optimum" setups, an exposure meter can be used to advantage. Before making a reading, be sure to turn the background illumination off. Otherwise, too much light will enter the photoelectric cell and result in too high a reading. Another caution: If the subject to be photographed is less than twice the diameter of the cell, you may get too low a reading because a considerable amount of unilluminated background will also be in the meter's field of view. In the majority of such cases, however, you can get a reasonably accurate reading if you place your hand under the glass plate beneath the specimen, while making the reading. This permits the outer fringes of the cell to receive the incident light from your hand.

If the subject is extremely light or extremely dark, make the usual allowance in exposure—about a half stop more for a dark subject and a half stop less for a light one.

When an exposure meter is used, it is a simple matter to balance the tones of

FIGURE 12—*A demonstration of the effects obtainable by varying the intensity of the background lighting.*

(A) *The brightness reading from the major portions of the subject was the same as that from the trans-illuminated glass; the background was "balanced," that is, it had the same brilliance as the specimen.*

(B) *Photograph made with the incident illumination twice as great as that read from the transilluminated background. Hence, the background was half as bright.*

(C) *Here the background was twice as bright as was required for balance.*

background and subject. This can be done by keeping the lighting on either one constant and then adjusting the intensity of the other. Since the lighting given in the table, "Lighting and Exposure Data," is fixed, when using the data take a reading off the specimen first. Then, by means of the variable voltage control, balance the intensity of the lighting for the background so that it is one half that of the specimen value when a dark background is wanted; equal to that value for a medium-toned background; and twice that value for a light background. If it is desired to alter the lighting on the specimen to obtain "optimum" lighting, the above procedure can be followed in reverse by keeping the intensity of the background at a selected level. An example of the results obtainable by varying the intensity of the background lighting is shown in Figure 12. Readings should be made close to the edges of the specimen, not at the far corners.

Another way of modifying the background is by making a double exposure. Make the exposure for the specimen first —the specimen being properly lighted but with the illuminator lights *turned off*. Then make an exposure with the background alone lighted. The longer this second exposure is, the more brilliant the background tone will be.

Mounted Specimen

Basic recommendations on lighting and exposure that have been given for unmounted specimens are also applicable to the photography of a specimen in a jar (Figure 13). Certain new problems, however, are involved:

1. The jar usually must be photographed in an upright position. Hence, the camera axis must be horizontal.

2. Reflections of the lights in the glass jar are troublesome unless they are deflected away from the field of view. You can do this by arranging the lights at the desired distance and at a height that is a few inches above the top of the jar, and then tilting the jar—top toward the lens—until the reflections disappear from the image on the ground glass or when viewed from the lens position.

3. Waviness and striations on the glass surface sometimes cause disturbing reflections, regardless of how the jar is lighted and tilted. You can often subdue such reflections by placing a KODAK POLA-SCREEN over the lens. Rotate the POLA-SCREEN while observing the effect in the image on the ground glass—or use a KODAK POLA-SCREEN Viewer to determine the result you want. Complete control of these reflections can be obtained when KODAK POLA-LIGHTS are used in addition to the POLA-SCREEN over the lens.

4. Mounted specimens require both vertical and horizontal backgrounds. Place a single large sheet of lightweight cardboard or paper beneath the jar, curving it upward behind so as to form an unbroken sweep of background. In this way, there is no distracting sharp line between horizontal and vertical planes.

FIGURE 13—*A typical photograph of a mounted specimen.*

Special Applications

Since each gross-specimen photograph is an individual problem in the correct handling of reflections from the light sources, the most logical approach is to decide whether or not reflections can serve a useful purpose. If so, they should be used to delineate the subject to advantage. This requires a setup similar to the one shown in Figure 14. For "optimum" lighting, the ratio of the amount of light provided by the modeling light and the fill-in light usually should be about 2/1 for miniature color films, and 3/1 for sheet color films.

Many specimens are thin and flat. If specular highlights are not permitted to remain in order to indicate contours and textures, the record may look like a photograph of a cut section. To depict these characteristics the lighting should be arranged at a great angle—about 75°—to the lens-subject axis, so that glancing shadows outline the shallow surface contours of the subject. At the same time, the direction of the lights can be

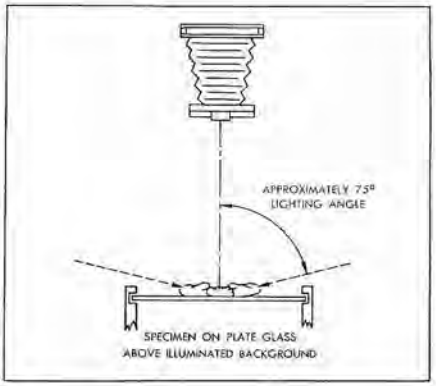


FIGURE 14—*Arrangement of illumination to delineate a whole specimen having textured surface.*

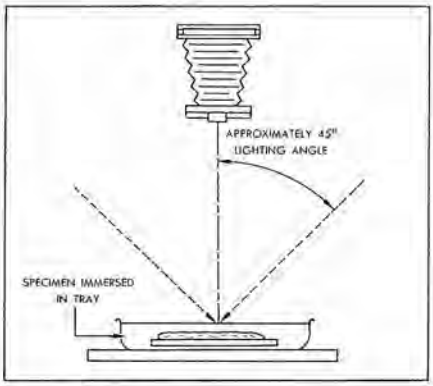


FIGURE 15—*Lighting arrangement for photographing a sectioned specimen immersed in a solution.*

adjusted until the reflections from the texture elements and rounded parts are located for best delineation. Lamps with clear-glass bulbs should be used in order to provide small, sharp reflections that do not obscure detail.

If, on the other hand, reflections are not desirable, they should be eliminated by some method, such as the setup illustrated in Figure 15. Take, for example, a section of liver which is actually a flat section having no surface contours. In this case, no reflections are needed to highlight prominences; indeed, their presence would probably degrade the intricate details.

To remove the reflections, such specimens can be photographed under a saline solution, using the following method: After washing to remove debris, the section is pinned to a piece of heavy building board that has been covered with oilcloth. Thus mounted, it is placed in a glass tray in which saline solution is slowly poured, only enough being used to barely cover the surface of the specimen. It is lighted by a lamp placed on each side of the camera at an angle of about 45° to the lens-subject axis. (Another method that can be used for removing reflections is to place a KODAK POLA-SCREEN over the lens and use POLA-LIGHTS for lighting the specimen, as mentioned on page 21.)

Here is still another suggestion that may be useful on occasion. When only a ragged section can be made, a piece of clear plate glass laid on the cut surface as it rests in the solution will compress the rough texture and permit better emphasis of details. Care must be taken that no air bubbles are trapped under the glass. To expel them, lower one side of the glass into the solution before immersing the other.

Information that may be of special interest to the experienced photographer is contained in the KODAK Pamphlet *Photomacrography*. It deals with photography of very small specimens. The booklet is, of course, available from photographic dealers.

KODAK Film and Filter Data for Photography of Gross Specimens (with Tungsten Illumination)

APPLICATION	KODAK Film	ASA Speed	Filter		Filter Factor
			For 3200K Lamps	For Photoflood Lamps	
Full-Color Photography ▼ For 2 x 2-inch slides	KODACHROME II Professional, Type A: KRA 135-36	40 32	— 82A	None —	Factors taken into account in speed rating.
	EKTACHROME-X (Daylight Type): EX 828 EX 135-20 -36	20 16	— 80A	80B —	
For roll film transparencies	EKTACHROME-X (Daylight Type): EX 120, EX 620, EX 127	20 16	— 80A	80B —	
For sheet film transparencies	EKTACHROME, Type B:	32 25	None —	— 81A	
Color negative material for transparencies and paper prints*	KODACOLOR-X (roll): CX 135-20, CX 828, CX 127, CX 120, CX 620	25 20	— 80A	80B —	
	EKTACOLOR Professional, Type L (sheet):**	80† 64†	None —	— 81A	
Black-and-White Photography ▼ To portray morphologic appearance; dark-red areas having light or normal bordering tissue	PANATOMIC-X (sheet): PANATOMIC-X (roll): FX 135-20 -36, FX 828, FX 127 FX 120, FX 620	64 32	None		—
In which corrected (visual) rendering is desired	PANATOMIC-X (sheet):	64	X1		3
	PANATOMIC-X (roll):	32	X1		4
To portray light-red areas having light or normal bordering tissue in which contrast and detail is to be enhanced.	PANATOMIC-X (sheet):	64	No. 66		2
	PANATOMIC-X (roll):	32	No. 66		2.5
	ROYAL Ortho (sheet):	250	None		—

*Large color transparencies obtained by printing on KODAK EKTACOLOR Print Film; 35mm slides on KODAK EKTACOLOR Slide Film from color processing laboratories; color prints on KODAK EKTACOLOR Professional Paper; and black-and-white prints on KODAK PANALURE Paper.

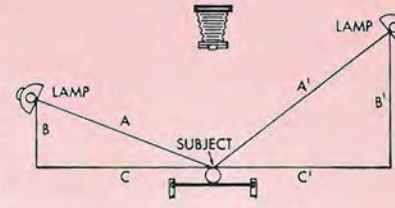
**Note additional data on filters in instructions packaged with film.

†For 1-second exposure.

Lighting and Exposure Data for Photography of Gross Specimens

Specimen Size	Film	Exposure In Seconds At f22*		Lighting Distance (in inches—see diagram below †)					
		3200K Lamps	No. 1 Photoflood Lamps	A	B	C	A¹	B¹	C¹
Small to Average. Lighting will cover a circle 15 in. in diameter.	KODACHROME II Professional, Type A	1	1½	30	15	26	30	21	21
	KODACOLOR-X	2	3						
	EKTACHROME-X (Daylight Type)	3	5						
	EKTACHROME, Type B‡	1½	2½						
	EKTACOLOR Professional, Type L	1	1½						
	ROYAL Ortho	⅛	¼	24	12	21	34	24	24
	PANATOMIC-X (roll and 35mm)	1	2						
	PANATOMIC-X (sheet)	½	1						
Any specimen whose long dimension is greater than 15 in.	KODACHROME II Professional, Type A	2	3	41	22	36	42	30	30
	KODACOLOR-X	3	5						
	EKTACHROME-X (Daylight Type)	6	10						
	EKTACHROME, Type B‡	3	5						
	EKTACOLOR Professional, Type L	2	3						
	ROYAL Ortho	½	1	41	22	36	57	40	40
	PANATOMIC-X (roll and 35mm)	4	8						
	PANATOMIC-X (sheet)	2	4						

*Based on the use of 500-watt 3200K clear lamps with filaments toward subject, or No. 1 photoflood lamps without reflectors or in blackened reflectors. If a correction filter is indicated for color films, the filter factor is calculated and included in the exposure recommended, with the exception of special recommendations packaged with KODAK EKTACHROME Film, Type B. Filter factors are **not** calculated in the exposures recommended for black-and-white films. These recommended exposures do not take into consideration the exposure increase necessitated by the use of long bellows extension or extension tubes.



†Diagram at right depicts arrangement of lamps and subject, and manner in which distances are utilized; all dimensions in table are given to the nearest inch.

‡Refer to instructions packaged with EKTACHROME Film for filter and exposure factor due to long time exposures.

The data appearing on pages 23 and 24
are accurate at the time of printing.
Future changes in films may
require modification of this information;
current KODAK Literature can be consulted.

Note on colored background materials

Colored glass can be purchased from local dealers. They are listed in the phone book under plate glass and/or mirrors. A good combination is "Medium Blue Plate" plus a ¼-inch thick sheet of "Heat Absorbing Polished Plate Glass," available from dealers for the Libbey-Owens-Ford Glass Company. (General Sales Offices at 811 Madison Avenue, Toledo 1, Ohio.)

Should difficulty be experienced in obtaining glass locally, then certain plastic sheets are suitable. Local jobbers of theatrical and night-club lighting equipment can be consulted. Theatrical "gelatins" are not thick enough, but plastic lamp filters about 0.01 inch thick will do. Peacock blue is a good color. When no local outlet exists for such material, the blue-green, "P.C. Color No. p-32" plastic sheet (supplied by Hoffend and Sons, Incorporated, 274-282 Sanford Street, Rochester, New York 14620) can be ordered. The size of the sheets wanted should be stated.

The Celanese Corporation of America also manufactures a blue-green acetate sheet that would be suitable: E305, .010 inch, GG, S712. This is sold through jobbers in various parts of the country. The address of the one nearest to a given locality can be obtained from the above Corporation. The following can also be contacted: Cadillac Plastics Company, 727 Lake Street, Chicago, Illinois; Transparent Products Corporation, 1739 West Pico Boulevard, Los Angeles, California.

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