Minolta
SYSTEM HANDBOOK

SR-T 101 SR-T 100 SR-M



Joseph D. Cooper

MINOLTA SYSTEM HANDBOOK

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Minolta System Handbook

SR-T 101 · SR-T 100 · SR-M

Joseph D. Cooper

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Joseph D. Cooper

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Preface

The making of this book has been an exciting experience. It began with a decision, some years ago, that I should accumulate pictures made with Minolta SR cameras for a book I might someday do. The decision to advance to its actual writing was made in response to an invitation from Mr. Sam Kusumoto, President of the Minolta Corporation in New York, and from Harold Center, Advertising Manager. I had worked with both of them in writing earlier books about Minolta cameras.

In the planning and execution of this book, my aim was to present photography from a total systems standpoint. This includes, broadly, the interplay of the photographer as perceptor with his subject matter through the medium of camera systems. The latter includes mainly the viewing, exposure control, and optical components, but all of these, too, are interrelated. This book is a blending of physical and psychological principles—the uniting of what one sees with the mind and what the camera records. I felt, too, that a book about photography should include many examples of the practical application of principles, whether in use of lenses or in the interpretation and recording of light and shade. I am indebted to the photographers who so generously contributed from their own picture libraries to help in this regard.

Also, I acknowledge with appreciation the aid given me by Ted Kato (my principal source of technical materials), John Jonny (with whom I discussed problems of technical application) and Ted Rosenberg (who was an important resource in editorial review), all of the Minolta organization. And, of course, I am indebted to Minolta's Osaka personnel, who provided general technical and informational support.

During the developmental phases, I had the benefit of the ideas of Graham Finlayson, Richard Gee, Suzanne Szasz, and Gene Vos. I enjoyed the creative enthusiasm of Dennis Rizutto.

AMPHOTO editors Robb Smith and Susan Wolf were principally responsible for creative assembly of the mass of words, illustrations, and charts into book form. Julius Kaufman guided the book through production.

Photographers who contributed substantially to the first edition: Victor Blackman, Otto Callisen, Lucien Clergue, Bob Collins, Joseph D. Cooper, Stuart Davis, Robert Dehesdin, Graham Finlayson, Richard Gee, Tore Hakansson, Francisco Hidalgo, Al Paglione, Cleland Rimmer, Dennis Rizutto, Suzanne Szasz, and Gene Vos. The author's black-and-white photographs were printed by Image, Inc., Washington, D.C.

JOSEPH D. COOPER

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THE PAGE-NUMBERING SYSTEM

Pages in this book are numbered so that each chapter has its own pagination. This is intended to facilitate the insertion of new material incorporated in the pages of the loose-leaf supplement service. Each page has a reference both to its chapter number and to the page sequence number.

Chapters are indicated by Roman numerals while pages are indicated by Arabic numerals. For example, **II-7** means chapter two, page seven; **XI-23** means chapter eleven, page twenty-three.

Color pages are numbered differently. Each color sheet will have the chapter number followed by the letter "C" and an Arabic sequence number all printed in red. Thus, **III-C-3** means the third color plate in chapter three.

Supplement Page Numbering. Insert pages are distributed through the supplement service for incorporation into this book. Each supplement will have a Newsletter, which will include specific instructions for insertion and removal of new and old pages. When existing pages are revised, they will retain their original numbering. Each page will, however, be imprinted with a reference to the issue number of the supplement with which it is distributed. New page insertions are identified by decimal notation added to preceding page numbers. Thus, if a new page is to be added between III-8 and III-9, it will be identified as III-8.1. The reverse side will be III-8.2. In addition, new pages will carry a reference to the supplement with which they are distributed.

CHAPTER I

Better Photography and the Minolta SR System

In the beginning there was a box. In the front of the box there jutted out a big lens, while in the back a viewing screen enabled the photographer to focus and compose the picture, which shortly would be recorded on a coated glass plate. In time the plate holders were modified to accept sheets of coated film, which in turn gave way to roll film. This was the real beginning of miniature photography, for it led to the intermediate stage of cinematography, which developed around the availability of long spools of film. It was only a question of time before the long spools were replaced by shorter spools that could be used in small, hand-held cameras. Among these was the Leica of 1925, which utilized motion picture film in a camera that combined film advance with shutter cocking. This type of camera had another great advantage: It could be cradled quite comfortably in the hands while the photographer composed the picture in the eye-level viewfinder.

In 1936 another important event took place—the development of the Kine Exakta, a 35mm camera that utilized the standard miniature format of 24 × 36mm between the two sets of film-sprocket perforations. This reflex camera allowed the photographer to focus the image on a viewing screen and see pretty much what would be projected onto the film after the shutter-release button had been depressed. This was a great engineering feat, for previously reflex cameras had been big, boxy affairs, inconvenient to take along and expensive to use because of the large size of the film format. Now the photographer could focus and compose precisely, while also using inexpensive film. The arrangement was still not the most convenient one, for the image was upside down and it darkened toward the corners; the photographer had to squint through a magnifier while imagining how the picture would look reversed from left to right and turned rightside up. The Kine Exakta was interesting, but its viewing inconveniences stood in the way of success. It was not until after World War II that the great innovation of the pentaprism changed the whole technology of 35mm photography by allowing the photographer to hold the camera conveniently at his eye

while seeing a magnified image with objects in their natural places, rightside up and laterally correct.

Minolta's camera history began in 1928 with the formation of the Japan-Germany Camera Company, which one year later introduced a roll film camera using number 127 "vest pocket film." Thirty years after its founding, the Minolta organization introduced the first of its single-lens reflex cameras, the model SR-2. We will return to the history of Minolta cameras later in this chapter. At this point we will review the basic features of the Minolta SR cameras. The chapter will conclude with suggestions on how to obtain maximum benefit from this book.

THE BASIC ANATOMY OF THE MINOLTA SR CAMERA

This section contains brief explanatory discussions of the reflex principle, the exposure control system that is integrated with the reflex operation, the basic attributes of the Minolta Rokkor lenses, and the range of capabilities of Minolta SR cameras.

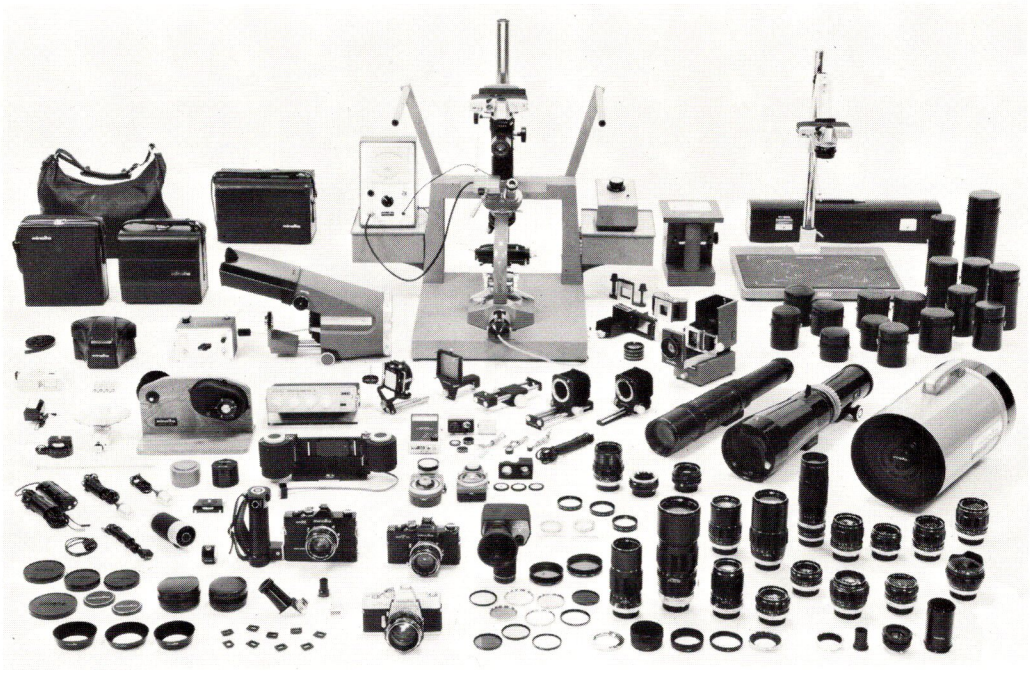
The Reflex Principle

The mirror-reflex mechanism of an advanced single-lens reflex camera is a marvel of mechanical and optical design and split-second coordination. The complete act of focusing, composing, and viewing involves three optical components: the lens used in picture-taking, the mirror used in intercepting the image created by the lens and reflecting it into a viewfinder, and the viewfinder itself. The image perceived in the viewfinder is brought to sharp focus on a viewing screen. The photographer renders the image sharp by rotating a ring on the lens barrel to the left or right while observing the effect on the viewing screen. Whatever is seen within the screen area will be recorded on the film.

The particular advantage of the reflex system of focusing is that you can use a wide range of lenses of different focal lengths on the same camera body and that you can focus with each of them over a wide range of distances from very close to very far. For focusing purposes, in comparison with rangefinder cameras, the reflex system is best with long-focus or telephoto lenses and in close-up photography. One must acknowledge that for work with extreme wide-angle lenses, rangefinder systems of focusing are superior, but for purposes of composing the total image and perceiving the lighting effects, including precise patterns of reflection and highlight, the single-lens-reflex system is superior.

When the image has been focused and composed and you are ready to take the picture, you simply press down on the shutter button. This activates a series of mechanical operations: The mirror flips up so that the image projected by the lens may reach the film plane at the rear of the camera; the lens aperture, or diaphragm, closes down automatically to a preset *f*/stop; a curtain shutter travels across the film plane for a measured interval during which the image is recorded on the film; the lens aperture returns to its wide-open, or full-aperture, position; and the mirror returns to its original position so that the image is once more seen in the viewfinder. Only for a fraction of a second is the viewfinder image blacked out.

These operational sequences are fairly standard for most SLR cameras. Differences among cameras lie for the most part in the quality of manufacture. The viewing screen of the Minolta SR cameras, for example, renders images exceptionally bright, and the reflex mirror is one of the largest found in any 35mm



A camera is a system. Shown here are lenses, exposure meters, close-up accessories, flash equipment, oscilloscope attachment, photomicrographic system, slide projector, accessories for SR-M camera, and numerous other items.

It's a grand concert by little children each of whom can no doubt be recognized by his parent, so clearly are the details rendered. 58mm Rokkor, 1/125 sec., *f*/8, Neopan SS. M. Miya.





Eilan Donan Castle, Loch Duich, Scotland. The somber Scotland sky, suggestive of a Shakespearean play, was captured in all of its darkness without a filter by Richard Gee, editor of the British magazine *Photography*. He used a 135mm lens and Ilford FP4, 1/125 sec., between *f*/8 and *f*/11. The crisp detail gives evidence of the sharp-cutting optical performance of Minolta Rokkor lenses. Gee uses a 135mm and 35mm lens set for most of his picture-taking situations, a very popular pair.

camera, in order fully to reflect all of the image for exposure-measuring purposes. Furthermore, the viewing area also functions as a control center in which the photographer can perceive all of the operational variables without having to take his eye away from the viewfinder. Through its central control function, the viewfinder serves as the means through which the optical, exposure-measuring, and exposure-taking mechanisms are all brought together in unified interaction.

The Rokkor Lenses

Each of the interchangeable lenses for the Minolta SR cameras consists of optical components within a lens barrel and three mechanical linkages to the camera. These linkages consist of a bayonet lens mount, which is designed so that the lens can be affixed to the camera body easily, yet securely; a meter-coupling linkage for camera models with through-the-lens exposure-measuring; and a diaphragm-coupling mechanism, which provides automatic opening and closing of the lens aperture in synchronization with the operations of the camera shutter mechanism. Obviously, precision is required in the manufacture of the mechanical linkages to assure that precision focusing is maintained, exposure measurements are correctly translated into lens-aperture and shutter-speed settings, and the diaphragm closes down instantaneously to the desired, predetermined aperture for each exposure.

Every camera system, of whatever make, has its own operating characteristics. It is difficult, therefore, for independent lens manufacturers who assemble lens components into the functional totality which we call a *lens* to individualize the variety of mechanical linkages that connect the spring-loaded features of the lens with the particular mechanical characteristics of individual camera systems. Independent makes of lenses of high quality are to be found, but the camera owner must determine in each case if the performance of the lens will form an integral part of his own camera system. The owner of a Minolta Rokkor lens can be sure that it was designed and manufactured specifically with the physical and mechanical attributes of Minolta SR cameras kept in mind.

The optical functions of the lens are to gather and transmit an image in the form of light rays and to project that image to the film. The light-gathering properties of a lens are denoted by an *f*/number, which is an expression of the relationship between the diameter of the lens and its focal length. These terms are explained in the next chapter. The *focal length* denotes the angle of coverage, which in turn leads to the designation of a lens as *wide-angle, normal* or *standard,* or *long* or *telephoto.*

If you have two lenses of different makes and both are designated, for example, 135mm *f*/2.8, the only thing you can deduce from this, assuming accuracy in lens designation, is that both lenses have the same light-gathering properties and the same angles of view. Performance may be quite different. Apart from the mechanical linkages, the image-forming properties of a lens are governed by its design, the quality of the glass used in manufacture, and the precision of grinding and assembling. Over the years, Minolta has itself made progressive improvements and refinements in particular lenses which continue to have the same optical designation, such as the 58mm *f*/1.4.

It is not generally known that very few of the world's camera makers have manufacturing facilities from beginning to end, for both camera and lenses. In Japan, Minolta and only one other manufacturer can claim this distinction. This is important in that a manufacturer with such integrated facilities is

able to maintain complete control over the properties of his materials and the manufacturing tolerances. It also means that any kind of glass needed by the manufacturer for use with the unique design of a particular lens can be made readily.

One of the problems in lens design is that the lens ordinarily is predisposed to project a curved image, although the film is held in a flat plane. Hence, unless otherwise corrected, sharpness in the middle is accompanied by loss of sharpness at the edges and in the corners. On the other hand, if the lens, without other correction, were to be focused for the images in the corners, the central areas would tend to be out of focus. This, of course, is an oversimplification, but it points to a problem in lens design: Lenses are usually evaluated according to the extent to which they correct for such optical defects as spherical aberration, coma, astigmatism, field curvature, distortion, and flare. Furthermore, lenses are evaluated according to their resolving power—their ability to form distinct images of fine detail—and their optical contrast, or ability to delineate sharply areas of tonal contrast so that they do not overlap each other. These terms and others will be discussed further in the chapter on lenses.

The lens designer tries to minimize each type of lens aberration and to improve optical performance at the same time. But he must compromise, for there is no such thing as total correction. Aberrations of certain kinds cannot be corrected but merely reduced for any particular lens, assuming performance at given focal distances and apertures; furthermore, correction for one aberration is not necessarily compatible with that for another type of aberration. With improvements in optical glass, however, and the availability of the high-speed computer to assist the lens designer, improvements are continually being made. As a practical matter, Minolta lens designers strive to assure even brightness from corner to corner of the image at the film plane, high resolving power, high optical contrast, faithful color reproduction, and minimization of optical aberrations and other defects that distort or soften images.

From design to finished product many steps take place which must be carefully monitored to assure that quality is maintained. From each "melt" of glass within the Minolta factory, the satisfactory portion usable for lenses is usually limited to 50 per cent: No lens components are made of glass that has bubbles or striae, for the latter in particular can cause optical distortions. In lens grinding, accurate control of curvature and thickness of each lens element must be maintained; the distances between elements and groupings must also be maintained critically; all elements must have common optical and physical axes; and each lens as a whole, mechanically coupled to its mount, must pass a standard performance test for sharpness and accuracy of focus at every aperture.

Much, much more could be said about the fascinating sequence of manufacturing operations which culminate in the aggregation of metal and glass we call the lens. Notwithstanding the closest attention to maintenance of performance standards, individual lenses will vary minutely from each other; this is unimportant, however, provided there is a standard of acceptability at the final test point, which is the case with Minolta lenses.

One final characteristic of Rokkor lenses that should be discussed is achromatic coating. All modern camera lenses, of whatever make, are coated with chemical compounds through evaporation processes in order to achieve maximum transmission (or refraction) of light and minimum reflection, which without any coating would be approximately 20 per



The limit of sharpness with Rokkor lenses generally is in the film and developing rather than in the optics. Robert Dehesdin used bounce flash on the subject while burning out the background separately for contrast. 100mm Bellows Rokkor. Agfapan 800 developed in Atomal.



Edward Steichen, dean of photography, in his country house around his ninetieth birthday. The detail in both the shaded porch area as well as in the background was possible only because the hazy bright sunlight reduced image contrast. The Rokkor 21mm lens enabled Suzanne Szasz to record the total scene as an entity while giving prominence to the foreground. Plus-X Pan.

cent. Coating reduces this loss of light and at the same time helps prevent flare and ghosting. Images become sharper and are generally improved, especially when some light in front of the lens might otherwise cause fogginess and a general softening of the image.

Minolta's achromatic coating is a double coating. It is very difficult for a single-coated lens to reproduce all colors equally well, especially when color film is used. The double layers effectively prevent reflection over the entire visible and invisible spectrum. The first coating is a deposit of antimony oxide and the second layer, thicker than the first, is magnesium fluoride. In combination, these coatings give a green cast to the lens which is characteristic only of Minolta Rokkor lenses.

One important feature of achromatic coating is that it filters out ultraviolet rays. Unless these rays are prevented from reaching the film, they give the picture a characteristically blue cast. This is due primarily to the sensitivity of color film to ultraviolet rays below the 400-millimicron, visible-blue level. A separate UV filter will eliminate the objectionable rays, but the achromatic coating of Rokkor lenses goes a long way toward producing high-fidelity color pictures under all weather conditions, serving as a filter without actually being one.

Another function of achromatic coating is to reduce flare or light scattering and fog which may cover a section of the film due to the effect of strong light reaching the lens surfaces. Flare reduction is important in both color and black-and-white photography.

Extended Capabilities of the SR System

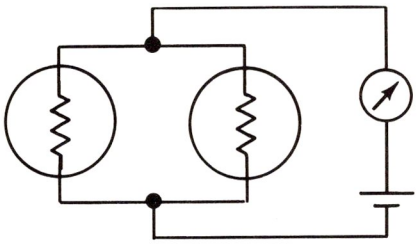
In addition to taking pictures with Rokkor or other lenses, the reflex system is uniquely adaptable to many other photographic applications. In photomicrography the camera body is attached to the eyepiece of a microscope, using the total optical system of the microscope as the source of image input for the film inside the camera. For occasional uses, the viewing system of the camera can be used by itself. In more extensive applications, separate viewing mechanisms are available, which are interposed between microscope and camera body.

One of the most common uses of the reflex camera is for taking close-up pictures. Moderate magnification of objects can be achieved through the use of close-up attachments, but for greater magnification, extension tubes and bellows extension devices are interposed between the camera and the lens.

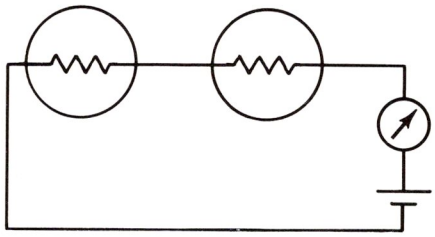
Photography through telescopic devices is also convenient, because the camera's own viewfinder can be used for focusing. The camera without lens is coupled to the eyepiece of the telescopic device.

The Exposure-Control System

The exposure-control system of a meter-coupled Minolta SR camera consists of the range of lens apertures (commonly called the *f*/stops), the range of shutter speeds, and the CLC exposure-measuring system. For any particular combination of lighting and subject matter there is one ideal exposure reading. At its simplest, this is determined by composing the subject in the viewfinder and then adjusting either the lens aperture or the shutter setting or both until a pursuit needle in the viewfinder is aligned with a pointed indicator that responds automatically to changes in light value. For unusual conditions, however, the photographer will have to do some independent thinking about how he takes his reading and whether he needs to make a compensatory setting



ORDINARY 2-CELL CDS CIRCUIT



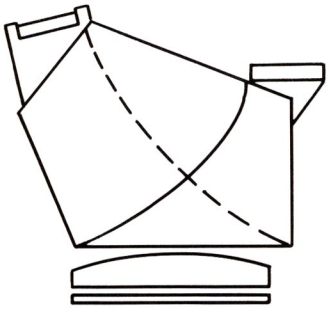
MINOLTA CLC 2-CELL CDS CIRCUIT

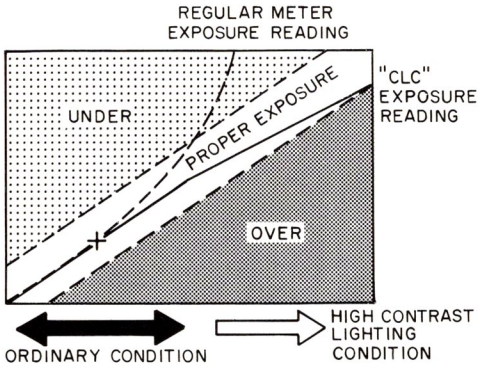
The CdS cells in Minolta CLC system are connected in series, causing each reading to be affected by the other and resulting in automatic compensation to prevent underexposure of darker area in high contrast situations. Ordinary circuitry of other cameras has CdS cells connected in parallel, causing each cell reading to be completely independent of the other and resulting in tendency to favor highlights.

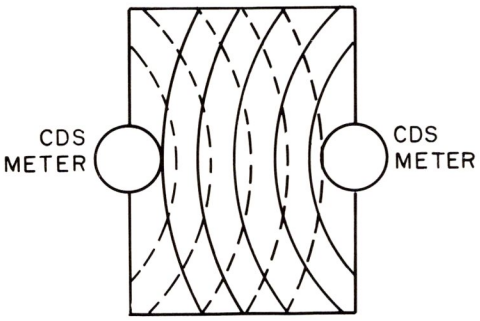
in lens aperture or shutter speed. The use of the CLC exposure-measuring system is explained in the following chapter on basic camera operations. Here, through the accompanying illustrations and diagrams as well as some supporting text, the technical concept of the CLC system is explained as part of this general presentation on the Minolta SR camera system.

Since one of the features of the Minolta SR-T system is full-aperture exposure measurement, an aperture simulator is part of the meter-coupling mechanism. Therefore, as you make changes in the lens aperture setting, the lens aperture actually remains wide open for focusing purposes, but at the moment of exposure it closes down instantaneously to the preselected aperture. In this way you enjoy the best of two worlds: While focusing and composing at full aperture you have the convenience of the full, corner-to-corner brightness of the viewfinder, even though the picture might actually be taken at one of the smallest aperture settings; then, when the actual exposure is made, the lens diaphragm automatically reverts to the widest aperture immediately after the moment of exposure.

In one way or another, all through-the-lens, exposure-measuring systems depend upon an averaging out of the light and dark image areas gathered within the total viewing rectangle. A straightforward averaging meter has the disadvantage, however, of giving false readings when there are wide ranges in contrast between important subjects, because the average represents neither extreme. With the spot-metering system, the photographer is expected to take sample readings and do his own averaging, which may be unsatisfactory when working fast. One important variation is the center-weighted system, which takes a total reading but gives added prominence to the central portion on the assumption that this is the most important for the photographer. The Minolta solution to these problems is the exclusive CLC system, which stands for *Contrast Light Compensator*. CLC meters tend to integrate highlight readings into the overall brightness range of the scene, preventing the meter from giving undue prominence to the highlights while drastically underexposing shadow details. The effect is a compensated reading, such as would be made by a competent photographer reading different sections of the scene with a separate exposure meter and according some additional exposure to the shadow areas







The two CdS cells are located on top of the pentaprism, one near the exit node and the other directly opposite. The two cells overlap each other in their reading of the total image on the groundglass. The accompanying graph shows comparative effects in reading high-contrast lighting conditions. With all exposure-metering systems, low-contrast situations provide similar exposure readings. As contrast (point "X" in graph) increases, however, ordinary CdS parallel circuit will favor bright areas, thus underexposing shadows. CLC series circuit tends to measure darker picture areas to produce realistic exposure within contrast range of film.

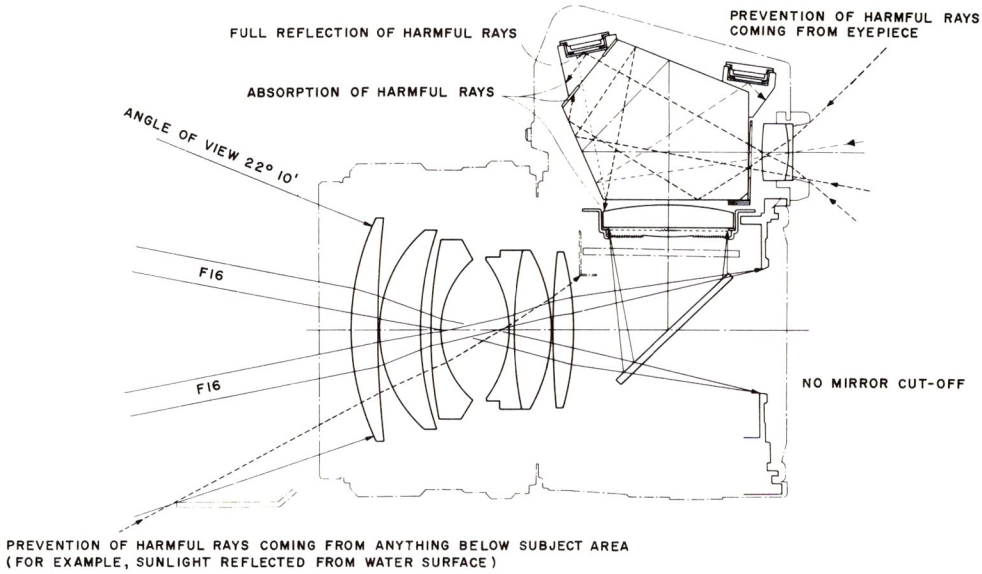
so they would come through with more detail. Of course, when the luminescent value of the scene is evenly distributed, CLC gives a mean or average reading of brightness levels in the same manner as other through-the-lens, exposure-measuring systems.

This system was designed to overcome the tendency, discovered through extensive analyses of actual picture-taking results, for photographers to underexpose shadow detail. Hence, for ordinary picture-taking, the CLC system automatically compensates for what you might otherwise overlook. For unusual conditions, the CLC system accomplishes what is done by most advanced photographers, who make their own compensated readings selectively with the assistance of an independent meter.

The CLC metering system employs two CdS (cadmium sulfide) cells mounted in the top of the pentaprism viewfinder. The metering system is programmed so that each of these cells reads a separate, overlapping part of the groundglass image and in so doing, exerts an influence on the other. If one cell reads too much contrast, it is suppressed somewhat in this reading by the action of the other cell.

In addition to achieving proper balance between highlight and shadow, there are additional mechanical design features that help prevent unwanted light from affecting the reading. For example, to compensate for the fact that the corners of a viewing screen tend to

become darker when the aperture is open wide, a common problem with all lenses, all Minolta MC lenses are designed to insure accurate exposure measuring by being given a vignetting correction.



An important feature of Minolta camera design is the elimination of unwanted light entering either the lens or the viewfinder eyepiece. Unwanted light entering the lens causes image impairment, particularly through the condition called flare. Light rays entering the eyepiece can affect the exposure reading and adjustment. This diagram shows the mechanical configuration of the SR-T 101 designed to minimize entry of harmful rays and to absorb them where they have passed into the viewfinder system.

SOME BACKGROUND ON MINOLTA

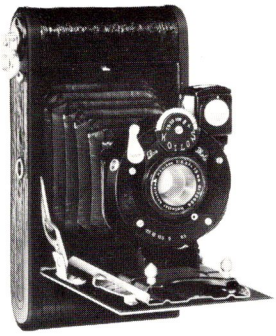
The principle purpose of this section is to review the developmental history of Minolta SR cameras, particularly for the benefit of those photographers who still have and use earlier models. For the benefit of camera buffs, collectors, and antiquarians some of the interesting landmark cameras in Minolta history will also be displayed, mainly through illustrations and captions. In this section, also, some additional background will be included with respect to the Minolta factory operations and related industrial and camera products.

A Brief History of Minolta

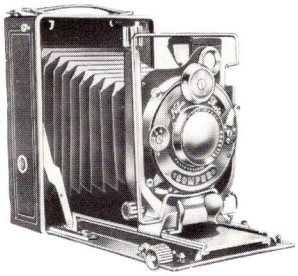
In 1928 Mr. K. Tashima, the original founder of what is the present Minolta Camera Company, established a small company called Nichi-Doku Camera Shokai. The English translation of this name was Japan-Germany Camera Company. This was an indirect testimonial to the pre-eminence of Germany in photographic and optical manufacturing at that time. Mr. Tashima imported his lenses and shutters from Germany, but other camera-body parts were made in



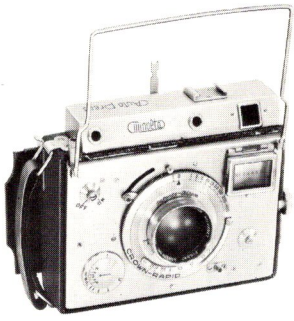
Actors relaxing on location in Sweden with film director Mai Zetterling. Graham Finlayson used a 35mm lens at *f*/4, with a small flash bounced off ceiling mixed with daylight from windows. This light combination froze the action and illuminated the scene evenly.



First of the Minolta cameras in 1929 was the Nifca, which used German optics and shutter.



The roll film model was followed in 1939 by production of the then-popular view-type camera with groundglass for cut film and film packs.



A sophisticated press camera of 1937 with built-in rangefinder, flash synch, and German optics and shutter, the Auto Press replaced earlier models, which featured Zeiss lenses.

his own factory, using machines imported from Switzerland, France, and Germany. By 1929 he was able to bring to market his first Minolta camera, which was called the Nifcalette. It used number 127 roll film and had a 75mm *f*/6.3 lens, which was rather fast for the day.

Two years later, in 1931, the company was established as a joint stock firm under the name of Molta Company with the trademark MINOLTA. As the company's first factory was set up in the Osaka countryside, surrounded by rice fields, Mr. Tashima adopted the name *Minolta,* because it means "ripening rice fields." Behind the rice fields was a mountain called Rokko, so in deference to it, Minolta lenses were named *Rokkor.*

In the years following, the company prospered and expanded. In 1937 it was reorganized as Chiyoda Kogaku Seiko Co., Ltd., and a new plant was estab-



Last of the highly reputed Minolta-35 series, which, with their Leica-thread interchangeable lenses and focal-plane shutters, were the predecessors of the SR series. First of the Minolta-35 series was produced in 1947.



In 1957 the Minolta Sky was designed as one of the most advanced cameras of its type to replace the Minolta-35 series. It boasted intermediate focal-plane shutter speeds, life-size view/rangefinder, and automatic parallax correction. Minolta never produced this one; instead, it committed its facilities to production of the SR series.



The extensive line of Minolta cameras includes fixed-lens rangefinder cameras, twin-lens reflex cameras, and subminiatures. Shown here are the popular Minolta Autocord with CdS meter, the Minolta Autopak-8-D10 movie camera, and the Minolta 16-MG-S subminiature camera.

lished for body assembly. Five years later an optical plant was established, enabling Minolta to manufacture its own lenses and to assemble them into the final camera in their own factories. After a rather quick recovery from the damages of World War II, Minolta brought out Japan's first postwar camera in 1946—the Minolta Semi III, another folding camera which made 16 exposures on number 120 film using a Rokkor 75mm *f*/3.5 lens. That same year another plant was established, and a long term expansion plan was inaugurated. Then followed a series of important events for Minolta. In 1957 the company produced Japan's first planetarium. In 1959, it expanded into the production of industrial projectors and office copying machines. The year 1962 was a very important one for Minolta: It was then that the SR-7 was introduced as the world's first still camera with a built-in CdS light meter; America's first space flight, the Friendship 7, honored Minolta by using the Hi-matic camera; and in that year, too, the firm name was changed to Minolta Camera Company, Ltd.

Nineteen sixty-six was the year in which the SR-T 101 was introduced after eight years of experience in the marketing of SR cameras. Two years later, 1968, when Minolta was 40 years old, the Minolta Space Meter was carried by Apollo 8 astronauts on man's first trip around the moon. In 1969, Apollo 11 carried the Space Meter to the surface of the moon. The SR-T 100, a simplified version of the T 101, was introduced in 1971.

Today, Minolta operates in five plants, which produce a variety of lenses, cameras, and business machines. The most sophisticated of manufacturing processes are used, as evident in the procedures followed for the manufacture of lenses and cameras. It is actually more difficult to make a fine camera than a microscope or telescope. All are delicate, precision instruments, but only the camera gets hard and often brutal use and is expected to perform satisfactorily nonetheless. A camera must therefore be built to withstand the knocks and shocks of years of travel and bumping.

Minolta designs and makes not only the machines that make the delicate parts, but sometimes it also makes the machines that make the machines! Manufacturing tolerances are tinier than the



SR-2. First of the Minolta SR cameras featured automatic diaphagm, quick-return mirror, shutter speeds to 1/1000 sec. October, 1958.



SR-1. Similar to SR-2 except that fastest shutter speed was 1/500 sec. July, 1959. Later model, August, 1960, introduced non-rotating shutter dial. The following year, depth-of-field preview button incorporated.



SR-3. Replacement for SR-2 featured detachable selenium-type coupled exposure meter. August, 1961.



SR-7. Replaced SR-3, featured first built-in CdS meter mechanically coupled to shutter. July, 1962.



SR-1 with detachable CdS-type exposure meter, microprism focusing; otherwise same features as preceding SR-1. 1965.



SR-7 Model V. Redesigned body, lighter and more compact. May, 1965.



SR-1 Model V. Redesigned body, lighter and more compact. May, 1965.



SR-T 101. First of the current line of SR-T cameras featuring through-the-lens exposure measurement. Matching MC lenses. Accessory shoe attached. 1966.



SR-1s. Moderate-priced alternative to SR-T 101 featured detachable CdS meter. Last of the SR-1 series. 1967.



SR-M. First of Minolta's motorized cameras featuring built-in motorized film advance and rewind, remote shutter control, power supply in handle. Professional model without exposure meter. 1970.



SR-T 100. Similar to SR-T 101 in all respects except top shutter speed 1/500 sec. instead of 1/1000, no mirror lock-up, no self timer. 1971.

mind can grasp. Some of the machines have been designed to detect their own mistakes and bring attention to them by stopping and ringing a bell to call an attendant to the trouble spot. In spite of all, Minolta doesn't trust the machine implicitly. Before each new part enters the assembly line, it is microscopically tested by people. The magnitude of all of this can be imagined when you realize that into an SR-T 101 camera go 1,057 individual body parts. And then there are the lenses.

How to Use This Book

This book has been designed as a mixture of complete information about the features and operating characteristics of Minolta cameras, lenses, and equipment, with practical information on the fundamentals of picture-taking. Some chapters are procedurally oriented, such as the following chapter on basic camera operation and the one on operating techniques in connection with the use of close-up equipment. The chapter on lenses is mainly reference-oriented, for, apart from introductory presentations on the uses of different categories of lenses, it contains reference information pertaining to each Minolta Rokkor lens. Other chapters combine information on photographic principles and techniques with explanations of the use of relevant Minolta equipment. An example is the chapter on motorized picture-taking; another is the chapter on principles of exposure, which also includes information on the specialized Minolta exposure meters.

The book contains three types of pic-



By shooting against the light, Lucien Clergue picked up the shadows coming toward camera, creating feeling of depth in addition to interesting pattern. 200mm lens, Plus-X, *f*/16, 1/125 sec.



The soft overhead light reduces the contrast between objects in shade and open background. The traveler will find many opportunities to record interesting details of people, places, and things. 55mm lens, Kodak Tri-X. Joseph D. Cooper.



The awesome majesty of the sea and the weather are conveyed in this difficult light picture of a beach during a Japanese winter. 55mm, *f*/11, 1/250 Tri-X. K. Fujie.

Brooklyn Bridge at night. With a fast lens, 58mm *f*/1.2, and a fast film, Kodak Tri-X, hand-held pictures can be taken under an extremely wide range of lighting conditions without the use of auxiliary lighting and camera supports. Francisco Hidalgo.

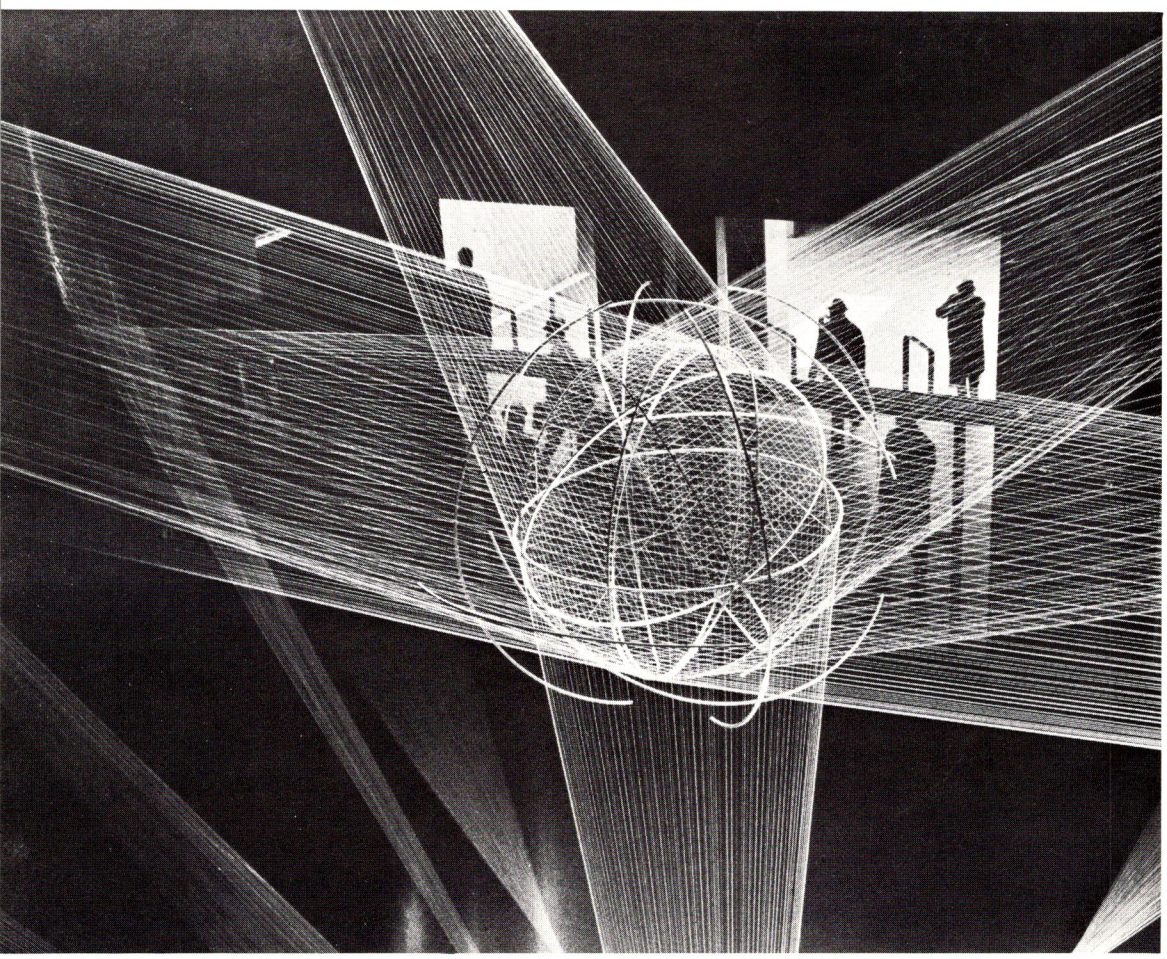


"Sorry, wrong number," was the caption given by Al Paglione of the Hackensack, New Jersey *Record*. Woman desperately needed to make call and was assisted by policeman at overturned telephone booth. 28mm lens enabled photographer to work close and get in essential details. Tri-X.

tures: equipment illustrations to display Minolta equipment and its use; comparison pictures that show effects such as those obtainable with different lenses or in different types of lighting; and pictorial illustrations, mainly by accomplished photographers, which bring out the effects that can be achieved with Minolta equipment under a great variety of conditions. The illustrations are intended to convey, through the combination of image and words, information that would be difficult to convey through words alone.

The chapter on basic camera operations goes beyond the mere description of such familiar steps as loading and unloading the camera and focusing. In fact, this chapter is intended to be used as a small guide in itself to the handling and care of camera equipment under a variety of conditions.

The chapter on image management is an introduction, in effect, to the use of lenses and to the interaction among such variables as photographer, lenses, picture-taking distance, angles of view, placement of objects within the picture area, and lighting. The chapter starts with a discussion on the differences between how you see with eye and brain and how the camera sees with the fixed capabilities of lens and film. Aside from dealing with the problems of lighting and exposure in greater detail, this chapter is another fundamental unit, which explains how to take pictures with a diversity of lenses.



Wire sculpture, Pan Am Building, New York. Subjects in background silhouetted by light from rear. 28mm, Tri-X. Stuart Davis, Hackensack *Record.*

The chapter on fundamentals of exposure goes beyond the procedural description of the use of the CLC exposure-measuring system, which is covered in preceding chapters. Rather, the chapter on exposure is another fundamental presentation of the interplay between light, film, and filters, among others.

These are anchor chapters. Others treat specialized aspects of photography with Minolta equipment or serve as expansions on particular topics.

Since the pictures included in this book were selected as amplifications of text, the reader is urged to study them and their captions in that light. From time to time, supplements to this book will be issued to describe new equipment and its use and to expand upon particular aspects of photographic techniques.

CHAPTER II

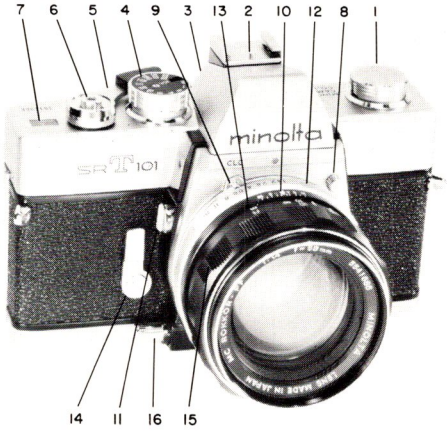
Basic Camera Operations

This chapter covers the basic manipulative procedures applicable to current Minolta SR cameras. Most of these also pertain to earlier, presently discontinued models, although there are some differences in film loading and the acceptability of interchangeable lenses, along with minor changes in the design of camera details. The operation of the motorized control of the Minolta SR-M is covered in the separate chapter on motor camera operations.

The operating procedures pertinent to the camera itself covered in this chapter include the movement of the film into and out of the camera, lens interchange, focusing and viewing, and exposure controls. In addition, this chapter covers recommended procedures for holding and supporting the camera, making exposures, use of various lens attachments, care of camera and lenses, and management of problems such as the weather, storage, and travel.

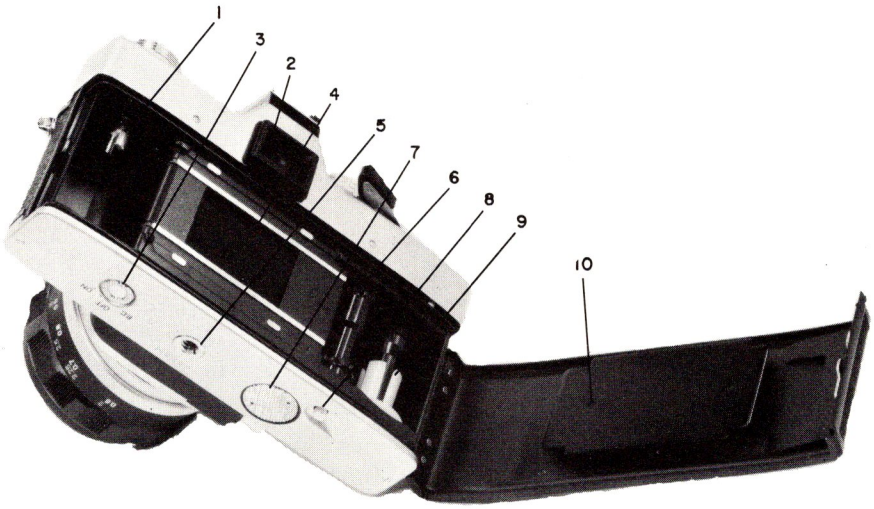
Features of the SR-T 101—front view.

1. Film rewind crank and back cover release knob
2. Accessory shoe
3. Pentaprism
4. Shutter and ASA speed dial
5. Film advance lever
6. Shutter release button
7. Frame counter
8. Lens release button
9. Meter coupler
10. Depth-of-field scale
11. Mirror lock-up button
12. Diaphragm ring
13. Distance scale
14. Self timer lever
15. Focusing ring
16. Diaphragm stop-down button



FILM OPERATIONS

The procedures pertaining to film in the camera cover loading, indexing the film through the exposure-metering system, advancing the film progressively for each exposure, and then unloading the film. In addition to these basic details, most of which are fundamental to all sophisticated camera operation, a number of small points related to individual variations in camera usage will be discussed. The running text will treat the procedures in summary, relying upon illustrations and captions for more detailed explanations. Also, the running text will cover the handling of special situations.



Features of the SR-T 101 and SR-T 100—back cover open.

1. Rewind shaft
2. Finder eyepiece
3. Battery switch
4. Focal-plane shutter
5. Tripod socket
6. Sprocket
7. Battery cover
8. Film rewind button
9. Film take-up spool
10. Film pressure plate



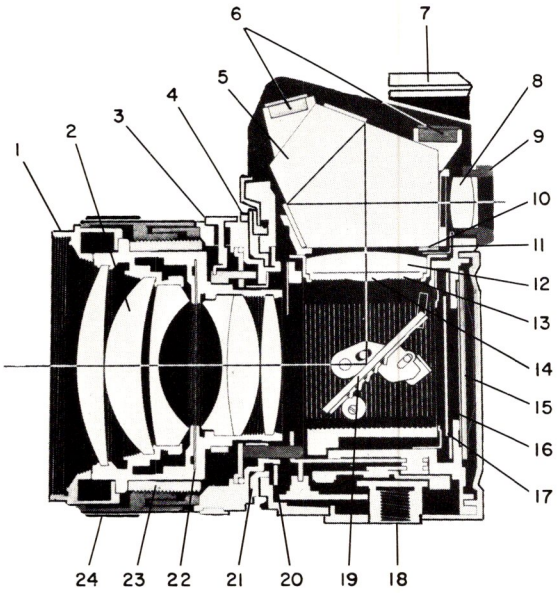
Black "pro" model of SR-T 101, identical otherwise to regular model.



SR-T 100. Identical to SR-T 101 except for absence of 1/1000 sec., mirror lock-up button, and self timer.



SR-T 101, identification of "FP" (1) and "X" (2) Terminals.

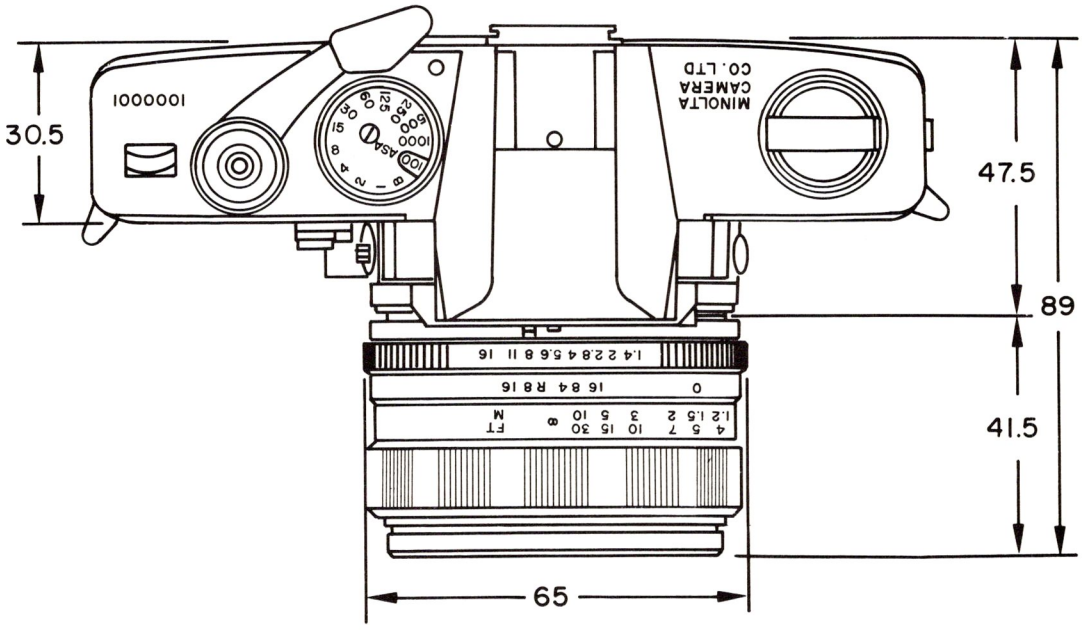


Cross section of camera showing both external and interior parts and optical light path.

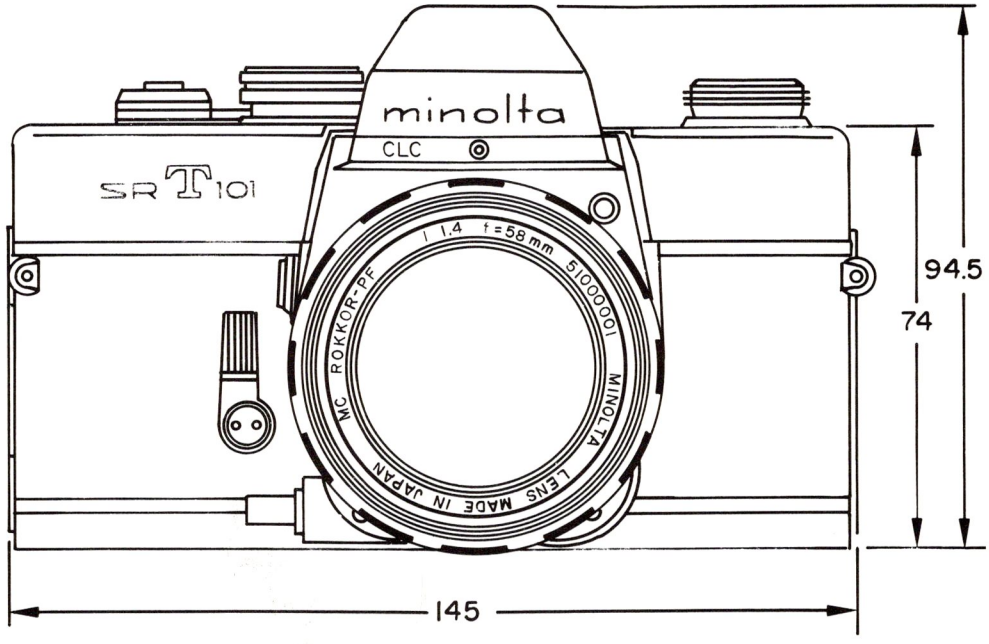
1. Filter mounting screw
2. Lens
3. Diaphragm ring
4. Coupler
5. Pentaprism
6. CdS cells
7. Accessory shoe
8. Finder eyepiece
9. Eyepiece frame
10. Shutter speed scale
11. Shutter speed indicator
12. Condenser lens
13. Fresnel lens
14. Fine microprism
15. Film pressure plate
16. Film
17. Focal-plane shutter
18. Tripod socket
19. Reflex mirror
20. Automatic pre-set pin
21. Lensmount
22. Diaphragm
23. Helicoid
24. Focusing ring



Oversized instant return mirror prevents image cut-off and incorrect exposure readings even with longest focal length used.



Outer dimensions, mm, of SR-T 101 and 100.

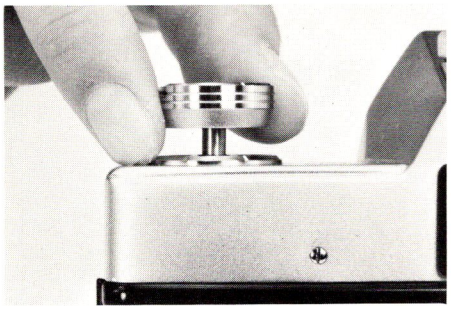


Film Loading

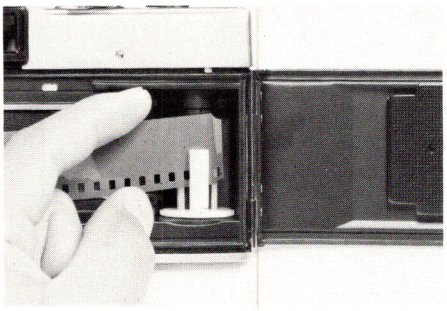
First, open the camera back by pulling up the rewind knob until the back pops open. When loading film, you can lock the film magazine in place in the film chamber as a first step or, alternatively, you can insert the film leader into the slot of the film take-up spool as a first step, whichever you prefer.

If you start by inserting the film leader into the slot of the take-up spool, you

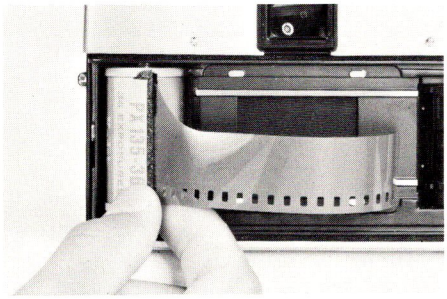
Sequence of steps for loading film and preparing for first exposure.



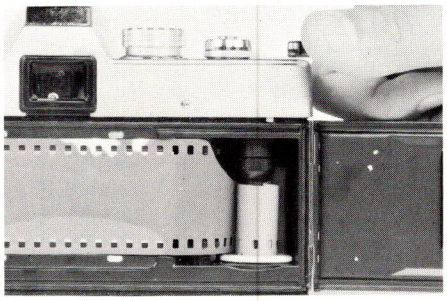
To open camera, lift knob until resistance felt, then pull a little more until back cover pops open.



Insert film leader in slot of take-up spool.



Put magazine into film chamber, and push back cover release knob down all the way.

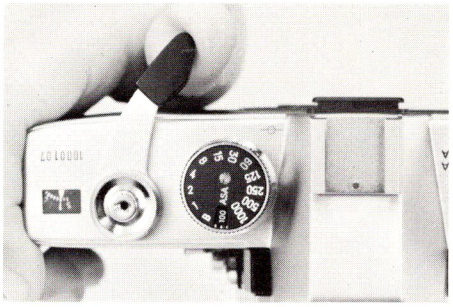


Operate film advance lever in several short strokes until film is wound firmly around take-up drum and both sides of film perforations are engaged with teeth of sprocket gear. When film advance lever locks, press shutter release button and continue.

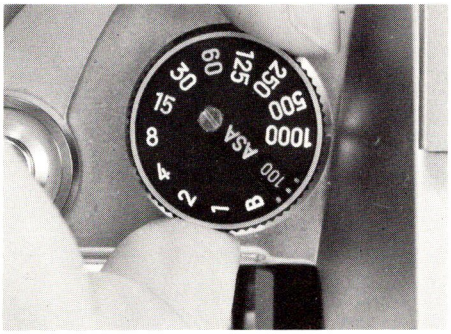
should first have drawn out enough film leader from the film magazine to cover the distance between the film chamber on the left and the take-up spool on the right. Then, when you clear the film chamber by raising the cover-release knob, the film magazine can drop neatly into place. If, on the other hand, you start by locking the film magazine into the film chamber, you simply pull the film leader across the back of the camera until a short length can be fitted into a slot of the take-up spool.

The film should be advanced across the back of the camera until both sides of the film perforations are engaged by the teeth of the sprocket gears. Advancing the film is accomplished by alternately operating the film advance lever and pressing the shutter-release button. Once the film perforations mesh with the sprocket teeth, the camera back can be closed if the open edge of the film magazine presses snugly against the back of the camera and the film lies flat. If, however, there is too much slack or buckle in the film, you may eliminate this by gently pushing the excess film length back into the film cartridge. In any event, after closing the camera back, rotate the film-wind crank gently in the direction of the arrow to pick up any remaining slack.

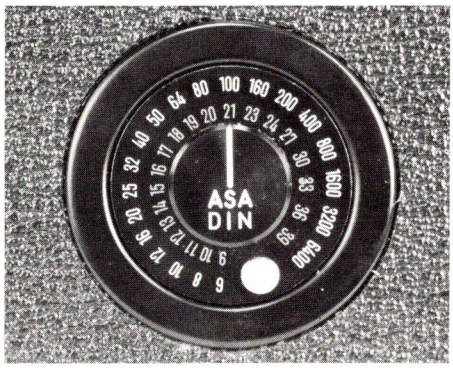
With the camera back closed, the film is advanced until the number "1" appears in the frame-counter window. The shutter release is not pressed again until the first frame is to be exposed. When shooting black-and-white film, some photographers who do their own developing and make contact sheets from the negatives may leave the lens cap on and make a single blank exposure for frame number "1." This enables them to write



Snap camera back shut, then advance film, and press shutter release button until "1" appears at arrow in window.



Set ASA film speed on shutter speed dial. Lift spring-tension dial until desired ASA rating appears opposite center mark of window.



ASA/DIN conversion scale on back of camera can be used to convert from American film ratings to European or vice versa. Turn knob of dial until known film speed appears opposite white pointer. Inner gradations are DIN.

an identification of the roll on frame number 1, which will then appear on the contact sheet. This is of no use when making color slides.

Film Indexing

On camera models having built-in exposure controls for through-the-lens metering, the film speed (exposure index), or sensitivity rating, which is usually stated on the film box or in the accompanying instruction sheet furnished with the film, must be indexed into the shutter-speed dial. The sensitivity rating of the film is usually called its *ASA* rating. (*ASA* was originally derived from the initials of the former American Standards Association. The initials ASA are being superseded by ANSI, short for American National Standards Institute.*) The German equivalent is referred to as the *DIN* rating (from Deutsche Industrie Norm). A conversion scale on the outside of the camera back shows the corresponding ASA and DIN ratings or speeds. The terms *film speed, film rating, film sensitivity rating, exposure index, ASA rating,* and *DIN rating* all refer to the same thing.

By aligning the appropriate ASA or DIN rating with the white pointer line located just above the letters "ASA" on the conversion scale, you'll have a reminder of the sensitivity rating of the film in the camera. This is an optional step. For through-the-lens exposure coupling, however, it is important to index the film rating on the shutter-speed dial by lifting and rotating the dial until the number corresponding to the rating appears in the little window opposite the letters "ASA." Intermediate ratings are indicated by dots. These can

* Until the ANSI terminology becomes a more generally accepted part of equipment notation, the designation *ASA* will be used in this book.

be mentally approximated. Their exact equivalents are given in the accompanying table.

The film rating you use would ordinarily be that given by the manufacturer unless special development procedures are used to push exposure. This is frequently done with black-and-white films as well as with certain color reversal (color slide) films. Some photographers will also overexpose their black-and-white films by assigning a slightly lower film rating to them and compensate by underdeveloping slightly. Whatever the case, the desired film rating, whether official or personal, is the one to index into the shutter-speed dial.

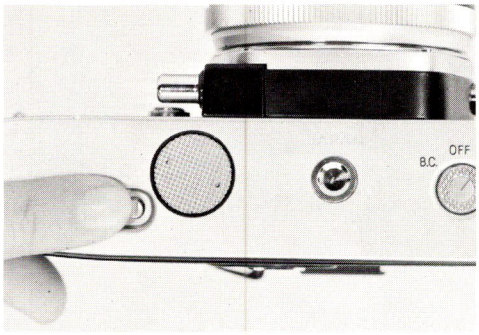
To avoid error caused by the need for changing the film ratings for different kinds of film, some photographers will standardize their operations so that they adhere to a single film rating. This is more easily done when standardizing on either color or black-and-white, but when both are used, one must be particularly careful. Again, some photographers who standardize on black-and-white films rated at ASA 400 will assign a personal rating of 400 to a film such as High Speed Ektachrome, which then must be specifically marked for development at that rating.

If you put a camera away with film inside, label it conspicuously to identify the kind of film. You are less likely then to inadvertently open the back and, if you use both black-and-white and color at the same film ratings, you'll know what is in the camera.

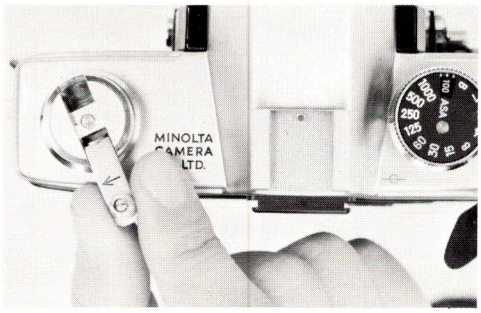
Film Advance

After each exposure the shutter release is automatically locked. Before making another exposure, you must advance the film by activating the film-advance lever. It may be turned to the right as far as it will go in a single stroke or activated in two or more short strokes. In either event, the lever will come to a dead stop, indicating that the film advance has been completed. As the film is advanced, the rewind crank will rotate in the same direction as the forward movement of the film. This serves no particular function but does provide reassurance that the film is actually advancing. Ordinarily, the film should not be advanced unless you expect to take another picture at that particular time. If the film has been advanced and the exposure is not made, the shutter will automatically remain in a cocked posi-

To unload film, depress rewind button on base of camera; if it does not remain depressed when you remove finger, follow instructions below.



Lift rewind crank and turn clockwise. Ordinarily, you will encounter slight resistance when film is being disengaged from take-up spool. If firm resistance is felt while rewinding, *do not force rewind crank.* This is probably due to accidental release of rewind button on base of camera. Hold button depressed while rewinding film two revolutions. Then, actuate film advance lever one full stroke without depressing button. Now, procedure can be started all over again as explained above.



tion until the next picture is made, which could be hours, days, weeks, or months. The only real hazard in this is that it puts constant pressure on the shutter spring, which may fatigue it over a long period of time.

When the last exposure has been made, whether on a 20-exposure film magazine or a 36-exposure magazine, you might know this from visual inspection of the film counter. If, however, you are shooting merrily away with the camera at your eye, you will also know that the end has been reached because you will not be able to complete the film advance stroke; also, the shutter-release button will remain in a locked position. *Do not force the film advance.* Press the release button at the base of the camera as shown in the accompanying illustration, and rewind the film into the film magazine. If you do not do your own developing, rewind the film completely into the magazine so that nothing protrudes. In theory the felt light trap of the film magazine provides maximum protection when a length of film protrudes from the film magazine. Actually, in the ordinary handling of the film magazine with protruding lengths of film, the tugging or other displacement that might occur could cause light to leak in more readily. The leader should be allowed to protrude only when you wish to do your own developing and (1) you wish to make a temporary or permanent notation on the end of the film leader for identification purposes or (2) you need to have a protruding length of film to use in a daylight-loading tank. To make sure you have a protruding film leader when you have rewound the film, listen carefully as you rewind for the sound of the film leader disengaging from the take-up spool; then stop rewinding.

LENS INTERCHANGE

This section discusses the attachment of lenses to Minolta SR camera bodies. It covers current meter-coupled lenses, designated as "MC," older lenses, which are not meter-coupled, and the acceptability of lenses other than those made by Minolta.



Frames lost because exposed to direct light when camera back opened with exposed film on take-up spool.

Procedure for Interchanging Lenses

Lens interchange is independent of shutter operations and of the presence or absence of film in the camera. The Minolta camera has its own bayonet lens mount. You attach lenses simply by lining up the red dot on the lens barrel with the red dot on the camera body and turning the lens clockwise until it comes to a "click" stop. Remove lenses by pushing the lens-release button down and rotating the lens counterclockwise until it stops and the lens can be lifted out freely. Meter-coupled lenses are automatically engaged to the mechanical linkage of the exposure-control system without further action on the part of the photographer.

A bit of personal routine or technique will be needed to accomplish the simple task of handling two lenses securely, one of which is to be attached and one of which is to be removed, without risk of damage. There is no problem whatever when you are working at a desk or table, but when you are without such a solid support, standing or sitting, just a bit of juggling will be needed. If you have a gadget bag, you should first remove the rear lens cap from the replacement lens. With the lens remaining in the bag, you can attach the rear lens cap to the lens taken off the camera. Then, the new lens can be attached to the camera body, as previously described. When putting a lens on a table, the front of the lens should rest on its surface, so as not to put any pressure on the diaphragm pin at the rear of the lens.

Avoid touching the surfaces of the lens, front and rear, during handling. Do not leave the bayonet socket of the camera open for any longer than is necessary to insert another lens. Otherwise, dust may collect on the mirror and in the shutter mechanism. If the camera body is to be left without a lens, a body cap should be inserted in the same manner as a lens.



Lens change is independent of whether film is in camera or shutter has been cocked. To remove lens, push release button down and rotate lens counterclockwise until it stops and can be lifted out. Note that red dot on lens top appears under red dot in front of pentaprism. This is guide for positioning of lens to be mounted on camera. Turn lens clockwise until it stops with a click. When removing lens from camera and setting it on table, front of lens should be facing down. *Never rest lens on its unprotected rear (unless rear cap attached), for this can damage diaphragm control pin.* If lens is left removed, replace with body cap to protect insides from dust.



Lens Compatibility

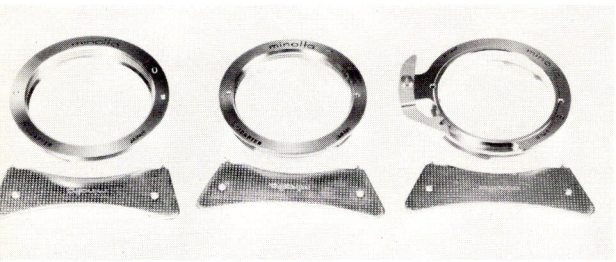
Only those Rokkor lenses having the designation *MC* will link to the built-in exposure-control systems of Minolta SR-T cameras. Rokkor lenses originally manufactured for use with older Minolta SR camera models will, in most cases, fit SR-T models, but they will not have full-aperture meter coupling. They must be used with the stop-down method of exposure measurement described below. Some lenses made for earlier Minolta SR models might not fit current models. There is no certain way of listing all the lenses which fit and do not fit inasmuch as variations were made progressively in the design of the diaphragm controls. When attempting to use older lenses with current camera bodies, check to see that the diaphragm opens and closes smoothly when the diaphragm ring is turned.

Accommodating Other Makes of Lenses

Independent makes of lenses are available for leading single-lens reflex cameras including those made by Minolta. These may vary widely in quality of both optics and lens mounts. If you plan to use such a lens with your Minolta SR camera, make sure that it has meter coupling as well as an automatic diaphragm. Even though it has the automatic-diaphragm feature, there is always some risk that the linkage between the diaphragm-control mechanism of the lens and the shutter-release mechanism of the camera may not be as positive as in the case of lenses designed specifically for your camera. Hence, it is important that you test the performance of any independently made diaphragm-coupled lens or accessory before you actually buy or put it into use.

Lens Mount Accessories

Several different accessories, other than lenses, are designed for attachment to the bayonet-mount receptacle. These include extension tubes, bellows extensions, microscope adapter, and oscilloscope adapter. They are attached and removed in the same manner as lenses. Some independent makes of extension tubes are available which provide direct coupling to the automatic-diaphragm control. As with independent makes of lenses, these might be satisfactory, but there is always some risk of slippage in the successive linkages, so the lens diaphragm might not close down fully before the shutter curtain moves. If independently manufactured accessories are used, the photographer is advised to make actual exposure tests with the extension devices as well as with a diaphragm-coupled Minolta lens at the equivalent lens aperture to determine whether there is any difference in exposure.



Adapters to permit use of other lenses on Minolta SR bodies; left to right: Pentax/Practica thread adapter, Leica screw-type adapter, Exakta adapter. Using small wrenches shown here adapters are locked into Minolta lens mount after which they can accept indicated lens type. To remove adapters, push lens release button and use wrenches to turn adapters counterclockwise. Meter and diaphragm coupling not applicable. Leica-type lenses will focus within limited range.





Suzanne Szasz photographed school children indoors by existing light with standard 58mm lens wide open at *f*/1.4. Kodak Tri-X rated at ASA 800.

Focusing and Viewing

The ability to focus easily with a wide variety of lenses on subjects close to or far from the camera is one of the chief attractions of the single-lens-reflex system of photography. Sharpness of image is only one advantage. The other great advantage is that you can also use the viewing screen for composing the image both from edge to edge and in depth. At their simplest, viewing and focusing consist of pointing the camera toward the object of interest, rotating the lens mount until the image is perceived sharply on the focusing screen, which is seen through the viewfinder eyepiece, and making adjustments in shooting angle so as to capture the desired image area to best pictorial advantage. There are, however, focusing aids and special viewing accessories that enable you to go beyond the limitations of the unaided eye. Then, too, one should use the variable focusing characteristics of the lens in order to control selectively the sharpness zones of the picture. These various elements are taken up below.

Screen Focusing

When you look through the eyepiece at the viewing screen, you will observe three distinct areas: a center spot composed of very fine microprisms, a fine groundglass collar surrounding the center spot, and over the rest of the viewing screen a very fine Fresnel lens made up of concentric circles spaced close together. Each area serves a different purpose in focusing.

The standard focusing screen has a conventional groundglass with center microprism consisting of many diagonal lines. To focus, you turn the lens clockwise or counterclockwise until the blurred image seen at top is rendered sharp.





The central microprism spot is used for quick focusing with most lenses, although there are some minor exceptions. When you focus with the microprisms, the target image will appear to snap into critical focus or maximum sharpness when the microprism or diamond pattern becomes least obvious and when the target image itself appears to be sharply delineated and smooth. When the target image is out of focus, you will observe a double or rapidly vibrating image.

With certain long lenses a darkening of the microprisms may interfere somewhat with focusing. In that case, the surrounding groundglass collar should be used. This phenomenon, common to all reflex-camera systems, is caused by the inability of the microprisms to accommodate extreme angles of view or small lens apertures without darkening. As a practical matter, lenses through 200mm at full aperture can be used, although there is the slightest suggestion of darkening with the 200mm lens. The 300mm lens can also be focused with the microprisms, but a slight patterning will be observed even at full aperture. With extension tubes or extension bellows, this darkening will be observed and, as with the longer focus lenses, focusing should be done with the clear, groundglass collar.

The groundglass collar is particularly useful for focusing detailed subjects, although the microprism center spot is to be preferred for continuous, smooth surfaces or textures without delineating contours or lines. The Fresnel portion of the viewing screen can also be used for focusing, although its principal use is to increase overall image brightness into the corners of the screen. The total surface of the focusing screen should be used when composing for depth of field (as explained below), particularly when you wish to observe effects to be achieved at the aperture to be used in actual exposure.

It is usually not possible for everything in the picture area to be equally sharp unless something flat is being photographed or if objects are very close together. In general, the purpose of focusing is to bring into greatest sharpness those objects most important in the picture, although sometimes a creative photographer may deliberately want important parts of a picture to be out of sharp focus. Focusing is done by turning the distance scale ring of the lens, while looking through the viewfinder, until the object is seen most sharply and clearly. A typical procedure in reflex-camera focusing is to rotate the lens in either direction while narrowing the focus down carefully to the point of sharpest image delineation. With a little practice you can tell just how much to rotate the lens to accomplish this.

Since viewfinder focusing is done with the lens aperture fully opened, you may want to see actual depth of field as it will be recorded on film. This is easily done by depressing the preview button on the camera body next to the lens, after advancing the film. Doing this automatically stops the lens down to the preset aperture. The preview button must be pressed in again to restore focusing at full aperture. Some lenses have their own spring-activated aperture control. Removing finger pressure from the lens control returns the lens diaphragm automatically to its open position.

With lenses that have preset diaphragm controls, operated manually, there are two control rings for the lens aperture. The preset ring acts as a mechanical limit to how far you can turn the diaphragm ring on the lens. In practice, you turn the preset ring to the desired *f*/stop. Then, you turn the diaphragm ring to the right to the widest lens aperture for focusing. When you stop down the lens aperture, by turning the diaphragm ring to the left, it will not turn beyond the desired *f*/stop.

A useful feature of the Minolta SR





Above, Rokkor 100mm, *f*/5.6, 1/125 sec., Konipan SS (ASA 100). Right, M. Kawamoto. Probably standard lens, *f*/5.6, 1/125 sec.

A low shooting viewpoint emphasizes foreground and subordinates objects beyond. A high viewpoint covers ground in depth, particularly important when you wish to show activity of people at various distances from camera.

K. Aeba. Rokkor 55mm, *f*/8, 1/60 sec., Neopan SS (ASA 100).



viewfinder is the 1:1 ratio between the size of image details on the viewing screen and those of the real subject or scene when using a 58mm normal lens at infinity. The enlarged details make it easier to focus; moreover, you can sight the subject with both eyes open—one looking through the eyepiece and the other looking at the open scene without discomfort. The practical value is in being aware of adjacent areas, which can be important in action or sports photography.

The viewfinder reveals 94 per cent of the picture area. The missing six per cent is the equivalent of the area covered by the edges of a slide mount. Of course, that six per cent is actually recorded on film and is available for print-making from negatives and from color transparencies in strip form or removed from their slide mounts.

Focusing and Viewing Aids

Eyepiece correction lenses are available for use by farsighted and nearsighted individuals. These lenses fit into the slot provided in the camera eyepiece. They are available in nine strengths from +3.0 to −4.0 diopters. The person who prescribes your eyeglasses will tell you what correction you need. The correction should be for the particular eye you will use in focusing and viewing, since there may be differences between the two eyes.

A soft *rubber eyepiece,* which fits over the camera eyepiece, is an optional accessory to assure more rapid and accurate focusing control by conforming precisely to facial contours around the eye and blocking stray light.

The *Magnifier V* is an aid to critical focusing when doing close-up work and

Check List of Factors Causing Unsharp Pictures

1. **Dirty lens:** Fingerprints worst offender; blow or brush off dust; use lens cleaner and tissue sparingly; don't overlook cleanliness of rear lens element.
2. **Stray light:** Flare caused by bright light source striking lens; minimize through use of lenshood when light off to side.
3. **Inferior lens:** Use Rokkor lenses designed for camera; substitutes only if high quality.
4. **Improper use of lens attachments:** All lens attachments add reflective surfaces, but picture quality not affected with single attachments, except where focus may shift with dark filters; avoid combinations of more than two filters and close-up attachments; with deep filters or strong supplementary close-up lens, focus by stop-down method; keep attachments clean.
5. **Mis-alignment of lens:** Usually a matter for repair service.
6. **Focusing error:** Usually due to poor eyesight and focusing under poor light conditions or both; check need for eyepiece correction lens.
7. **Camera movement:** Very difficult to avoid other than through use of fast shutter speeds hand-held or tripod (or other solid support) with slow shutter speeds. Hand-held limits of safety for most lenses 1/125 sec., but with lenses 200mm and longer, faster shutter speeds advised; slow shutter speed limits governed by surrounding movement and vibration and, for hand-held, own physical condition.
8. **Flat lighting:** Appearance of sharpness enhanced by side-directional bright-source lighting which brings out textures and contours through casting shadows; impression of unsharpness maximized by flat, diffuse, non-point source lighting.
9. **Improper development:** Mainly overdevelopment of black-and-white negatives.
10. **Poor enlarger lens** (also poor slide projector lens): Use projection optics of highest quality giving edge-to-edge sharpness.
11. **Unsteady enlarger head:** Lack of rigidity results in slight movement or vibration in exposure softening edges of image details.







Above, Anglefinder V and Magnifier V. Both attach easily by sliding over finder eyepiece. Anglefinder is used for waist-level viewing, copystand viewing, shooting over heads of crowds, shooting at right angle for candid viewing, and so on. Magnifier is used to blow up section of focusing screen in order to focus more critically, especially with wide-angle and telephoto lenses as well as in close-up photography. Both finder accessories have their own correction eyepieces. Right, magnifier shown in place with extension rings for close-up photography. Lower right, attachment of anglefinder.



using extreme wide-angle lenses. By magnifying 2.5× this device enables you to be more selective in focusing. This is an advantage with wide-angle lenses since they produce an apparent great depth of field which is advantageous for the portrayal of sharpness except when extreme enlargements are to be made. In such cases, the principal target areas need to be critically focused. The Magnifier V can also be used when taking telephoto pictures in order to target more critically on the subject, whose outlines might be confused somewhat by atmospheric haze. Eyepiece correction lenses are not needed with this accessory inasmuch as an adjustable eyepiece with locking screw permits focusing for individual eyesight.

The *Anglefinder V* is a versatile device that enables you to take pictures from a low viewpoint—down to the ground level if necessary—or when using the camera on a copy stand in a position that makes the eyepiece otherwise inaccessible to the eye and when candid photography is to be performed. In the latter case, with the camera pointing to the side at the target subject, the photographer can appear to be looking in a direction at right angles to the lens. The subject, not having the photographer looking directly at him, is then more likely to be at ease, which is a great aid to natural or candid picture-taking.

The Anglefinder V can be turned in a complete circle, allowing you to focus from any position. It has an adjustable eyepiece, which can be focused for individual eyesight, and thus makes unnecessary the use of eyepiece correction lenses. There is no reversal of image with the Anglefinder V inasmuch as it is used at the eyepiece without alteration of the image projected by the lens onto the film.

Some independent makes of lens attachments for right-angle viewing are available through camera dealers. These attach to the front of the lens to reflect

images at 90° angles, so the photographer can take pictures without seeming to be pointing toward his subjects. One such device, the Spiratone Circatach, is cylindrical, so that it appears to be a continuation of the camera lens. The 90° mirror picks up its image through an opening in the side. It is suited for use with moderate tele-lenses. Another type is the Mirrotach, which is triangular, conforming to a 90° configuration. It accommodates all focal lengths. Both cause the images on film to be reversed. Unique effects can be achieved, such as taking overhead shots of subjects on the beach or ground. This is done by turning the mirror to face downward while pointing a lens of suitable focal length at a slight angle upward or even straight ahead, as the case may be.

Scale Focusing

You can also focus by estimate, although this is risky at close quarters or when using telephoto lenses. It is more likely to be a safe procedure for the experienced photographer using standard and wide-angle lenses. Turn the focusing ring on the lens until the approximate distance appears opposite the indicator line at the very top of the lens. It is a good idea to learn to approximate distances by reading the markings on the lens after you have focused through the viewfinder.

One technique of scale focusing useful when you need to shoot pictures quickly without taking the time to focus through the eyepiece is to set the distance scale on the lens for known distances at which familiar objects will conveniently fit the frame. For example, if your experience in positioning a head shot within the viewfinder using a 100mm lens calls for a distance setting of 4.5 feet, you can set this distance on the lens and then approach the subject, knowing that it will be in focus when the desired image size is reached. For refinements of such focusing, you merely move forward or backward slightly for sharpest focus without touching the lens.

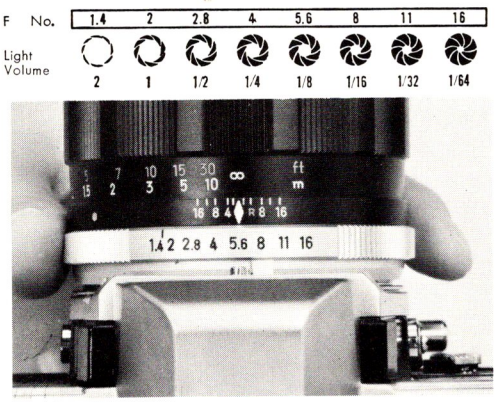
Depth of Field

Theoretically, you focus the camera lens for a given distance. That is, the image is in sharp focus only in a single plane. As a practical matter, objects in front of and behind that plane of sharpest focus will also seem to be sharp. The common technical term for this is *depth of field,* which is the same as *zone of sharpness.* Beyond this zone and in front of it, the image becomes noticeably less sharp for objects further away.

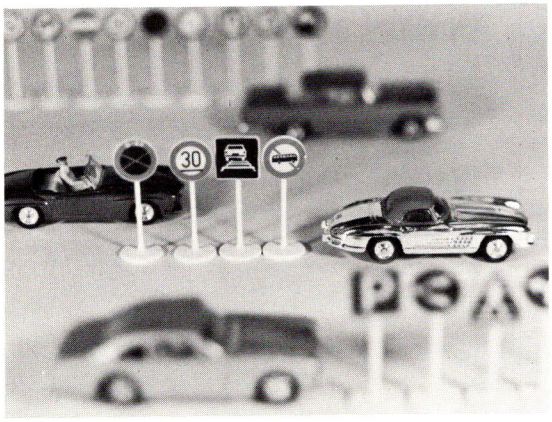
For each lens a depth-of-field finder is engraved on the lens mount; thus, the lens itself conveniently shows the zone of sharpness for every combination of *f*/stop (lens aperture) and distance setting. The field finder is easy to use. On either side of the distance indicator line, you will note the full range of *f*/stop numbers. Bracketing the lens distance scale between the identical *f*/numbers will show you the near and far limits of the region of sharp focus at whatever distance setting you have chosen. For example, assume that you have the 58mm lens on the camera focused at 15 feet with a lens aperture of *f*/11. On each side of the distance indicator line find number "11" and project it forward to the distance scale. This will show that the region of sharp focus extends from about 10 feet to about 28 feet.

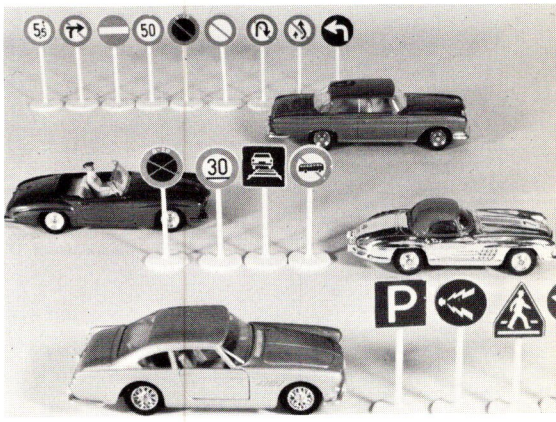
The most important control over depth of field is the lens aperture. The smaller the aperture, the greater will be the depth of field at any given distance for the given lens. On the other hand, as you open the lens aperture, the region of sharp focus decreases at the same distance setting.

The same characteristics pertain to distance and depth of field. The closer you get, the more shallow is the region

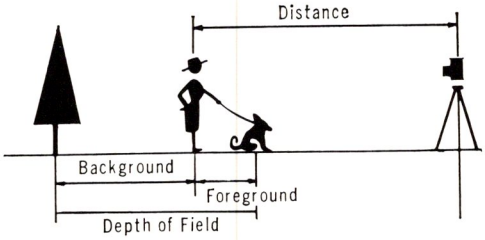


Index for aperture setting is diamond symbol in front of diaphragm ring. Each full aperture represents half amount of light transmitted by next smaller number or twice as much light as adjacent larger number. Figure "R" to right of diamond symbol is used as index for setting aperture when using infrared films. For approximate range of depth of field at any focused distance for a given lens aperture, numbers to right and left of diamond symbol, representing *f*/stops, indicate nearest and farthest points of sharp focus. Small lines without numbers are intermediate *f*/stops. Diagram at top left shows relative amount of light admitted to camera at each *f*/stop.

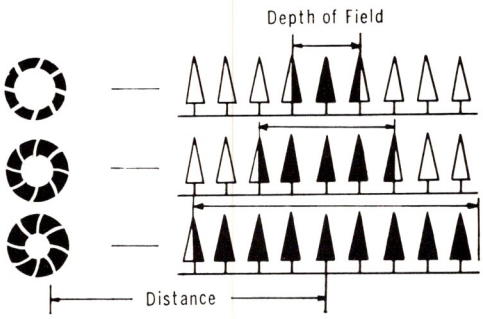




Focusing is normally done at full aperture. This does not show actual depth of field to be achieved at moment of exposure. Stopping down the lens, using the preview button to show effects with a smaller lens aperture, might yield an image on the viewing screen such as the one on the right. It will, however, be much darker on the screen, although this has no relevance for correct exposure.



Schematic representation of depth of field. Upper diagram shows that when focusing at a given distance, zone of sharpness in front of that distance will be about half that in back of it. Lower diagram shows that as aperture becomes smaller, depth of field becomes greater and vice versa.



of sharp focus; whereas the more you back away from the subject, the deeper is the zone of sharpness.

One of the important aspects of depth of field is in achieving desired pictorial effects. By manipulating the distance setting, you can determine beforehand just where in the zone of sharpness you want

an object to be. Suppose, for example, that you want to take a portrait where the face would be sharply delineated while the background would fade out. First, by focusing the camera you would find the distance of the subject. Then, you would turn the distance scale until the subject fell just within the limit of the far end of the region of sharp focus. It would help, also, to set the camera for one of the larger *f*/stops (smaller numbers). This would give you an even shallower region of sharp focus. Find your working *f*/stop to the right of the distance indicator mark on the lens mount. Then turn the distance scale setting ring until the subject falls just within the bracketed area, to the left of the *f*/number.

Additional discussion of depth of field from the standpoint of pictorial planning and control is to be found in the chapter on lenses and image management.

EXPOSURE CONTROLS

This section describes in brief the operation of the Minolta CLC exposure-measurement system. *CLC* stands for *Contrast Light Compensator*. This exclusive system of exposure measurement is designed to emphasize correct exposure of darker picture areas in situations or scenes in which high-contrast lighting conditions would otherwise exert too strong an influence on exposure readings.

In brief, for an ideal negative or color transparency (however the photographer defines *ideal*), the major factors that govern the required exposure settings on the camera are the intensity of the light source, the reflectance properties of the subject, and the light sensitivity of the film. Of course, other factors come into play, including the intended development process, whether or not filters are used, and whether or not the photographer intends achieving special effects at one range or the other of the scale of brightness and darkness. These special considerations are taken up in greater detail in the separate chapter on exposure. Here we will go into the operation of the exposure controls of the camera itself. First we will go into the functions of the lens apertures or *f*/stops and the shutter speeds and their interrelationships. An understanding of these elements will enable you to achieve better results with the CLC exposure-measurement system, which in itself is quite simple to operate—in fact, one of the simplest of the through-the-lens, exposure-measurement systems. This section will conclude with instructions on the use of the various mechanical and electrical exposure components, including the shutter release, the self timer, the mirror lock-up, and flash exposure synchronization.

Table of Intermediate (Half) Stops

Full f/stop	½ f/stop
	f/1.2
f/1.4	
	f/1.7
f/2	
	f/2.5
f/2.8	
	f/3.4
f/4	
	f/4.9
f/5.6	
	f/6.9
f/8	
	f/9.8
f/11	
	f/13.5
f/16	
	f/19.6
f/22	
	f/27
f/32	





Low shooting position usually important with small children, household pets, but each circumstance governs. Children, left, photographed best from low viewpoint, but background is distracting. High viewpoint at right shows baby to best advantage and cuts out background distraction. Rokkor 55mm, existing light.

Lens Apertures

The amount of light coming through the lens is regulated by a diaphragm whose opening can be made larger or smaller by your adjustment of the *aperture setting ring*. The numbers on this ring are used as calibrations or "gate valves" to tell you precisely how much light is coming through your lens. These numbers are often called *f*/stops. They express the ratio between the diameter of the opening and the focal length of the lens. The standard range of *f*/stops can be seen on the 58mm MC Auto Rokkor *f*/1.4. They are 1.4, 2, 2.8, 4, 5.6, 8, 11, and 16. This complete range may not appear on any given lens, but, with minor exceptions, the scale of *f*/stops on any Minolta lens will correspond to at least part of this numerical progression. Some Rokkor lenses—as well as other makes of lenses—begin with *f*/stops not in the standard sequence. Examples are 1.2, 1.7, 3.5, 4.5, and 6.3. For exposure computation purposes, these may be considered as intermediate half-stops. When the widest opening is one of these intermediate stops, the next *f*/stop marking on the aperture setting ring will be the next standard number. For example, the next setting after 1.7 would be *f*/2; the next setting after 3.5 would be *f*/4.

The smaller the *f*/stop number, the larger the lens opening. Conversely, the numerically larger *f*/stops identify smaller openings. Thus, on the 58mm lens, the widest lens opening is *f*/1.4 and the smallest is *f*/16. Each larger *f*/number (smaller opening) admits half the amount of light of the preceding number. Thus, *f*/2 admits half as much light as *f*/1.4. Conversely, each smaller *f*/stop (larger opening) admits twice as much light as the preceding one: *f*/2 admits twice as much light as *f*/2.8. It can be seen, therefore, that this standard progression of *f*/stops serves to vary precisely the amount of light coming through the lens.

Shutter Settings

While the lens aperture regulates the amount of light coming through the

lens, the shutter regulates the duration of exposure of the film to that light. The shutter-speed numbers are engraved around the edge of the shutter-speed dial. Each number other than "1," which stands for a full second, is the denominator of a fraction whose numerator is one. Hence, "2" means 1/2 sec., "4" means 1/4 sec., "60" means 1/60 sec., and so on up to "1000," which means 1/1000 sec. The full range of numbers is 1, 2, 4, 8, 15, 30, 60, 125, 250, 500, and 1,000. (The fastest speed of the SR-T 100 is 1/500.) The letter "B" stands for "Brief Time," although historically it was referred to as a "Bulb" exposure. The "B" setting holds the shutter open as long as the shutter-release button is held down. This must be done with a cable release, as prolonged finger pressure on the shutter button would cause camera movement.

Each higher shutter number admits one-half the light of the preceding lower number. Thus, 1/250 passes one-half as much light as 1/125. Conversely, each lower number admits twice as much light as the next higher number, so 1/250 passes twice as much light as 1/500.

Intermediate Settings

In order to accommodate small variations in lighting conditions, most Minolta lenses have half *f*/stops. These are not marked numerically on the aperture rings; rather, they are intermediate indents or click-stops between the standard *f*/stops. At any point on the lens aperture ring, a movement from an intermediate setting to a full *f*/stop or vice versa is the equivalent of one-half a standard *f*/stop, regardless of whether one is dealing with apertures at the widest or narrowest dimension. There are no intermediate shutter speeds. *Do not attempt to use intermediate settings by manipulating the shutter-speed dial.*

Selection of *F*/Stops and Shutter Speeds

When do you use which *f*/stop and which shutter speed for a given situation? This is largely a matter of the strategy you wish to follow with respect to depth of field, stopping subject motion, or control of camera movement. At this point, you can skip to the next topic on use of the built-in exposure meter and its use in selecting proper exposure settings and then return to this discussion, or you can stay with this topic just a bit longer, as it is really a logical prerequisite to understanding the proper use of an exposure-measurement system.

For any given set of exposure conditions and desired pictorial effect there is only one correct combination of *f*/stops and shutter speeds. As a practical matter, most films have considerable latitude, which enables you to under- or overexpose slightly and yet get a negative from which you can make an acceptable print or get a color slide that can be hand-viewed or projected. Color films usually have less latitude than black-and-white films; nevertheless, the good photographer strives for a perfect exposure every time.

Of the two exposure controls, the *f*/stop setting is the more important one from the standpoint of pictorial effect. It controls the depth of field (depth of the zone of sharpness). The smaller *f*/stops (larger numbers) produce progressively greater depth of field and vice versa. Except in action photography, the shutter-speed setting does not control pictorial effect in any way. Slower shutter speeds increase the risk of camera movement, while faster shutter speeds minimize that risk. Hence, from a pictorial standpoint you would ordinarily want to start with selection of a desired *f*/stop for depth-of-field control. For example, suppose you are photographing a group whose members

are spaced at varying distances, some of them pretty close to the camera. You would then want to use the smallest *f*/stop, since this would give you the deepest coverage. If you focus at 7 feet, everything would be sharply focused from a little more than 5 feet to about 10 feet. If you back away a little more and refocus, you can get everything from 7 to about 18 feet within the zone of sharpness.

Now, let's assume that for the given light conditions you find that your shutter must be set at 1/15 sec. in order to use an aperture of *f*/16. This is too slow for a hand-held exposure. Your first compromise, therefore, is to use a faster shutter speed to minimize the risk of camera movement. Ideally, you should adjust the speed to 1/60 sec. This is two settings away on the shutter dial. You must, therefore, make an adjustment in the lens setting to make up for the smaller amount of light. Turning the lens-aperture ring two stops would give you *f*/8. Now you find that at 10 feet everything is sharply focused from a little more than 8 feet away to not quite 13 feet away. If this covers your picture scene—as it probably will for a group—then you will have solved your exposure problem. If you need greater depth of field, you might take a chance by compromising on intermediate settings of 1/30 sec. and *f*/11, but then you must be very careful to avoid any jarring of the camera while making the exposure.

Now let's switch to another scene, one in which there is action. Depth of field may still be important, but you have the governing consideration of how much action-freezing you want to accomplish. Let's assume that you are using the same film and are taking pictures under the same light conditions described in the previous example. Some boys are playing football and are running at a diagonal course. You decide that a minimum exposure must be at 1/250 sec., which will stop all motion. Since this admits less light, you must open the lens wider. Let's use the previously noted exposure of 1/60 sec. at *f*/8 as our point of departure. Since 1/250 is two settings away from 1/60, you open the lens two settings wider than *f*/8—to *f*/4. In other words, 1/250 sec. at *f*/4 will give you the same effective exposure as 1/60 sec. at *f*/8. What is different is that in exchange for a faster shutter speed to stop the action, you have lost some depth of field by opening the lens a bit wider.

Using the CLC Exposure-Measurement System

The following material pertains solely to the use of the CLC (Contrast Light Compensator) system of the Minolta SR-T 101 and SR-T 100. It does not apply to the following models of Minolta SR cameras: the current SR-M, which has no coupled meter; the older SR-1 and SR-3 cameras, which have externally coupled optional meters; and the older model SR-7, which has a built-in, coupled (but not through-the-lens), reflected light meter. The techniques of exposure measurement for these cameras are those described in the separate chapter on exposure, which form part of the discussion on reflected light meters. What now follows is a description of the use of the CLC system. A more extended description of the technical concepts inherent in this system is presented through the accompanying diagrams and captions.

In order to understand the unique advantages of the CLC exposure-measuring system, it is necessary briefly to examine alternative systems. These fall into two main categories called *spot* and *averaging systems*. There are also combinations and variations of the two. The center-weighted system is an example of a combination approach in that it measures the entire picture area, averaging

it, but then gives extra weight to the center spot.

The spot method provides a reading of a central portion of the total picture area. This is satisfactory and accurate where there is little contrast or when the main subject reflects as much light as does the center spot area and therefore calls for the same exposure. Where there is a wide range of tonal values, several readings must be taken and averaged with due regard for their contrast range. This takes additional time prior to exposure and in some cases obviates taking a picture, such as when target subjects are moving about and entering or leaving the image area.

On the other hand, averaging systems provide an integrated or single, arithmetically-averaged aperture setting for a given shutter-speed setting. Although this method may be adequate for pictures in which there is very little contrast or in which tonal values are fairly evenly dispersed throughout the contrast range, the averaging method will not be suitable for measuring exposure needed for pictures with a wide contrast range, ones that contain dominant highlights and important shadow or darkness areas in which detail should be preserved. When high and low reflectance areas are averaged, neither is adequately exposed. It is somewhat like taking two people aged 20 and 60 and saying that their average age is 40. None of this is to say that competitive camera systems will not yield satisfactory results with their particular exposure-measuring systems. In fact, if one could take the time to do his own creative averaging of all the key subject reflectance areas, using a spot measuring system, this might be an ideal solution. Minolta believes, however, that it has produced a more practical solution through the CLC system in that, for most contrast situations, the camera will do automatically what the creative mind would otherwise have to compute for itself.

A characteristic of pictures made with an averaging system is that they tend to favor the highlight areas while underexposing the shadow areas and the details of middle tone areas, which tend to come out rather dark in the transparency. Although this defect can be compensated somewhat in black-and-white print-making, the same cannot be done in color projection or in color print-making. The Minolta solution is to arrange two CdS metering cells in series so that each is able to have an influence on the other. In average scenes, or where the predominant area is without high contrast, the CLC system will automatically provide a reading equivalent to an average. In high contrast or other situations where light distribution is uneven, the CdS cell measuring darker areas will influence the one that tends to give dominance to brighter areas. The effect is to dampen the brightness reading so as to give more exposure to darker areas. All of this is computed automatically by the two cells interacting with each other and communicating their combined information to the exposure indicator needle in the viewfinder.

Inside the viewfinder on the right side you will note two movable indicators. The pointed indicator responds freely to changes in light and depends on the readings made by the CdS cells. The circle-tipped follower-needle is activated by changing the lens aperture or the shutter speed. When both indicators are aligned, aperture and shutter speed are then in correct combination for proper exposure.

If you wish to give more dominance to highlights or more dominance to shadow areas, as you may determine necessary for specific scenes, you may set the aperture one-half stop under or over by aligning the pointer indicator with the bottom or top, respectively, of the circle-tipped follower needle. Of course, you can vary from the indi-

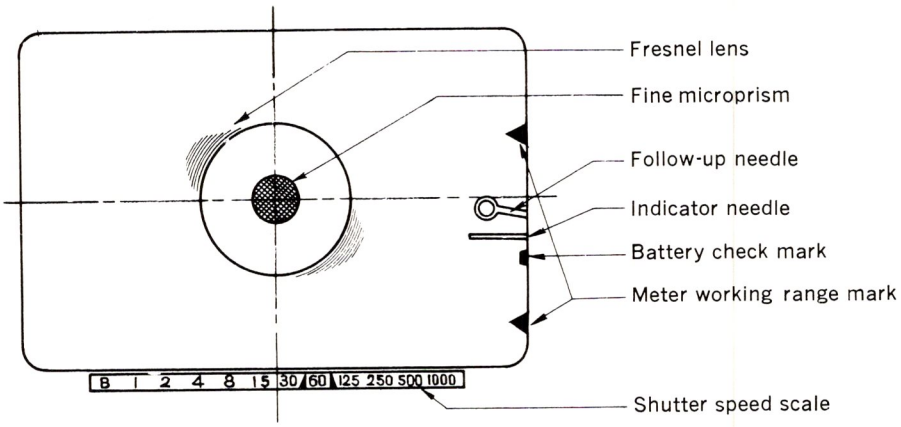


Diagram of viewfinder functions, SR-T 101, 100. Correct focus is achieved when indicator needle and follow-up needle are aligned, with small circle bisected by needle. Through observation you can observe degree of under or overexposure as shown by size of gap between two needles. This may be useful in achieving specific exposure effects. Bracketed number of shutter speed scale corresponds to actual setting on camera, enabling you to change shutter speed without removing eye from viewfinder. When battery is tested, indicator needle will point to area represented by battery check mark.

cated readings even more in order to achieve special effects, but such adjustments in the exposure controls—aperture or shutter speed or both—should be made manually by external adjustment.

The exposure-measuring system will give correct readings for many different combinations of lens aperture and shutter settings that will be equivalent to each other. For example, the viewfinder screen (other than in the SR-T 100) may show a shutter speed of 1/250 while the lens-aperture ring may show for the particular scene an *f*/stop of *f*/8. If you are taking a picture of fast sports action, you might decide to choose a faster shutter speed of, say, 1/500 sec. You can make this adjustment either by turning the shutter-speed dial while looking through the viewfinder or by presetting the shutter speed. In either case you will have to turn the aperture ring to find the *f*/stop that corresponds with the new speed. In this case it will be *f*/5.6. At this point you might want to review again the preceding discussion under Selection of *F*/Stops and Shutter Speeds.

Filters require no special exposure compensation, except perhaps where deep red ones are used. In general, the behind-the-lens exposure measurement automatically takes account of the light loss when a filter is placed in the optical path in front, within, or behind the lens. Inasmuch as CdS cells have a low sensitivity to red, not corresponding to black-and-white film sensitivity, you can get false readings and hence overexposure with deep red filters. You may, then, need to take a reading without the filter in place and make a manual adjustment in lens or shutter settings to compensate for the filter factor for the particular film emulsion.

Stop-Down Exposure Measurement

When using non-meter-coupled lenses or when using meter-coupled lenses in combination with bellows and ring extension devices that do not have meter-coupling, you must use what is called "stop-down measurement." Instead of taking your readings at full aperture as



To see depth of field at a preselected aperture, depress preview button. Aperture will remain stopped down until you depress preview button again.

is normally done with the MC (meter-coupled) Rokkor lenses, the procedure is to turn the lens-aperture ring to the desired *f*/stop and to take the exposure reading in that way. The image on the viewfinder screen will be darker than usual because of the stopping down of the lens. It will brighten or darken as you make adjustments in lens aperture while sighting through the viewfinder. Inasmuch as the microprisms will tend to darken, focusing should be done at full aperture whereas exposure readings should be taken with the lens stopped down. Under this method it is not necessary to activate the depth-of-field preview mechanism, for actual depth of field is visualized by stopping down to the intended aperture.

Creative Exposure Variations

No exposure-measuring system can substitute for your personal judgment when you wish to achieve specific effects for unusual conditions. Sometimes you will decide to give more exposure to darker areas because you want them to predominate, or you might decide to favor the highlights, thereby overriding the CLC reading. In a uniformly illuminated scene, your decision might be to go for a picture in either low key or high key.

When you are shooting a subject that has a wide contrast range and you want to favor either the high or the low, the simplest procedure is to point the camera so that it takes a reading for one or the other. For example, if you wish to eliminate the influence of the sky when taking an exposure reading of a landscape, you would point the camera downward so that the viewfinder would exclude the sky. You would do the same if you wished to take a reading for a sunset, in which case you would exclude the ground.

Bear in mind, however, that when you are taking a reading of a more or less uniformly illuminated subject, even if it is very dark or very light, the meter will give you an exposure reading that would produce the equivalent of a normally illuminated scene. That is, if you were to take a reading of an early evening scene, the exposure reading would lead to a shot that looked as though it were earlier in the day. If you want a scene to come out darker, you would have to give the picture much less of an exposure—by as much as one, two, or more stops depending upon the effect to be achieved. You can experiment with the effects of average lighting ranging from bright to dark by taking a series of blank walls of different brightness. For example, you might take a picture of a bright wall, another of an average or medium wall, and a third of a dark wall. When comparing the three negatives, you would find them all of approximately the same density.

As a further example of this, I once took a picture of a harbor at dusk with the lights of buildings and street lamps just coming on. The exposure was meter-controlled without other adjustment. After development, the picture came out as though it were taken during daylight. In this case, I should have used either a faster shutter speed or a smaller lens

aperture to reduce the amount of light striking the film. Remember, for average scenes the meter will think for you. If the scene is of average brightness, you are in good shape. If the overall scene is darker and you want to retain the darkness, you must cut back on the exposure; whereas, if the overall scene is very bright and you want to retain the effect of exceptional brightness, you must give slightly more exposure than is indicated by the exposure-measuring system.

Mercury Battery Information

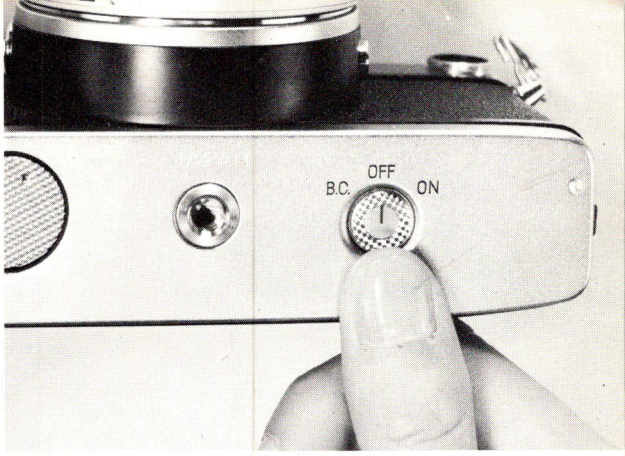
The Minolta SR-T camera uses a 1.35v, button-shaped battery intended for photographic applications (Mallory PX-625, PX-13, Eveready EPX-625, EPX-13, or equivalents). Whichever battery you use, even though it might fit the battery chamber, it is important that the letters *PX*, which indicates photographic use, be part of the designation.

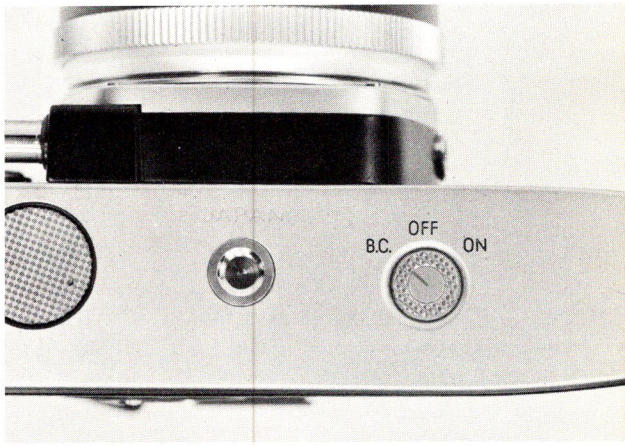
To install the battery, remove the battery-chamber cover with your thumb by turning it counterclockwise. Place the battery in the chamber with its plus side out and replace the cover.

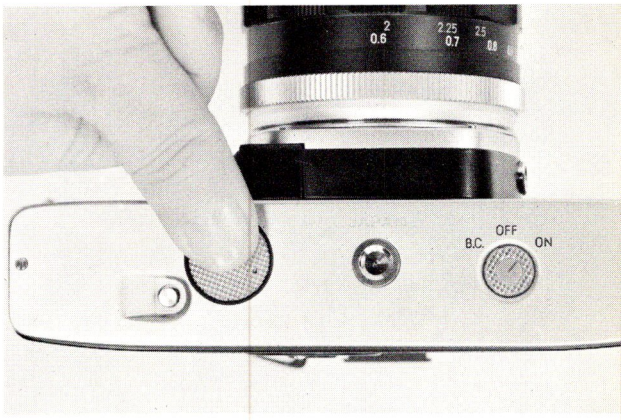
The battery should be handled carefully with dry, clean hands, as any moisture or dirt may cause deterioration. Before putting the battery into the camera, clean both sides as well as the contact points of the battery chamber with a dry cloth.

When the camera is not in use, the battery switch on the base of the camera should be turned to the "OFF" position.

The battery has a long life, but it should be checked from time to time, particularly after long periods of disuse. You do this simply by turning the battery switch on the base of the camera to the "B.C." position. If the free-moving indicator needle points to the battery check mark on the viewfinder screen, the battery can be regarded as having







When camera is not in use for short periods, turn battery switch to "OFF." To check on battery strength, turn switch to "B.C." position and observe alignment of indicator needle with battery check mark in viewfinder. When battery is to be replaced or when camera is not to be used for a prolonged period, twist open battery cover by thumb pressure and remove mercury battery. Replace with Mallory PX-625 or equivalent.

adequate electrical energy stored in it. Do not leave the battery switch at the check position, for doing so will cause a high battery drain and render the battery dead in a few hours.

When discarding a mercury battery after replacement, do not throw it into a fire and do not attempt to open it. Discard it in the trash without further manipulation.

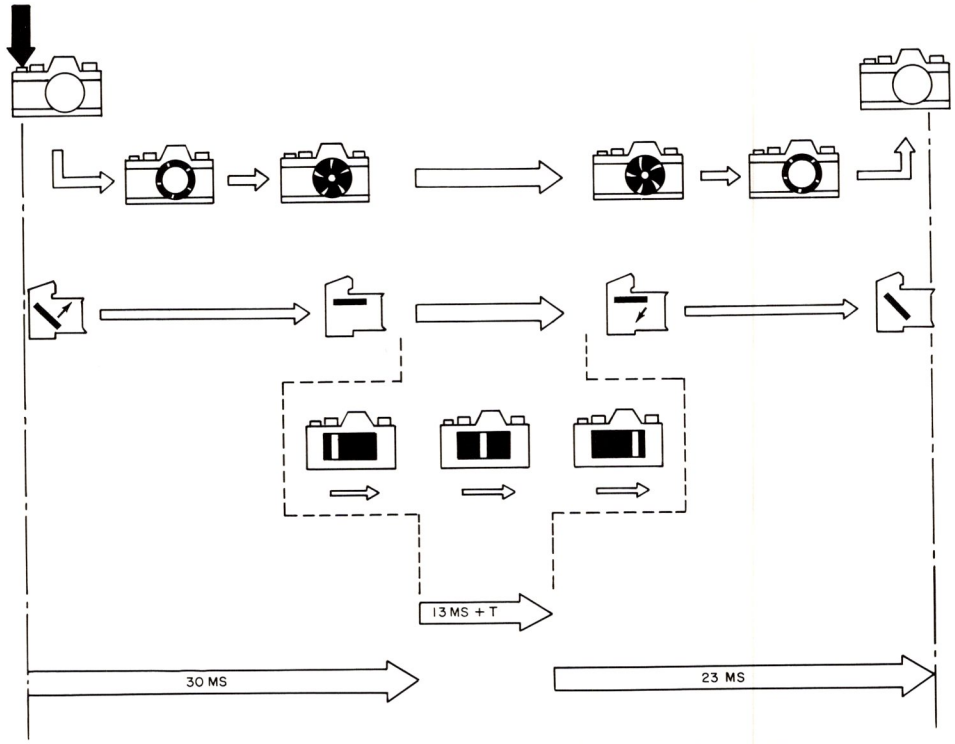
The Shutter Release

In normal picture-taking, the index finger rests lightly on the shutter-release button and squeezes gently at the moment of exposure. This is probably the most decisive moment for two reasons: One, you want to capture pictures involving people or animals or moving objects at the most critical moment of action and desirable composition; and two, you want to make sure that you do not ruin the picture by vibrating or jarring the camera at the moment of exposure. As obvious as the latter might seem, the most common fault in picture-taking is camera movement. The usual tendency is for a person to plunge downward with his finger instead of squeezing with a combined gentleness, firmness, and restraint. For practice, mount a mirror on the back of the camera and position it so that it reflects a light source onto a wall. Watch the wall to see whether, when making dry-run (without film) exposures, you are able to squeeze the shutter release without bouncing the light reflection on the wall.

Once you have mastered the finger-release action, you can practice with slow shutter speeds (from 1/30 sec. or more) to see how much movement you get during exposure. The rule of thumb is that the slowest hand-held shutter speed possible will approximate the focal length of the lens. Thus, for a standard lens of 50, 55, or 58mm focal length, the shutter speed would be the nearest equivalent of 1/60 sec. For lenses in the range of 85 through 135mm the recommended slowest hand-held shutter speed would be 1/125 sec. For the 200 and 300mm lenses, the shutter speed would be 1/250 sec., and for the longest lenses, the 1/500 or 1/1000 sec. speed should be used. Working from the other direction toward the widest-angle lenses, you would still hold to the maximum, relatively slow speed of 1/60 sec., for when you get any slower you risk movement. Some photographers, nevertheless, are able to make free-standing exposures at incredibly slow speeds without apparent movement in their pictures. If you can rest the camera against a solid surface, you can use most slow speeds with impunity. With lenses up through 135mm one technique is to standardize on a shutter speed of 1/125 sec., with exposure control achieved through varying the lens aperture.

Bear in mind that selection of shutter speeds is governed also by the film speed. For example, if you are using a very fast film that calls for an exposure of 1/500 sec. at *f*/16, you have very little latitude. You might go to 1/500 sec. at *f*/11, but you certainly could not use a personal standard of 1/125 sec. Here we can refer to another rule of thumb for selection of shutter speeds and lens apertures when the exposure meter is not used. This might be the case with the Minolta SR-M, which has no built-in meter, or with the Minolta SR-T when you are shooting fast and do not have time to make through-the-lens meter readings or when you wish to preset the camera for a "grab shot" under circumstances when any prolonged activity at the eye would draw attention to your picture-taking.

The general rule is that for direct, bright sunlight a safe shutter speed is the nearest approximation to the film speed at a lens aperture of *f*/16. Hence, photographers who use the very popular Kodak Tri-X Pan, which is rated for nor-



Synchronization of diaphraghm and shutter release actions with elapsed time.

When shutter release button is depressed, the following actions take place:

1. Preset lever is activated by spring tension to close lens diaphragm down to preset f/number.
2. Action of preset mechanism simultaneously causes mirror to flip up and out of direct path of light from lens to focal plane.
3. Action of mirror lever causes first curtain to begin its run across focal plane, thereby beginning exposure of film.
4. Action of first curtain triggers release of second curtain after predetermined delay governed by shutter speed setting.
5. Just before second curtain action is completed, lens diaphragm is re-opened.
6. Diaphragm action causes mirror to be released to its normal down position. All of this takes place within 56 milliseconds plus exposure time.

mal exposure at ASA 400, generally set their cameras at 1/500 sec. and *f*/16. The rule-of-thumb exposure for a color film with a film speed of ASA 64 would be 1/60 sec. at *f*/16 in bright sunlight. The photographer deviates from these settings by making equivalents. For example, he might decide to shoot at 1/125 sec. and *f*/11, which would be the equivalent of the rule-of-thumb settings. For different lighting conditions compensations must be made. If there is a bright, but hazy sun, an adjustment of one lens stop wider would be necessary. For a bright, overcast day, another lens stop would have to be opened up. For the next stage of loss in daylight intensity, one more stop would have to be opened up. You would need to make yet further compensations for the direction of light, for the rule of thumb is applicable only to direct, frontal lighting.

A most useful accessory is a cable release. This is intended mainly for relatively slow shutter speeds so as to introduce a more gentle action between your fingers and the camera body. The cable release fits into the screw socket on top of the shutter-release button. If you are to make time exposures, you will want

to have a locking cable release for use when the camera is on a tripod or otherwise securely held on a firm surface.

Besides the standard Minolta cable release, others are available in a variety of lengths from any camera dealer. Exceptionally long lengths of 20 feet or more are also available when you wish to have absolute control over the timing of a picture when you are not next to the camera itself or when you want to get into the picture with the cable release still held in hand. Even longer air-pressure releases are available for single-shot remote control.

A special-purpose release is the Prontor Ultra Slow Speed Cable Release. This has a built-in timing mechanism, which permits you to preselect any exposure time ranging continuously from 2 to 32 full seconds. The shutter dial must be set at "B" and then, when the timing device is set for the desired exposure, pressure on the cable-release plunger will cause the shutter to open and remain so until precise completion of the desired exposure interval. Another Prontor device is the Spotlight Cable Release. This has a miniature spotlight built into the cable release crown so that the photographer may have sufficient illumination when working in the dark to set his camera manually. This is particularly important in flash photography.

The self timer on some Minolta models offers another means of activating the shutter release. Although its original purpose was to allow the photographer to get into the picture with the camera mounted on a tripod, another and perhaps more important use is to activate the shutter release without finger pressure when making slow-speed exposures. The self timer delays the release of the shutter for about ten seconds from the time you press the self timer release button.

To operate the self timer, advance the film so as to cock the shutter at the same time. Next, push the self timer lever down through an arc of about 90°, and then, when you are ready to take the picture, press the self timer release button, which will be revealed after you have pushed the self timer lever down.



Self timer is used sometimes when photographer wants to get into his own picture, but it is also used frequently with camera on tripod to take slow-speed exposures. After lever is pulled down to position shown, it can be released at will by depressing tiny button immediately above it (covered when lever is in normal position).

If you activate the self timer lever without having first advanced the film, the lever will stop after turning about 45°, while the shutter itself would not be released for it would not have been cocked. If you have activated the self timer mechanism by pushing the lever down and then decide that you wish to override the self timer you can do so by using the shutter-release button in the normal way.

Mirror Lock-Up Control

The mirror lock-up system of some Minolta models is helpful mainly in close-up photography, motorized sequence photography, photomicrography, and in making slow exposures, because it eliminates the possibility of camera motion caused by the movement of the mirror when the shutter is released. The mirror lock-up control is also used in

conjunction with the older type of Rokkor 21mm wide-angle lens, whose rear element projects deeply into the interior of the camera. The mirror lock-up is not needed in conjunction with the current model 21mm lens.

To operate the lock-up control, turn the mirror lock button downward (clockwise) until it stops. The mirror will return to its usual operation when the lock button is returned to the red mark. The mirror lock button operates independently of the shutter release and film advance and can, therefore, be activated at any time.

When the mirror is locked in an up position, the exposure meter of the camera cannot operate. An independent meter must then be used.

Flash Synchronization

Minolta SR cameras are synchronized for the use of both ordinary flashbulbs and electronic flash. The connector cord from either of these light sources is inserted into the correct terminal. For flashbulbs the correct sync terminal is the one designated as "FP." For electronic flash, the connector cable tip should be inserted into the "X" terminal. A fairly wide range of shutter speeds can be used with different flashbulbs, as discussed in the separate chapter on that subject. Electronic flash units are ordinarily used with the shutter dial set at 1/60 sec.—the red figure on the shutter-speed dial. Slower speeds can also be used, down through one second. A wide range of accessories can be used in flash photography, including simple extension cords, which enable you to use more than one flash at a time or to take pictures with one flash unit aimed advantageously from a place other than on the camera itself; slave flash units, which are activated by the main unit at the camera; and special-purpose flash units in addition to the more general-purpose unit sold by Minolta.

Minolta flash units are attached to the accessory shoe on top of the camera. If a heavy duty flash unit is to be used, it should be attached to a mounting bracket screwed into the base of the camera.

LENS ATTACHMENTS

Most of the attachments to your lens which you might need either for protective purposes or to extend the range of use of your camera are available as Minolta accessories, although some attachments of a specialized character are also available as independent items of equipment not made by Minolta. As a general rule, your best assurance of quality is to use filters, close-up lenses or attachments, and lens hoods with the Minolta label on them. You can then be assured that Minolta quality will be maintained throughout. This is of critical importance, for example, with filters, for these must be optically flat, without any distortion properties that might impair the quality of the image projected onto the film. Minolta filters are made in Minolta factories; whereas one cannot be assured of the source of manufacture or of the quality of independent makes of filters, even though some of them are of the highest quality and can certainly match that of Minolta filters. As the accessories covered in this section are, relatively speaking, of little cost, this is not an area where it is worthwhile to save a few pennies.

Lens Hoods

Lens hoods or lens shades (sometimes called *sun shades*) are designed to prevent glare and loss of contrast caused by stray light hitting the lens. The design

of the lens shade must be matched to the focal length of the lens. Typically, the lens shade for a wide-angle lens is shallow so as not to interfere with the wide angle of view. Otherwise, there would be an effect called *vignetting*, which is the cutting off of light from the edges of the image. Lens shades for long focus lenses are built in as integral components of the lens mount. Such lens shades are rather deep, for the lenses have narrow angles of view. Lens shades are provided for all Rokkor lenses other than the 35mm *f*/2.8 and the normal lenses. Lens shades for these exceptions must be purchased separately. Generally, the detachable lens shades must be screwed into the front inside thread of the lens. If a filter or a close-up lens attachment or both are to be used on a lens, one or both are first screwed into the front of the lens and then the lens hood is screwed into that accessory. Of course, on lenses having built-in lens shades, the lens shade is first retracted so as to permit attachment of the optical accessory and then the lens shade is simply pulled out for use. Lens shades designed for the angles of view of particular Rokkor lenses are designated as *unique* in the lens data sheets.

Lens Filters

Minolta solid glass filters, like Rokkor lenses, are made in Minolta's own factories to the highest standards of optical quality. Surfaces are ground optically flat to avoid distortion and the disks are mounted in satin-finished metal rings, threaded to seat perfectly. The filters available for the different filter mount diameters for Minolta lenses are shown in the accompanying table. Descriptions of the purposes for which the different filters are used are given in the general chapter on exposure. The 1A skylight filter, which ordinarily is used with outdoor color film to reduce blue, screen excessive ultraviolet light, and produce warmer color, is used by some photographers as standard equipment on lenses in order to protect them from scratches, abrasions, and soiling. It may be used as standard equipment for black-and-white photography, but the photographer may want to consider whether or not he wants the slightly warmer cast in his color pictures.

Photographers who have special interests and who, therefore, need filters not available in the most common Minolta categories will find a great variety available from specialized manufacturers of filters. Many of these have very subtle variations to accommodate color films to a wide variety of light sources and daylight lighting conditions. The Tiffen Optical Company (71 Jane St., Roslyn Heights, N.Y. 11577), for example, makes 29 different filters for color film (not including color compensating filters and certain combination filters) and 28 different filters for black-and-white film. In addition, there are decamired filters for color balancing and conversion, and color compensating filters, which are used primarily in darkroom work. Then there are combination filters, which combine a special-purpose filter with a neutral density filter. In the neutral density range, a complete set of ten would cover densities ranging from 0.10 to 1.00.

Since a great deal of industrial photography and even home photography requires adaptation to fluorescent lighting, at least two filters are available, one for use with indoor type B films and one for use with daylight type films. These filters are designed to give "true-to-light" color renditions with average fluorescent lighting. They eliminate the deep blue-green cast that ordinarily results from shooting color films in fluorescent light.

Optical Lens Attachments

Another category of lens attachment, not really qualifying as filters in the



A compromise shutter speed used in these pictures to stop body movement but to show some image displacement in jump rope and in water. Fill-in light in these back-lit subjects provided by reflection from grass and light brickwork of house. 135mm, 1/500 sec., Plus-X. Clelland Rimmer.

ordinary sense, includes diffusers to produce soft diffused looks on portraits, particularly of elderly people who have harsh facial lines; prismatic devices that break the image up into three or more multiple images for special effects; diffraction gratings, which break up the light to give special, creative color effects; and devices that cause highlights to sparkle for special effects.

An interesting novelty is the so-called *split-field lens,* which is, over one-half its surface, a close-up lens attachment, while the other half is made of plain, optically flat glass. Split-field lens attachments enable you to focus sharply on two different subject distances. Thus, you can focus through the plain part at an object at infinity while focusing



through the close-up portion at a closer object. The positioning of the two halves can be vertical or diagonal or whatever. At least one manufacturer, Tiffen, makes these in +0.5, +1, +2, and +3 diopters. The Spiratone Proxitar attachments come in two close-up ranges: Model 10, whose close-up half focuses on a range of 10 to 13 in., and Model 20, which has a close-up range of 20 to 38 in.

Close-Up Attachments

The standard front-lens, close-up attachments provided by Minolta are designated 0, 1, and 2 for the different degrees of image magnification produced with these lenses. Although theoretically they call for slight adjustments in exposure, as a practical matter, these can be ignored and exposures can be made through the lens without compensation. Close-up lens attachments that yield greater magnifications are available from camera dealers. They are of independent manufacture, and go to as much as 10 diopters of magnification. These more powerful close-up attachments yield narrower depth of field and increased optical distortion, calling for the use of very small lens apertures. Minolta close-up lenses are specially corrected for distortion. The use of close-up lens attachments is described in the chapter on close-up equipment.

Lens Caps

Lens caps are normally provided with the lens when purchased, both a front lens cap and a rear lens cap. Should either be lost, a replacement can be purchased. The one exception is that when the camera is sold with a normal lens, no rear lens cap is provided, for the lens is already mounted on the camera. The separate lens data sheets will have information on the replacement identification of the front lens cap. The rear lens cap is common to all Minolta lenses.

CAMERA HOLDING AND SUPPORTS

In this section we deal with the seemingly simple problem to which some brief reference was made above in the treatment of shutter speeds: the problem of holding or supporting the camera during the moment of exposure so as to minimize camera movement or vibration. Failure to hold the camera motionless at that critical moment is probably the most important reason for a lack of sharpness, which otherwise you might be inclined to attribute to improper focusing or dirt on the front of the lens when neither may be the case. When examined under extreme magnification, a film negative or transparency may show a minute amount of image displacement, sufficient to destroy the sharpness of image contours. This displacement is actually the result of the movement of the camera during exposure, which creates a double image that is imperceptible as such at ordinary magnifications. One of the problems to be discussed here, accordingly, is how to hold the camera when it is not supported on a tripod or a solid, non-vibrating surface.

Some distinctions will be made between the necessity for the rigid support of wide-angle lenses and normal lenses as opposed to the lenses of longer focal lengths. Commonly, it is held that the problem of movement is greater with the longer focal lengths. In part, this is attributable to the physical length of the lens, which in itself may be a cause of vibration. The greater problem is that the longer lens magnifies all defects, so that any degree of image displacement caused by camera movement is blown up to visible proportions through the magnification afforded by the lens. If, how-

ever, you were to photograph an object twice at the same relatively slow shutter speed, first using a normal or wide-angle lens and then using a lens of long focal length (a telephoto lens), and do it in such a way that the size of the image on film was the same in both cases, you would probably find about the same amount of image unsharpness due to displacement caused by camera motion (omitting the size factor of the longer lens). What this means is that the same caution must be exercised in control of camera motion with lenses of any focal length.

Incident to this discussion of camera-holding techniques we will also take up briefly the methods of blind targeting, used when pictures are to be taken without the camera at the eye.

Hand-Held Techniques

When taking a picture at relatively slow speeds—and in some measure at any speed—you must consider the relationships among the position of the camera at your eye, the position of your body, your stance, any outside influences such as wind or extreme weather, the size and weight of the lens, and whether there are any physical supports for the camera or you. All of these factors play upon each other. Notwithstanding the things said above about the problems of movement with wide-angle or telephoto lenses, the latter do require more care in that they start out with a greater magnification of the effects of camera movement; whereas pictures taken with a wide-angle or normal lens do not, overall, receive the same degree of magnification even when enlarged or projected.

In ordinary picture-taking, the camera is held at the eye. When taking pictures at reasonably fast shutter speeds, you need take no particular precautions other than to make sure that you are standing comfortably with arms and index finger in an equally comfortable state. There should be no tension in your index finger as it rests upon the shutter button. If the shutter speed should be a little on the slow side, the position of your feet starts to become a bit more important. Ordinarily, in a standing position, your feet should be somewhat apart in order to give you a more stable base. If possible, you should lean against a solid support, such as the roof of a car, the top of a fence, a telephone pole, a solid wall, and so on. You might sit facing the back of a chair and use the top as a source of support. Or you might kneel with one knee on the ground and one elbow on the other knee. What happens is that the lower you go, the lower becomes your center of gravity, which helps decrease the likelihood of movement.

In general, it is easier to take a picture with the camera held horizontally rather than vertically. This is due to the fact that horizontally your hands can easily cradle the camera; when it is held vertically, your arms, wrists, and fingers are all under tension. Greater care must then be exercised in holding the camera and some preference given to the use of somewhat faster shutter speeds if at all possible.

Of course, as you seek lower positions in order to have either sitting or kneeling support, you also change the picture-taking point of view, which in some cases might be desirable while in others it might substantially alter the effects. Hence, you might need to take a picture while standing, perhaps with the use of some firm supports.

Since the telephoto or long focal length lens presents the most critical problem, the following suggestions relate to use of that category of lens. It must be observed, incidentally, that while the trend in telephoto design is for the longer lenses to become increasingly shorter and lighter, this increases the necessity of using greater care in taking pictures without camera move-

ment. One advantage of a slightly heavier lens is that it has more inertial stability, that is, it tends to remain in position in accordance with the physical law that a body at rest tends to remain at rest.

This first set of suggestions has to do with the holding of cameras and lenses of focal lengths longer than 135mm. The suggestions are applicable to other lenses as well, but not as critically. The slower the exposure, the more you must depend upon rigidity of support.

1. Make the camera part of your body configuration. That way, you are not separately controlling the camera and your own body movement. One thing that might help is to shorten the neck strap of the camera, and by pressing your right hand against the strap while holding the right side of the camera, convert the neck strap into a brace. Your left hand should be used as a support for the barrel of the lens while at the same time cradling the focusing ring between your thumb and one other finger. The use of the neck strap is, of course, optional.

2. In a standing position, away from other physical supports, your elbows should be close to your body, digging somewhat into your sides, which are used for support. Your feet should be spread apart comfortably, and your legs slightly flexed at the knees but not rigid. In this position, you can shoot straight ahead and downward, but if you must shoot upward you will need to alter your position, because you will no longer have as low a center of gravity. Also, you will not have the advantage of making your body a support for your elbows.

3. A lower viewpoint is not too much of a problem with one of the long lenses, at least so far as distant objects are concerned, so you can readily take advantage of sitting or squatting positions. An alternative to resting on one knee is the sitting position, with legs apart and elbows pressed against the inner sides of your knees. To make your body base more compact, you should lean forward from the waist slightly.

4. Whenever possible, when standing or otherwise, take advantage of solid supports. For example, when leaning against a tree or a wall, you can cradle the lens barrel in one hand, which is itself leaning against a solid object.

Miscellaneous Small Supports

Several kinds of highly portable support devices can be used for resting the camera on a solid surface, an irregular surface, or even on your own body.

The Leitz Table Tripod is a great favorite of professionals and advanced amateurs because it is both highly compact and versatile. The three-legged device takes up very little room in a gadget bag, for the legs collapse into a slim, compact shape when not in use. You have a choice of a small or heavy-duty Leitz ball-and-socket head to attach to the tripod. Together, the combination raises the camera from eight to nine inches, approximately, above the supporting surface. By pressing down slightly on, say, an automobile roof, you have a very solid support. This combination serves also as a chestpod. This is where the ball-and-socket head comes into play, because it enables you to assume a variety of positions while, by manipulation of the ball-and-socket head, you can point the camera in any direction you desire. A useful addition to this arrangement is your Minolta cable release. The Leitz ball-and-socket head is one of the most nicely machined photographic tools of this type you will ever encounter.

Your camera dealer will have a variety of other table-top supports, which can do double duty as chestpods. Then there are devices for screwing a camera support into the side of a tree (which damages the tree) or for clamping a camera



Examples of devices used to support cameras instead of regular tripods. Gitzo Suporphot Mini-Tripod (left) provides camera positioning from floor level up to 30 inches. Legs at minimum extension are 13 inches. Center pole may be reversed for floor-level photography without obstruction by the legs. Horizontal folding bar has leveling bubble. Miida Step-on Tripod (center) is used optionally as one-legged monopod or three-legged tripod, since legs retract or are withdrawn from monopod barrel. Use of legs overcomes side-sway problem with conventional monopods. For additional stability, photographer can step on two of the legs. Miida Elevator Tri-Clamp (right) will attach camera firmly to tables, poles, railings, and similar objects. With two legs added, it becomes convenient and sturdy table tripod. Pan head can be elevated or extended, making it convenient to mount camera as circumstances require for best visual access.

support with tripod screw threads onto the side of a table or chair. Those miniature tripods that have multiple section legs aren't worth very much for the support of a miniature camera at full extension, but they can serve very well as table-top supports.

Probably one of the least expensive camera supports is a bean bag or an appropriate modification of one. You can stuff a small cloth bag or a sturdy sock with lentil beans, barley, rice, or similar granular material which, within the bag, will conform to any irregular surface, will absorb vibrations and shocks, and will support the camera in an infinite variety of positions and angles while you sight in on your subject. The longer the lens, the larger should be the bean bag. A bag holding about one and a half pounds of material should be adequate for lenses up through 200mm, and a two-pound bag should accommodate a 300mm lens quite adequately.

Gunstock camera supports, or shoulderpods as they are sometimes called, are often used for the support of the longer lenses. These fit into the shoulder and armpit in the same manner as a rifle butt. With the aid of a clamp, the lens-and-camera assembly is fastened to the gunstock as support with the clamp around the lens barrel.

Many photographers find the pistol grip, because of its small size and great portability, a particularly convenient type of support. Usually, a pistol grip includes a cable release so that you focus with your left hand, sight with the camera pressed against cheekbone and forehead, and operate the shutter release with the fingertip at the cable-release outlet on the pistol grip.

The monopod is a collapsible, one-legged device, usually with a rubber tip at the base and a tripod screw at the top. By pressing down firmly, but gently, you eliminate downward movement, but you must be reasonably careful about avoiding movement from side to side. A beltpod fastens to the leather belt at one's waist and functions somewhat like a monopod. You can make a chainpod by

taking a light chain or piece of nylon rope and attaching it to an eyebolt that has a ¼-inch thread, which will fit into the tripod socket of the camera. The support is provided, oddly, by stepping on the loose end of the chain and pulling up until the chain or cord is taut. This eliminates up and down movement of the camera.

Tripods

An important point to remember is that a light camera needs a fairly heavy tripod; whereas, in a pinch, you can use a light tripod to support a heavy camera! The most important thing you need is rigidity. A light camera on a light tripod will not withstand the shock of being accidentally hit, the pressure of your hand on the camera, the wind, or any other external force. When mounting cameras with physically short lenses on them, you can use the tripod socket of the camera, but when a physically long lens is mounted in front of the camera you will probably need to use the tripod socket of the lens itself. The main idea is to find the center of balance; otherwise, the camera-and-lens assembly can whiplash during exposure. For this reason some photographers will steady the camera with their hand at the moment of exposure.

Together with the tripod you should have a pan-head as well as a ball-and-socket head. The pan-head allows you smoothly and easily to change the direction in which the camera is pointed. The ball-and-socket head, which can also be used for direction changing, enables you to level the camera regardless of irregularities in ground support. For additional flexibility, the tripod should have a center pole that can move up or down easily when a locking knob is released. Some tripods have reversible center poles that permit holding the camera fairly close to the floor or ground for low-level shots.

Tripods are sold with many different features, depending upon the make. Most important is to obtain a good one, with sturdy legs that lock firmly rather than the flimsy types that depend upon pull-out, tubular legs that lock with spring-pins. A cheap, flimsy tripod is worse than no tripod at all, because it encourages you to believe that you are getting a good picture. If you did not have the support, you would have to improvise a satisfactory substitute, which would call for some compensatory attention to the need for steadiness.

Inside train compartment, existing light, camera sighted blind, resting on knee, 21mm *f*/4.5, 1/2 sec. Ilford HP4. Bob Collins.



CAMERA AND LENS CARE

In addition to the conventional guidance on maintenance and repair of cameras, lenses, and other photographic equipment, this section will cover related topics, including camera and lens cases, gadget bags, weather conditions, equipment and film storage, and travel problems.

Equipment Maintenance and Repair

There is one first and everlasting rule about the use of any equipment: Do not force levers, knobs, rings, dials, or any other moveable parts when they offer resistance. This is especially true of a precision optical and mechanical instrument such as a camera. If a part is frozen or offers resistance, and if it does not respond to rational action, take it to any authorized Minolta Repair Service or, in the United States, to the Minolta Corporation, Service Department, 200 Park Ave. S., New York, N.Y. 10003. The same pertains to the need for any other repairs or adjustments.

This does not mean that any time the camera locks you must send it away for repair. Obviously, the film-advance lever and shutter-release button will lock when the film can no longer be advanced. Rewinding the film will remove this obstruction.

From time to time, depending upon how much use the camera receives, have it checked out and serviced. You should not, however, attempt to lubricate the camera yourself, because you might literally gum up the works by creating an attraction for dust particles.

When changing film, blow out any dust that may have accumulated inside the camera. You can use a blower brush or a small ear syringe, either of which will give you a concentrated blast of air. You can also purse your lips and blow, but keep them dry. At home or in your darkroom you can use canned, moisture-free vapor such as Omit Lint & Dust Remover. This is a hand-sized, self-contained compressor with a convenient snorkel, which can reach into the inaccessible corners and recesses of equipment.

When loading and unloading film, avoid touching the film curtain.

When changing lenses, avoid touching the surface of the reflex mirror. It is an extremely delicate, front-surface mirror, which can easily be damaged. If dust or grit gets on the mirror, remove it with an air blower, the ear syringe, or a good camel's hair brush. Above all, *keep your fingers off*!

Keep your fingers off the front and rear lens surfaces as well. Fingerprints or smudges of any kind will degrade the clarity and sharpness of the image. When you have to clean the lens surface, the first step is to remove all dust and grit. Use a blower, as described above. If this does not remove all the dust, use a soft lens brush. Liquid lens cleaners may be used sparingly, but do not rub vigorously. Be careful about the use of lens tissues; rubbing too hard with them over a period of time could remove the microscopically thin lens coating.

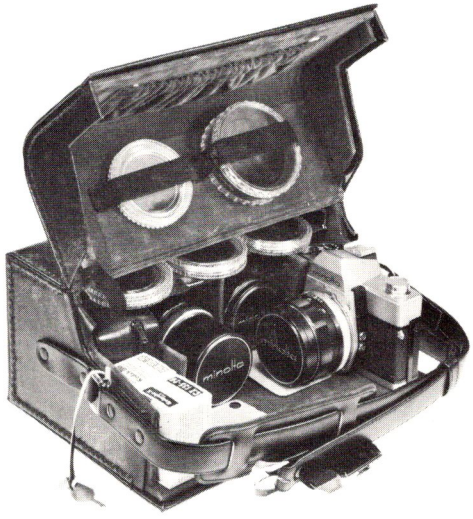
Avoid opening the camera on the beach, where there is a high probability of sand getting blown or kicked into the camera works. This is most hazardous on a windy day. Seek a wind-sheltered and activity-sheltered area in which to perform film-changing operations. If sand does land on the camera, *blow every particle off—every last one—before opening the camera.* If the film advance or any other part of the camera then fails to work smoothly, *don't force anything.* Without working the camera further, send it either directly or through your dealer to an authorized Minolta repair center. Mark the camera conspicuously: SAND IN CAMERA.

Prolonged exposure to sea air may

corrode parts of the camera. If sea water or spray lands on the camera, wipe it off immediately to prevent corrosion. If the camera actually falls into the water (provided you can retrieve it!), remove the film and soak the camera in several changes of clear tap water. Then dry the camera in an oven set at the lowest possible temperature, and rush it immediately to a repair center. Before wrapping up the camera, however, make sure it has been thoroughly dried.

Camera and Lens Cases and Bags

Camera cases, lens cases, and carry-all bags (also referred to as gadget bags) serve both to protect and carry one or more items. The camera case protects against jarring and bumping. It also provides some insulation against rough handling when the camera is packed in luggage. The lens case serves essentially the same function. It can be used with a carrying strap and suspended from the shoulder. When a number of lenses are carried loose in a carry-all bag, the lens cases protect against damage as the lenses jostle each other. The carry-all bag is a repository for one or more camera bodies, additional lenses, a flash unit, filters, film, cable release, and other items that may be needed to round out the armamentarium for a photographic safari. Each type of case has its advantages and disadvantages; there are no universal solutions. To some extent, the available cases will accommodate the needs of most photographers, but in the final analysis, you must adapt your carrying case needs to your own operating style and to the demands of the occasion.



Minolta camera bag holds camera with lens mounted, plus two more lenses, filters, film, and one additional accessory.

The Eveready Case

The standard Minolta camera case is made of a top-grade leather, semi-flexible and molded to the camera shape. It has a padded lens area for additional protection. For occasional picture-taking, the front of the case drops down and pivots loosely, so the camera can be used while in the case. A cut-out in the base permits access to the on-off control of the exposure metering system. When a fair amount of picture-taking is to be done, the top may be removed simply by detaching it from the back.

Professional photographers who work rapidly and may use two or more film magazines in a single shooting session are likely to work without a camera case and thus facilitate film changing. Instead, they attach a neck strap to the small protruding lugs on the front corners of the camera body.

Some optical accessories may be attached to the neck strap of the eveready case or to the independent neck strap that attaches to the camera. One can also carry several film magazines in small containers attached to the carrying strap. These may be either old film magazine containers which are attached to the strap with tape or small leather storage cases with zippered lids, which can be purchased from camera dealers. Each tiny case holds one film magazine and is

attached to the neck strap with a retaining loop.

Lens Cases

The leather lens cases furnished with Minolta lenses have zippered lids and metal loops to which neck straps may be attached. The smaller lenses can be stored in their cases within a non-compartmentalized carrying case. The 300mm MC Rokkor lens ordinarily will be carried in its own case due to its size. Of course, the same pertains to the other big lenses in the Minolta line. If you wish to carry several lenses in a non-compartmentalized case and wish also to have quick access to each, you can obtain from your camera dealer small, leather, draw-string pouches that, because of their softness, lend flexibility to the internal arrangement of the carrying case.

Carry-All Cases

The average photographer can do very well with a carry case that has room for one camera with a normal lens, an extra camera body, a moderate telephoto lens (up to 200mm), and a moderate wide-angle lens, along with space for some lens hoods, filters, and film. This is the carrying capacity of Minolta's Deluxe Carry Case, which is sold at a most moderate price. Of course, it will not have room inside to carry any useful tripod or bulky equipment such as flash slaves and clamps plus the additional flash units to be triggered by the slaves, and bellows units for close-up work in the field. Most if not all other over-the-shoulder carrying cases have room for little more than the outfit described above, which is really adequate for most amateurs.

Once you get beyond the capacity of a fitted carrying case, the answer to your problem may be additional cases. In fact, professionals might go into the field with several cases and the manner in which they outfit them can vary with the equipment needs of the particular assignment.

The first decision you must make in buying a carrying case is whether you want one with no subdivisions, which offers maximum flexibility for arranging your equipment, or a more elaborately engineered case that has a special place for everything. If you decide in favor of the roomy, boxy carrying case, then you must use individual lens cases inside the larger case, for if your lenses are not shielded from each other, they could be damaged. On the other hand, if you go to the compartmentalized case, you must be willing to accept some inconvenience when you need to take along equipment that won't fit inside the case. Some photographers solve the problem by taking along two cases: an over-the-shoulder case that will hold the most commonly used items for a particular assignment and a larger storage case with internal compartments for extra lenses, copying apparatus, flash equipment, film supplies, and so on. If you opt for one of the larger over-the-shoulder cases, be sure to get one that has both a carrying handle and a shoulder strap with a large, soft pad. Keep in mind, too, that the weight seems to get heavier and heavier as the day goes on, especially in hot weather. Then, add a factor for age.

The best-known of the luggage-type cases in aluminum is the Halliburton case. It is available in different sizes and you can have sponge-rubber inserts with cut-outs made for the contours of your individual equipment. You can also have several sets of inserts to accommodate various picture-shooting situations. As an alternative to the cut-out inserts, Halliburton offers inserts with finger-like projections of foam rubber, which hold irregularly shaped items of equipment firmly in place. The advantage of either type is that you can store

the case in a moving vehicle or airplane without fear that the vibrations will loosen screws and connections. Less expensive versions of the Halliburton cases are available, but each must be judged on its own for its steadiness and its resistance to moisture.

Another approach to the design of compartment cases is offered through the Fiberbilt line of luggage-type Adapt-a-Cases. The internal partitioning is done on a do-it-yourself basis. The case comes with a stock of thickly padded partitions of different lengths, which fit into slots spaced one inch apart in the padding of the partitions and side walls. Thereby, you can lay out the internal design of the case as the particular occasion requires. A variation of this line of cases uses diced foam, which consists of one-inch thick layers of foam rubber cut through almost entirely. You merely pick out the number of pieces needed to make up the particular configuration of lens, camera, or flash unit that will fit into the newly created empty space. Another layer of foam rubber in the lid of the case holds all of the equipment in place.

There are many other types of case, each with its own features. Some have bayonet mounts to retain lenses firmly in place without the use of lens cases or pouches to protect them from jostling against each other. The Spiratone Top-Drawer bag has an upper compartment which is so "zippered" that it can be opened independently or can be tilted back as a closed unit to provide access to the main compartment. Perrin brand cases are of both "top drawer" and "bottom drawer" designs. Spiratone offers a Carry-All bag for storage of miscellaneous items. Some separation of accessories and convenience of access are afforded by three outside pockets.

One type of non-case, which has a great capacity, should not be overlooked. This is the raincoat with deep slash pockets or the bush jacket with two sets of pockets at chest and hip level. I have one winter-weight coat of this type that has an additional inside zipper pocket that is quite commodious. If you carry a camera around your neck or off your shoulder and concealed inside the coat, you will have lots of room left over for lenses, filters, and film. Even when you are working out of a large case, you might consider carrying a camera with your preferred lens supported by its neck strap. Then you will be ready for the unexpected.

Travel and Weather Problems

An important principle when traveling is to anticipate the picture-taking conditions you will encounter, the need for some redundancy in equipment in case something goes wrong, and the opposing need to simplify your travel requirements. You can start out by planning to take just about everything you own along with you, but after you array your inventory for packing, you might decide to leave something home in the interest of traveling light enough to reach your destination. This is particularly important when traveling abroad. It is perhaps more important to take along an adequate supply of film and some of the smaller gadgets and adapters than too many lenses. Of course, if you are traveling by private automobile, this is not likely to be a problem, but if you are traveling by plane and plan to make any number of stops, the more you carry the more difficult it will be for you to travel conveniently and inexpensively.

When traveling abroad, be sure to register all of your camera bodies, lenses, and significant accessories. The customs agent at the port of departure will give you the necessary forms for registration. If he should suggest that your equipment is used and that you need not register it, insist on doing so anyway. Upon your return, you might very well encounter a customs agent or inspector

who will insist on having proof that you took the equipment out of the country originally. Whenever possible, and particularly when your equipment is not packed in a foam rubber case, you should carry your camera bag aboard an airplane. For one thing, it is least subject to vibration if you hold it in your lap; for another, if you could see how luggage often is thrown into the baggage compartment of the plane, you would not want to entrust your equipment to that kind of handling. If the airline personnel insist that you check the camera bag through, you should insist on having written assurance that this valuable equipment will be guaranteed to arrive safely.

Prior to going on an extended journey or vacation trip, make sure you have tested your equipment and that all is in good order. Allow sufficient time for this so that if repairs are needed you can have them made before departure. If you are buying new equipment, give it a work-out—again, allowing sufficient time before departure so that if you should have any questions you can have them resolved or have adjustments made before departure. If you are really serious about your picture-taking, you might want to take along two matching bodies so that if anything should happen to one you will always have the other.

Before departure make up your "D-day" list of what you will be taking along, including both what you have on inventory and what you might need to buy, the latter usually being plenty of film. Ordinarily, you should take along as much film as you need for the trip, space permitting. Simplify your film requirements so that you can get along with one black-and-white film and one color film. Some photographers will use one of the popular black-and-white films rated at ASA 400 and will also use a color film of equivalent rating or one that can be pushed to the same exposure index. Then there is never any problem of remembering which film is in the camera at which film speed. Another simplifying procedure used by some photographers is to take along a tungsten-type color film for use under artificial illumination (not flash) and an 85B filter to permit the same film to be used either with flash or with daylight illumination. If space is a problem, discard the cardboard containers in which the film is packed, but do not break the seal of the inside container for this acts as a barrier

Action easiest to stop when subject moving directly toward or away from camera.



to moist air. Incidentally, if you are traveling to another country, although you are ordinarily not likely to be challenged on the amount of film you are bringing in, this sometimes occurs; however, the customs officer will probably not challenge you if the film has been removed from its cardboard packaging. If you must buy films in another country, try to find a type with which you are familiar—something the equivalent of what you have been using at home. Films purchased abroad might include processing. If so, any authorized processing station representing the original manufacturer in any country may be expected to process your film without charge, but independent processors will not honor the entitlement.

One handy gadget to take along is a changing bag. It will come in handy for those rare occasions when something happens to your film inside the camera and you cannot do anything about it except in absolute darkness. Many different satisfactory brands of changing bags are available, but one I like very much is the Spiratone Expandar.

In hot weather, your main concern will be to keep equipment from being boiled in the sun and especially to keep film away from this kind of exposure. If you must leave film in an automobile, put it on the floor under the seat, except when the car is in movement. Above all, do not pack it into the glove compartment or the trunk. If you mail your film for processing, do not drop it into a mailbox during the hot weather. Rather, take it directly to the post office. The few hours in an oven-hot mailbox will be enough to affect the color balance of your film.

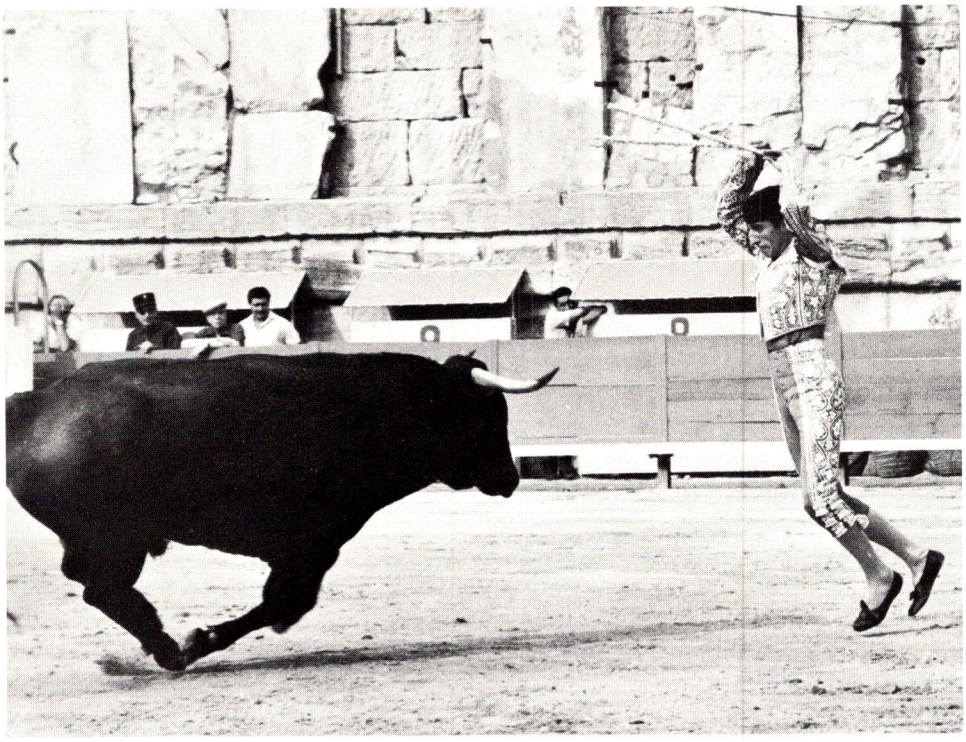
If you are traveling in the tropics or anywhere that heat and humidity are encountered, your main enemy will be fungus. Keep all your film tightly sealed both before and after exposure. For helpful advice on the handling of films, the taking of pictures, and the development of films under tropical conditions, write to the Eastman Kodak Company, Sales Service Division, Rochester, N.Y. 14650, for a copy of the booklet C-24, *Notes on Tropical Photography.*

Under freezing or subfreezing conditions, your main problem will be that moving parts might not operate if the lubricating oils in the equipment become congealed. Under conditions of extremely low temperature, the speed of your films could be reduced by one stop and there might be some slight changes in the color balances of reversal types of color film. Also, film may become very brittle. When you come out of the cold into relative warmth, moisture will precipitate on your cold equipment, clouding the lens and other cold surfaces. You may, then, have to wrap the equipment in a protecting material before taking it indoors. Conversely, you must be very careful when working outdoors in subfreezing temperature not to touch the cold metal or your skin might stick to it. You must not breathe upon a very cold lens, for the moisture might condense upon it and freeze instantly. For information on how to work under conditions of extreme cold, write to the Professional, Commercial, and Industrial Market Division of Kodak and ask for pamphlet C-9, *Photography under Arctic Conditions.*

Equipment and Film Storage

When you are not likely to use equipment for a protracted period, or if you make only occasional use of your equipment from time to time, there are a number of precautions to take:

1. Remove batteries from all equipment, including cameras, flash units, meters, and motor-drive power sources.
2. Store batteries and any unused film in the refrigerator or freezer.
3. Be sure to label the camera conspicuously if there is unused film inside, identifying the film by type.



Charging bull across line of view called for fast shutter speed, 1/500, f/11, Plus-X. Lucien Clergue.

4. Store your equipment in a relatively cool, dry place.

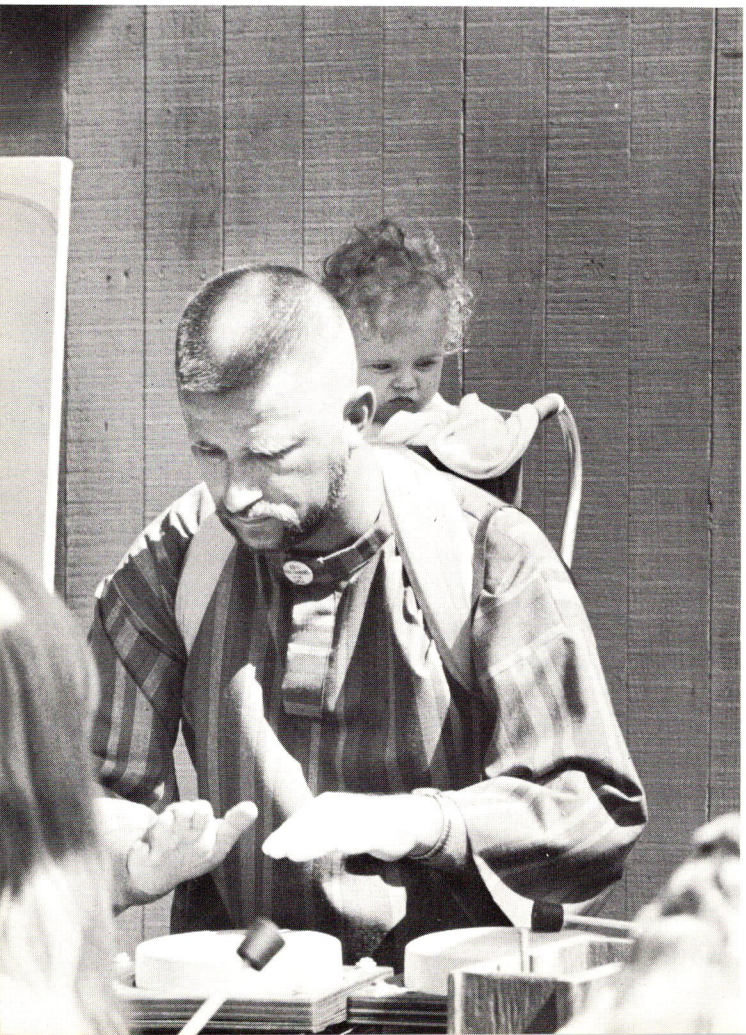
5. If equipment is not used for relatively long periods, it should be given an occasional dry run. You need to limber up the moving parts, especially to keep the lubricants in a fluid condition. Plugged into the house current, electronic flash equipment should be exercised by intermittent flashing.

Plane "stopped" in mid-air by panning. Victor Blackman, courtesy London *Daily Express*.





Movement of subjects acceptable if it contributes to mood or sense of action. 55mm, *f*/1.7, full aperture, Ilford FP4, 1/30 sec. Joseph D. Cooper.



Simple way to stop action is to catch peak moment before hands begin descent. 55mm, 1/500 sec., *f*/11, Tri-X. Joseph D. Cooper.

CHAPTER III

Image Management

The preceding chapter touched briefly on some aspects of the use and interchangeability of lenses, but it did not go into their creative use. This is the special province of this chapter and the one following. In this chapter we are concerned mainly with differences between how the photographer perceives, even with the reflex mirror, and how the film records the image. In a literal sense, the rectangular image recorded by the camera has no depth whatever. There are techniques for composing the image within that rectangular configuration, which will be discussed in this chapter, but of greater interest is the management of depth. This includes an understanding of perspective, selective focus, zones of sharpness, backgrounds and foregrounds, the influence of lighting on the feeling of depth, and the effect achieved when taking pictures from different viewpoints.

In all of this, the lens plays a prominent role in what we may call *image management,* which is the optical manipulation of objects in space. What effects are achieved when working very close to a subject? When using telephoto lenses to bring in distant objects, which appear to be pancaked? Why, with the same scene and the same lens, can we achieve a feeling of great depth under particular lighting conditions and uninteresting flatness under other lighting conditions? What are the important rules of good composition, and when and how can we deviate from them? These are among the questions to be treated in this chapter. In the succeeding chapter, each category of lens—wide-angle, normal, and telephoto—is described separately in terms of the particular attributes and uses of the lens group, while many pictorial examples are presented to show the result of lenses in actual usage.

EYE, BRAIN, AND CAMERA

Often it has been said that the camera does not lie. This is both true and false. Certainly, the camera does record what is perceived through the lens and projected onto the film, but you cannot call this the whole truth, for the image re-



This child rode directly into the scene to join the parade while the soldiers kept their military bearing. The 200mm lens pulled in distant scene and magnified the compression which is typical of all distant scenes regardless of lens used. Tri-X, exposed for shadow areas. Al Paglione.

corded may be something much different from what was perceived by the photographer at the moment he made the exposure. It is important that the differences between optical and human perception be understood, for such understanding relates directly to problems in selection and use of lenses in photography. An additional factor in the picture-taking equation is the effect desired by the photographer, taking into account both tone and texture.

Seeing with the Eye and Brain

Perceiving is done with the eye, but recognition and interpretation are done with the brain. Although the eye takes in an area of about 130° in any direction, it accomplishes this through a scanning action. Much of this scanning takes place without conscious effort, even when the eyes are not perceptively moving. At any given moment, when there is no scanning, critical perception is limited to a central area representing an angle of view of about 20°, corresponding to the field of view of a lens whose focal length may lie somewhere between 100 and 135mm. Over a larger field covered by an angle of about 50° the eye can pick up large objects and signs of movement. This extended range of perception corresponds to lenses having focal lengths ranging from about 45mm through 58mm. One might assume, then, that these two lens groupings most conveniently accommodate the human range of useful perception.

As the eye scans selectively within its roving and changing fields of view it automatically makes accommodations for differences in intensity of light reflectance and differences in the distance of objects from the eye. If you are looking at an object that is illuminated more on one side than on the other, you will automatically make eye adjustments to subdue the highlights in order to reveal texture detail while, when you scan the other side selectively, you will automatically amplify perception of shadow detail. Of course, the camera cannot make these selective adjustments in exposure with the result that often you will find that the film or a straight print has not rendered what the eye and brain saw in the original scene. As a practical matter, the human perceptor makes automatic adjustments for wide variances in image contrast, which you can accomplish on film only through a combination of effective light measurement and light placement.

To a considerable extent, the Minolta CLC exposure-measuring system compensates for this problem in the great bulk of ordinary picture-taking situations by selectively subduing excessive

Child is framed by the expanse of paving. Suzanne Szasz said: "I did not *decide* where the child should be in the picture—one gets to *feel* these things." Combination of 28mm lens to emphasize foreground and height of photographer brought out paving design without competing with child in picture. Plus-X.



highlight measurement while giving greater effect to the lower intensities of reflected light. Of course, the film itself will respond only in accordance with its own contrast characteristics. A film of low contrast will accommodate a greater range in tonal brightness than a film which is inherently contrasty. A further discussion of contrast will be found in the subsequent chapter on exposure principles and practices.

While the eye has a fixed focal length, which varies with the individual, it has the marvelous attribute of being able to focus automatically on objects at different distances without apparent effort. While it might seem that everything within the range of eye perception is sharp, this perception is effected only over some moments, during which time the focusing mechanism of the eye adjusts selectively to distance. Combined with this is the automatic functioning of the iris of the eye, dilating or contracting according to light conditions while at the same time narrowing or expanding the zone of perceived sharpness. These functions, it will be seen, must be performed mechanically by the camera through the deliberate intervention of the photographer.

Most of what we call seeing is done with the brain. True, the lens of the eye projects an image on the retina, but that image is transmitted to the brain for interpretation in the light of what each of us has learned about how things are expected to look. This is the fascinating area of perceptual constancy, which is of great interest to psychologists in the field of vision. The three main constancies are size, color, and shape. *Size constancy* has to do with how we perceive relative size. If two objects of equal or different size are next to each other, we can readily perceive the identity or difference. If, however, two objects of the same size are at different distances from the eye, they will ordinarily be perceived as being of the same size even though the camera would record the more distant object as being smaller. In the mind, the size of the more distant object is amplified, because through experience we know that it is supposed to be larger. We establish relative size by reference to other objects in the environment. At the same time the brain makes another automatic adjustment through perceiving depth relationships in terms of differences in the apparent size of what one has learned to be objects of equal or related sizes at the same distance. This phenomenon is at the heart of the whole area of perspective, which is governed mainly by the distance of objects from the lens but is also influenced by the attributes of the lens itself in a curious psychological manner. We will go into this more deeply in the subsequent discussion on perspective.

Color constancy refers to how we perceive and interpret different colors under different lighting conditions. For example, we will see a bright cherry red as being the same color whether the light is the sun at high noon, the slightly yellowish illumination from a typical household lamp, or the bluish illumination of a fluorescent bulb. The cherry red should look orange under tungsten illumination and purplish under fluorescent illumination, but since we expect red to be red, we make the mental accommodation automatically. Film cannot do this. It must be balanced specifically for the existing light. This phenomenon shows up in a wide variety of photographic conditions. For example, objects in a room tend to take on a color cast resulting from the reflection of light from the walls, draperies, and other surfaces of the room. This color cast is filtered out by the brain in ordinary viewing, since it knows that people are not supposed to look blue even though the light reflected from blue walls might make them appear so on color film.

The typical packed, pancaked, or compressed feeling one gets from a long shot with a telephoto lens, in this case 200mm. Effect of distance accentuated by haze in background, called *aerial perspective.* Graham Finlayson from the book *Portugal.*



The phenomenon of *shape constancy* has relevance for what is to be said in this chapter on perspective and distortion. If, for example, you are engaged in conversation with another person whose face is a few inches or a foot away from you, you will perceive nothing unusual about the proportions of the facial features because you know what the relative sizes and shapes should be. When, however, you take a picture as close as one foot away using an extreme wide-angle lens, you get an apparent gross distortion. This actually is what is projected by the lens of the eye onto the retina, but the brain interprets this information and renders normal that which otherwise you would consider to be distortion. The camera cannot do this and, therefore, you see the typical distortions of the frontal features. With the same lens photographing the same individual at a greater distance, you would not perceive the same apparent distortions.

Shape constancy shows up in other ways, as when you see a familiar object from an angle and recognize it as though you were seeing it frontally. For example, if a round card were to be turned so that you saw it at an angle, it would assume the shape of an ellipse. When photographed it would be recorded as an ellipse. Without the benefit of appropriate shadows and background you might think from the picture that the object is actually an ellipse. When, however, you see it in its actual form in front of you, your mind automatically recognizes its essential shape from the few dimensional and depth clues which are perceived.

We will encounter various applications of these aspects of perception in the ensuing text as well as in many of the pictures in this and other chapters. One other point that should be noted is that the eye perceives with a continuity of sensation, whereas, except when time exposures are made, the action of the camera shutter is to record only a brief moment in time. You might, for example, be enchanted with the catchlights on the surface of the water when the sun is setting in front of you. When you take a picture, you might be disappointed to find that you do not have the same abundance of catchlights. The next time you take such a picture, you should favor the longest practicable exposure consistent with lighting and film sensitivity conditions so as to simulate what the eye and brain perceive. It should be noted, however, that what the eye perceives is a succession of moments in the stream of time, but there is no accumulation of sensation, except impressionistically or through recall. With the camera, you can accumulate the chemical action of light on and within the sensitive film emulsion.

Lens and Camera

The most obvious difference between how the camera records an image and what is done by the brain is that the conventional camera can record only in two dimensions—height and width. It is one of the marvels of the photographic process, nevertheless, that the flat image, without physical depth, can convey the illusion of the depth as in the original scene. This is achieved through the placement of objects, their diminution of size in relation to each other, light and shade, and other depth clues. In many situations the photographer must understand how to introduce such clues, particularly through his lighting arrangements, in order to emphasize apparent depth.

The spontaneity of response to stimuli to eye and brain is, on the whole, not available through the camera and lens. This is not obtainable even under full automation, when correct exposure settings are made by the camera in response to the effect of perceived light intensity on an exposure cell. The film

Francisco Hidalgo avoids the average or the accustomed in practically all aspects of his picture-taking. He could have captured the drama of the people running from the path of the bulls only by getting to a high vantage point. 58mm, *f*/1.2 lens on a shadowless day at *f*/5.6, 1/60 sec., Tri-X. To shoot the horse guards from the very lowest vantage point possible, using a 28mm lens for wide coverage, he put the camera on the ground. Shot at *f*/8, 1/30 sec., Plus-X.



is still unable to give more exposure automatically to shadow areas and less exposure to brilliant highlights. The lens is unable automatically to bring different objects at different distances into focus. The photographer must intervene directly in determining the area of greatest sharpness upon which he wishes to focus the lens.

Whereas the focal length of the eye is fixed for the individual, the camera does have one great advantage in that change of focal length can be achieved by substitution of different lenses. To perceive details in larger scale with the naked eye, one would have to walk up closer. With the camera, one can accomplish this by attaching a telephoto lens.

The ability to accumulate the action of light on the film enables you to choose a longer exposure and a smaller lens aperture, if you desire it, or a shorter exposure and wider lens aperture.

The Total Field Approach

Taking a picture involves a three-way interaction among: (1) the photographer as a psychological perceptor; (2) the subject in its environment; and (3) the picture-recording and reproducing complex. The accomplished photographer takes all into account as he selects subjects for exposure and as he chooses a lens, a picture-taking position, and appropriate exposure settings. As we have seen, the photographer must interpret what he sees through the viewfinder both three-dimensionally and two-dimensionally. He enhances an effect through selection of a lens that enables him to move closer to a foreground object or to bring in a distant object more prominently. He selects a lens and a shooting position that together enable him to subordinate a background while giving prominence to a foreground. He might select a photographic film known for its contrast characteristics, which will help lend snap to a scene that otherwise might seem a little flat. Or he might use a film that will help soften the harshness and extreme contrast of tone and reflectance in a particular scene. He anticipates how a subject might appear when it is projected on a screen or when it is printed on paper. He uses filters to alter the quality of light reaching the film with consequent alterations in the colors and tones of the picture. A particular arrangement of form, line, and shade might suggest to him that through a certain kind of exposure in the camera and certain kinds of manipulations in the darkroom he could get an impressive rendition of tonal contrasts.

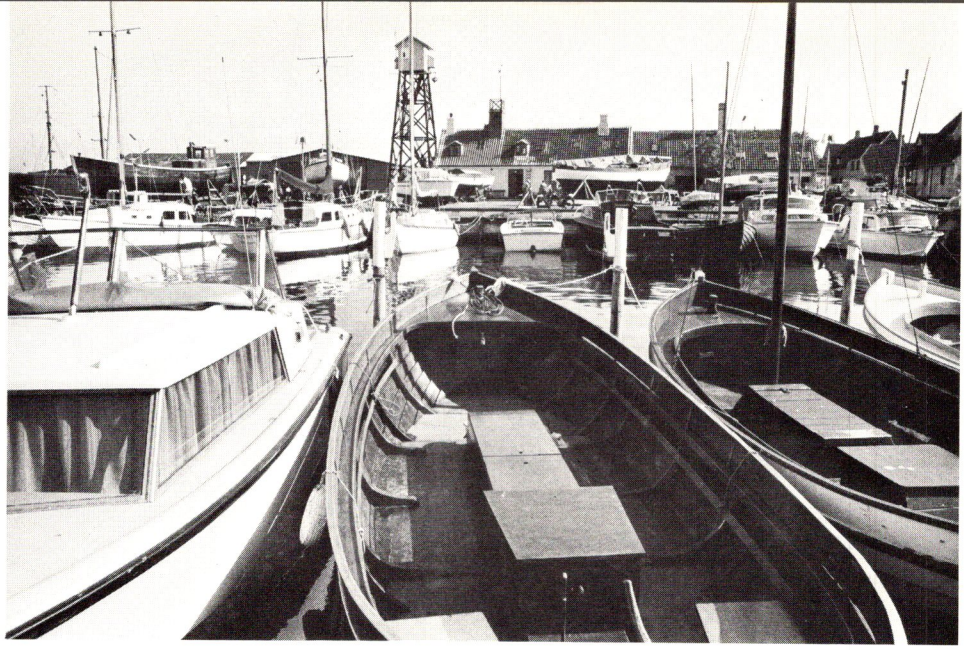
This kind of interplay will govern the decision-making of the experienced photographer almost without thinking. In many situations, as he peers through the viewfinder, all relevant factors come into play automatically, especially when the situation must be perceived and acted upon then and there, before the action or combination of picture elements is gone forever.

A great advantage of the automatic features of the Minolta SR camera system is that they enable the photographer to concentrate on what he sees through the viewfinder. The built-in CLC exposure-measuring system enables the photographer to accommodate the great majority of picture situations without conscious departure from the indicated exposure settings. This also enables him to devote his more creative attention to the exceptional situations.

In the remainder of this chapter we will concentrate on the problems of perspective and pictorial depth as related to the most effective use of the interchangeable Rokkor lenses. We will then relate these to the various rules and guidelines for achieving good pictorial composition.

The high viewpoint added interest to what otherwise might be an ordinary scene. The 200mm lens enabled Graham Finlayson to work from a distance. Note that objects at a distance maintain their relative sizes even though spaced apart in depth. The telephoto lens doesn't do this; it magnifies what would appear very much smaller when photographed with a shorter focal length lens. From the book *Portugal*.





Perspective is governed solely by distance of camera from subject, regardless of lens used. Above shot was made with a 28mm lens; middle shot with a 135mm lens. The bottom picture is a section taken from the 28mm shot. In image relationships it corresponds exactly to the 135mm shot; the only difference is in the graininess and lack of contrast.







Convergence of lines toward vanishing point in distance (theoretically infinity) accentuated by wide-angle lens because it brings in more of the broader foreground. Note relative differences in size of objects falling off rapidly toward rear. Black-and-white print from color slide, High-Speed Ektachrome-X. Stockholm Square. Joseph D. Cooper.

PERSPECTIVE IN PRACTICE

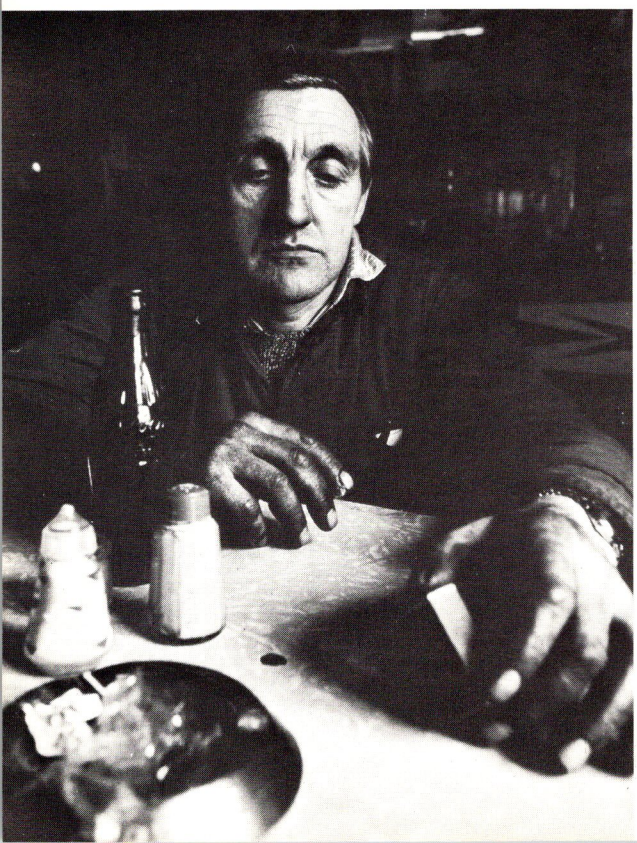
Perspective is, briefly, the seeing of objects in their depth relationships. An understanding of depth is important because it puts you into relationship with objects in the scene. In the simplest sense, closeness is implied by bigness of objects while distance is implied by smallness of objects. These size relationships are important for us in everyday living, apart from photography, because they provide us with clues to how close we are to objects and how to avoid bumping into them. In photography, we create and seek clues from images recorded on a flat surface to convey notions of closeness and distance of the observer from the scene as a whole as well as distances between objects within the scene and size relationships among those objects.

Clues to Depth Relationships

Convergence is the basis of all geometrical perspective. It is the illusion of parallel lines coming together at a point at a great distance or infinity, such as the familiar example of the railroad tracks. A photograph of a building taken somewhat from the side with the camera level would show a moderate convergence of lines from front to rear while the height of the front would be greater on paper than the height of the rear. Since we have learned through everyday perceiving that this is the way objects in depth should look, we take the impression of depth from such clues.

Size relationships of familiar objects tell us much about the distance and closeness of spacing of the objects. When you see two people who in real life are of about the same height appearing in





Truck driver in transport cafe. Graham Finlayson used a 28mm lens to emphasize table atmosphere and the great grubby hand. 1/30 sec., *f*/3.5, Tri-X.



Left, conventional use of wide-angle lens 28mm to include all of tall building without tilting camera. Picture above shows how relative size of foreground object is ascertained by reference to familiar figures; orange filter to darken sky. Right is detail taken from distance to minimize angular effect of pointing camera sharply upward; yellow filter. Below, foreground and background merge in confusion because there is nothing to separate them.









Tilting camera up slightly while lowering camera level gets rid of distracting background and substitutes sky. Face should be tilted downward slightly to avoid giving undue prominence to chin as at left. 135mm lens.





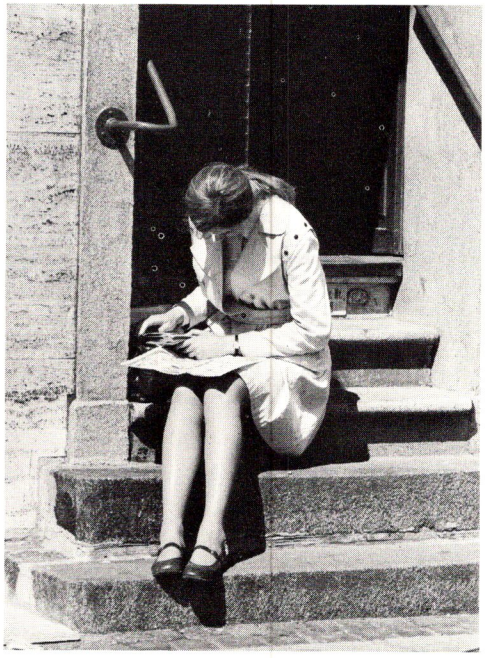
Lowering the camera viewpoint without tilting head downward slightly gives undesirable emphasis to chin, as in picture at right. Window display lighting, 105mm, f/2.5. Ilford FP4.





Statue in Hradcany, Prague. Existing light. Front view, 55mm lens, gives undue emphasis to knees. Side view, same lens and distance, de-emphasizes knees.





At left, 35mm lens views close, stretches out steps and lower body. At right, 135mm lens maintains relative size of legs, body, and steps, taken from distance four times greater.



High camera position shows activity of London street market in depth. Lower camera position, almost at table height, emphasizes foreground subjects, diminishes background detail. 28mm, Ilford FP4.



the picture in different sizes, you know that the larger of the two is closer to the camera. You also perceive relatively wide spacing between the two. On the other hand, if the two objects appear to be of about the same size even though one is further away than the other, you recognize this as an indication of fairly great distance between the camera and the subjects. Re-enforcing this perception is the apparent closeness of the two objects.

These two points are most important to understand if one is to be able to use wide-angle and telephoto lenses most effectively. They are actually different aspects of the *principle of diminution*, which, simply stated, is that objects further from the viewer or the camera will appear to be smaller and more closely spaced than objects that are closer. If we return to the railroad tracks and remember that they are held in place by wooden ties, we recall that as the ties appear to become narrower with increasing distance, they also appear to be more closely spaced. In practice, if you wish to have maximum separation between foreground objects and those behind them, you would get as close as possible, within the limits of pictorial suitability, to the main objects. Then, the rate of diminution of size is at its maximum and the two objects or sets of objects will appear to have the greatest space between them. On the other hand, if you were to want people in a group at varying distances from the camera to appear at about the same height and closely grouped, you would back away to achieve this effect and magnify the image through use of one of your telephoto lenses—the 100, 135, or 200mm in most cases.

Shadows provide many clues about depth as well as about the source and position of lighting, regardless of camera position and use of lenses. A picture taken on a dull, shadowless day gives us very few clues as to depth and is ordinarily referred to as a flat picture. We are accustomed to knowing that under any kind of directional lighting objects will appear to have depth because of their separation from the background as the result of shadows. The length of the shadow in relation to the size of the object tells us much about the time of day in an outdoor picture or about the position of lighting indoors.

An obvious clue to depth relationships is *overlay*, which needs very little expla-

Different perspective effects achieved from near water level with 55mm lens, from side of ship with 135mm lens, and looking down from ship rail with 135mm lens. Port au Prince, Haiti. Ilford FP4. Joseph D. Cooper.







This man's job at the Naval Air Station, Aberdeen, Scotland, is to keep the seagulls away from the aircraft engines. Richard Gee used 58mm *f*/1.4 lens, crouched slightly both for composition and simplification of background. Overcast day, 1/125 sec. between *f*/8 and *f*/11, Ilford FP4.

nation. It is simply the fact that one object is in front of and partially obscures another.

Aerial perspective is ordinarily associated with landscapes, for we are accustomed to seeing distant green mountains as though they are blue-tinted due to the abundance of ultraviolet radiation perceived cumulatively from a distance. The same phenomenon pertains to other forms of atmospheric haze and pollution. The greater the distance, the greater the amount of haze through which the lens must penetrate to bring in a distant scene. While the absence of such interference with clarity might be desired in many cases, its presence is an indication of distance. It is remediable only in part through the use of appropriate filters with black-and-white film to achieve contrast *or* the use of ultraviolet filters with either color or black-and-white film to eliminate or minimize the effects of the ultraviolet part of the spectrum on the film in the camera. Clues to depth include loss of detail in distant objects, a decreased expectation of brightness in such objects, and a proportionately smaller amount of image displacement on film when compared with closer objects that are also in motion.

The factors of closeness and distance as they relate to the management of depth will be taken up below.

Height and Angle of View

Height and angle must be considered both together and apart. *Height* refers to the distance of the camera from the ground under normal circumstances, when the objects in view and the photographer are both at ground level. *Angle* is the same as *tilt*. You can point the camera upward from the floor, waist, or eye level, or you can point it downward, usually from the waist or eye level. Picture-taking at an angle introduces problems of convergence, most notably seen with wide-angle lenses. What is called a *tilt distortion* with wide-angle lenses is merely the exaggerated convergence of horizontal and vertical lines recorded at close working distances without the benefit of the mental adjustment made automatically in ordinary three-dimensional viewing.

Shooting downward at low objects, such as small children or pets, simplifies the background but yields a distortion in size relationships among parts of the subject, which depends upon their distance from the camera.

Shooting upward also creates exaggerated perspective effects, the most common being the converging lines of tall buildings or skyscrapers. The most exaggerated view of tall buildings is achieved when shooting directly upward at an angle of 90°, which makes the tops of the buildings appear to be point-

Pointing downward at the reclining sunbathers does not show perspective distortion since figures lie across field of view without substantial physical depth. Man walking toward girls is foreshortened because feet are further away from camera than head.



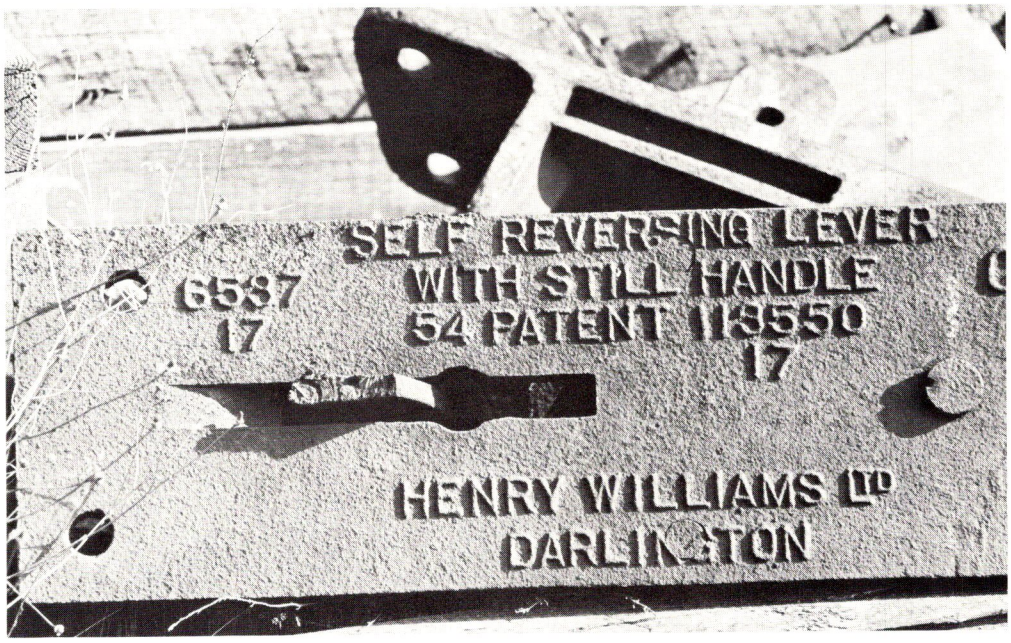
ing toward each other. An upward tilt of the camera often helps eliminate unwanted background details, as when shooting a portrait against a background of trees and rooftops. Merely by crouching just a little at an appropriate distance from the subject relative to the focal length of the lens being used, you get the sky for a background and a total absence of distracting forms and convergence.

When shooting parallel with the ground, at whatever height, the correct level is one appropriate to the subject as perceived by the ordinary viewer in such a situation. The world of a child is seen from a relatively low level, so pictures taken by adults would not seem as real to him as his own pictures. On the other hand, when the adult looks down toward the child, the adult makes accommodations for size and shape constancy, which cannot be done by the camera. Hence, to avoid foreshortening —the effect achieved when there is a rapid fall-off in size caused by working too close to the subject—the photographer should crouch or bend down to the level of the child or household pet or he should use a 100mm or 135mm lens at a distance sufficient to minimize the downward tilt of the camera.

Shooting from a high level is useful in achieving better composition and patterning of objects in depth. With the slightest of tilt, particularly when using a moderate telephoto lens, emphasis is given to the ground.

Shooting from a low level lends emphasis to tall, foreground objects, such as fashion models. The subordination of the background lends more drama to action, speed, and architectural forms. With a suitable background it leads to indefinite space and suggests vastness and magnitude.

Two examples of depth accentuated by side-lighting. This pertains even as to finely textured surfaces. In flat lighting, the protruding apartments would all have merged as though they were in a single plane. Notice how sharply oblique lighting of cast iron gives depth to texture and makes letters take on three-dimensional character.



100mm lens, Ilford FP4. Graham Finlayson, from *Just a Few Lines*, the book on abandoned railroad stations.

Cuenca-Casas Colgadas, Spain, 58mm f/1.2 lens, f/16, 1/125 sec., Plus-X, red filter for deep sky. Francisco Hidalgo.



THE MANAGEMENT OF DEPTH

Three aspects of depth are covered here: (1) the zone of sharpness, commonly referred to as *depth of field*; (2) pictorial depth, or the arrangement of objects, the positioning of the camera, and the selection of a lens to achieve desired pictorial effects; and (3) the use of light and shade in achieving impressions of depth. This last will be covered here briefly, because it is given a more detailed coverage in the chapter on artificial lighting.

Depth of Field

The concept and importance of depth of field were discussed preliminarily in the preceding chapter from the standpoint of camera operation. Depth of field is discussed here mainly as a matter of pictorial management. Theoretically, there is only one object plane of sharp focus. Within the limits of the resolving powers of the lens and the film this single plane of sharpness should hold up regardless of magnification. Depending on the viewing distance of the print, transparency, or projected image, there will also be observed a zone of apparent sharpness extending in front of and behind the plane of principal focus. Typically, the zone of sharpness represented in a depth-of-field table is applicable to a print of 8″ × 10″ seen at a viewing distance of about ten inches. For equivalent depth, a larger print would have to be held at a greater distance and a smaller print at a lesser distance. Mathematical formulations are available for this purpose, but since their result is never expressed as a viewing-distance guide on a print that is to be observed by many different people, one really need not concern himself with them.

It is often said that depth of field varies according to the focal length of the lens so that wide-angle lenses have

A moderately long lens, such as a 200mm, is extremely versatile in isolating details because of the highly selective angle and, at relatively close distances, throwing unwanted backgrounds and foregrounds out of focus. Selective focus puts emphasis on lower left figure. From story about South Yemen, courtesy *Daily Telegraph Magazine*. 1/60 sec., *f*/3.5. Graham Finlayson.





Note how selective focus gives desirable emphasis to foreground pattern yet retains background atmosphere. From the book *Portugal.* Graham Finlayson.

much greater depth of field than do telephoto lenses, while extreme wide-angle lenses are supposed to require hardly any focusing effort at all. This is a half-truth. If all images made by lenses of different focal lengths, all other conditions being equal, are reproduced to the same scale, then greater depth will be perceived in the pictures taken with the lenses of wider angles. The most common situation is the color slide or transparency. Since all pictures are reproduced within the same 24 × 36mm area, greater depth will be perceived for the overall scene taken with the wide-angle lens as compared with a telephoto picture, which captures only part of the same scene. If the more restrictive area of the scene covered by the telephoto lens were to be taken out of a picture made with a wide-angle lens under the same picture-taking conditions, and if the details were enlarged to equivalent size, depth of field in the comparison pictures would be found to be the same.

Using different lenses—whether the Rokkor 16mm or the Rokkor 200mm or any others—if you were to obtain the same image size on the film, by working closer to or further from the subject, depending upon the lens, you would find depth of field to be identical provided the same *f*/stop were used. The only thing that would change would be the size relationships of foreground and background objects, which would depend upon how close you are to the subject. In other words, depth of field is a function of image ratio or the relationship of size of object to film dimension at the same *f*/stop.

If you live principally in the world of black-and-white or color prints, which are enlarged to varying diameters according to the film used, the intended display, and the nature of the subject, you will be guided in the first instance by the *f*/stop as the principal determinant of depth of field. It would not matter whether you used one lens or another so long as you maintained the same image ratio. Second, you should always have in mind that, with any lens, the closer you get to the subject the narrower will be the zone of sharpness. When you get to the point of extreme close-up photography, the zone is razor-thin.

For those who work primarily with color slides, the same factors are governing, but since all of the slides are projected in sequence to the same dimension, you must expect that for the same shooting conditions and *f*/stops pictures taken with wide-angle lenses will appear to the audience to have greater depth of field than will pictures taken with telephoto lenses.

From the standpoint of effective image management, the photographer will choose combinations of lens aperture and shutter speed that give him deeper or shallower zones of sharpness, depending upon the subject matter. If he wishes to draw attention to a particular zone in the picture, such as in a portrait, he might want to take the picture at maximum aperture, which would usually call for a fast shutter speed or a low level of illumination. Under outdoor conditions this would call for the use of a slower film.

A related technique is to move the zone of sharpness forward or backward for desired pictorial effects while keeping the object of critical importance within the sharpness range. This is achieved by finding the distance at which the object is in sharp focus, as shown on the focusing ring of the camera, and then turning the focusing ring so that the indicated distance lies within the aperture brackets of the lens—toward the left to bring the zone of sharpness in closer and toward the right to move it out further.





Relative sizes of heads behind each other are clues to distance from subject and lens focal length. Usually longer focal length associated with comparable size. Both these pictures taken in hazy bright light, excellent for skin texture. Above, Bob Collins, Croydon, Surrey. Right, Richard Gee, editor, *Photography*.

The torn screen is rendered as an abstract by throwing the background out of focus, using 200mm lens. Stuart Davis, Hackensack, N.J., *Record*.



Pictorial Depth

Pictorial depth covers the treatment of objects in depth through selective use of lenses and positioning the camera relative to the objects in order to achieve desired effects with the background and foreground as well as to alter or control apparent size and space relationships among the objects.

If you work close to the subject with your camera you achieve the following effects in greater or lesser degree depending upon your working distance:

1. Foreground objects are accentuated to a greater size and are given greater pictorial separation from objects in the background or middleground.

2. Objects behind the immediate foreground diminish in size rather rapidly.

3. There is an apparent distortion in the foremost regions of foreground objects when working very close.

The use of extreme wide-angle lenses has a psychological impact upon the photographer. Since he must work close to his subjects in order to obtain large image scale, he becomes part of the scene with which he is interacting. With living beings he must adopt a working style that makes him personally acceptable as someone who really belongs in the situation. When working on a picture story, it is desirable to obtain some close-ups of individual beings or objects in order to provide accent. This may be achieved through the use of wide-angle lenses at short distances or telephoto lenses at greater distances.

Picture-taking at some extended distance from the subject may be done with any lens, but for recognizable details, this is the special province of telephoto lenses. Picture-taking at increasing distance from the subject has the following effects:

1. It renders the target area more compact. This is of special value when photographing groups of people arranged in depth rather than in a straight line across the field of view.

2. It conveys a feeling of distance through the effect of compression of detail in the background.

3. It maintains size relationships of objects in back of each other so that one is not excessively larger or smaller than the other.

With a telephoto lens you are separated from living beings, who therefore will usually go about their business in their own way without being conscious of your presence. This minimizes your interaction with your subjects while enabling you to render the details of the scene comparatively large.

As a matter of good pictorial composition, foregrounds and backgrounds should have some relationship to each other. This is the particular province of lenses from wide-angle through normal. The telephoto lenses, beginning with 85mm, tend either to be selective for particular objects or they tend to be background lenses.

A prominent object or some form that frames the scene provides a foreground anchorage for the rest of the picture. Since foreground objects can be rendered most sharp in their details, the haziness of the background becomes more tolerable. That is, where the background by itself might have seemed flat and without depth, the inclusion of prominent foreground objects may make the entire scene acceptable.

Another technique is to rely upon leading lines, which guide you from the foreground to the background. Most commonly, this might be perceived through a gracefully curving path or driveway. It can also lie in some other arrangement of objects that lead you from a foreground center of interest to a background center.

Some general rules can be stated about the treatment of backgrounds from the standpoint of good pictorial presentation:

1. The background should serve a useful purpose in setting off or complementing the foreground. It can be in

Clelland Rimmer had a row of prints of Che Guevara laid out on a table. He made this shot to demonstrate the progressive fall-off in sharpness away from the point of critical focus. 135mm, 1/60 sec., *f*/11, Kodak Tri-X.



harmony with the foreground or in contrast with it, but if the latter, it should not be directly competitive.

2. Contrast is normally a matter of a light backdrop for a dark foreground or a dark background to set off the principal bright subject in the foreground. In most cases, neither dark against dark nor light against light will serve as useful combinations.

3. A simple, strong foreground can be used to set off a complex or crowded background.

4. In color photography, especially when working indoors, background colors can be varied to achieve desired complementary or contrasting effects with the colors of dominant foreground objects.

5. When working indoors with artificial lighting, as much attention must be given to the background as to the main subject. When using flash with a subject at some distance from a background, you must expect darkness as the background effect, punctuated by scatterings of reflection from lighter objects. Much of this can be eliminated when you have control over the placement of objects, but when you work with existing situations you might be able to make only a few obvious changes, including the selection of your own shooting position.

6. With objects close to a background indoors, whether a blank wall or seamless paper, one of your main problems is to avoid too many shadows. You may need as many as three important lights for the main subject, but you will also need one or two lights for the background to control or subdue shadows and to heighten or lower the brightness properties of the background relative to the main subject.

7. Whether indoors or outdoors, arrange the objects or your own shooting position to avoid distracting verticals such as door jambs, telephone poles, and trees growing out of heads.

8. Focus selectively to achieve the desired degree of sharpness and unsharpness for the different pictorial planes. Use the depth-of-field preview button to see precisely the effect you will achieve after selecting your focusing distance and lens aperture.

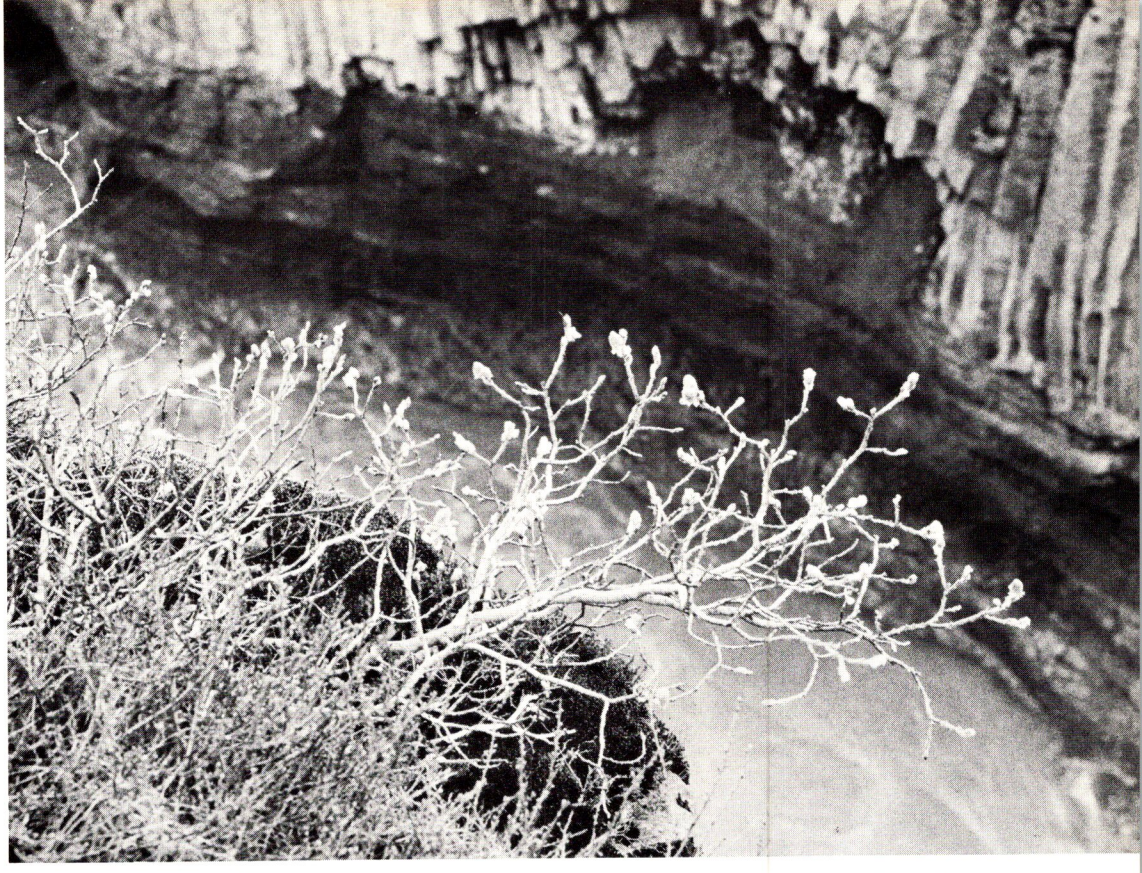
9. If you have control over the situation, experiment with and alter size and distance relationships among objects through choice of your own position and use of a lens of appropriate focal length, which will give you the desired image scale at your selected working distance.

Lighting and Depth

In completely shadowless lighting, where the sources may be many and diffuse, or on a dull, overcast day in which light is derived from every point in the cloud cover, it is very difficult to perceive depth relationships. Objects seem to blend into each other; they do not offer the clues to separation afforded by shadows. For portrait purposes, the best pictures are taken outdoors under a hazy, bright sunlight. For most other pictures, such lighting is also ideal, because it provides a feeling of depth through the casting of shadows while also enabling shadow detail to be recorded because of the diminished contrast.

Frontal lighting is least effective, particularly for portraits because of the squinting it produces. Frontal lighting does not cast the oblique shadows that help set objects apart from their environment. The photographer is thus obliged to seek a position in which the sunlight is not directly behind him. For most shooting, the dominant source of lighting should be at an angle of about 45° with fill-in lighting provided by reflection or supplementary lighting sources. The direction of the main source of lighting models the subject and provides the shadow patterns, which lend adequate depth.

When surface textures are to be



The foreground was emphasized, using the close-focusing 35mm *f*/1.8 lens at the edge of a sheer drop into a river in the bleak interior of Iceland. Stopped all the way down, the background was still effectively out of focus yet of clear form to put the vegetation in context. Ilford FP4, 1/125 sec., *f*/16. Joseph D. Cooper.

brought out, the main lighting source must be highly directional from the side. The angle of the sidelighting will be governed by the depth of the surface variations. To bring out printed images, such as engraved postage stamps, most clearly where a thin layer of ink rests upon the surface of the paper, lighting should be at a highly acute angle. With a deeply textured surface, the angle of lighting should be somewhat less; otherwise, it would merely skim the surface, and harsh shadows would black out the rest of the texture. To photograph the form and texture of a building surface, the sidelighting should be at a somewhat greater angle in order to bring out the structural forms in depth.

One of the most dramatic forms of depth presentation is through backlighting, in which the main source of light is directly behind the subject. This provides a pronounced separation of the main object from the background, but it is important to achieve just the right exposure, which retains a combination of good highlight and shadow detail. This is discussed further in the chapters on exposure and artificial lighting.

THE INFINITE RULES OF COMPOSITION

A great deal has been written on the subject of composition, which is how to place objects, color, and tones within the rectangular frame of the film for the best or desired pictorial effect. Sometimes good composition is found after the fact—after the photographer has taken many pictures and selects from them those which yield the most pleasing effects for which he can provide the

most appropriate rules of composition in afterthought. Under contrived or specifically designed conditions the photographer can apply his particular rules of composition before the fact. Even when shooting pictures under prevailing conditions, which cannot be controlled by the photographer, a knowledge of what makes good composition enables him at the very least to know when to shoot and when not. Even when the subject matter is most interesting, the photographer may know that the composition is very poor and that therefore he will not achieve pleasing results. Why should he take the picture unless, being a journalist perhaps, he must record some unique or dramatic action regardless of composition?

The special problems of composition in depth were discussed above. Here we will take up rectangular composition, dynamic elements of composition, and the use of color and black-and-white media. Whatever is said, however, remember that rules and guidelines cover the general run of situations; they do not cover unique situations in which you must make unique judgments. What counts most is whether the final outcome is pleasing for the people who are going to look at the picture.

Rectangular Composition

Rectangular composition pertains to the arrangement of forms within the film area, which is in the ratio of 1:1½ or 2:3 covering the film area of 24 × 36mm. Each situation calls for judgment about the best arrangements of objects as accomplished by placement either of them or of the photographer or of both. Usually the first decision a photographer must make is whether the picture is to be taken along the horizontal or vertical format. The proportions of the scene itself will generally be the most important factor, so this is usually not much of a decision. When the photographer has to select from within a larger scene, he should experiment holding the camera both ways in order to perceive how the selected part of the scene is to fit the limited picture area. In general, the horizontal aspect suggests repose or sideways movement, depending upon the subject matter. The vertical format is most appropriate for the depiction of height, strength, and magnitude.

Within this rectangular area the photographer usually strives for simplicity, for if he has too much to arrange and display, he tends to complicate the technical problems of taking pictures, particularly as regards depth of field, and is likely to achieve a hodgepodge of material. One of the first rules of good composition, therefore, is simplicity.

When there are many elements within the scene, they can be rendered more simply if they are related within some unified pattern, another principle of good composition. Related to this is the principle of rhythm or pattern. If there are many objects or forms in some parallel or related configuration, they take on a totality of pictorial impression.

The principle of balance refers to the weighting of different components of the picture in relation to each other, including objects, tonal masses, total contrast, and movement as opposed to the lack of movement. This does not mean that dark must be balanced equally by light. To the contrary, a quiet scene characterized by a great deal of gray or highlights can be balanced by the judicious placement of a single dense or dark object.

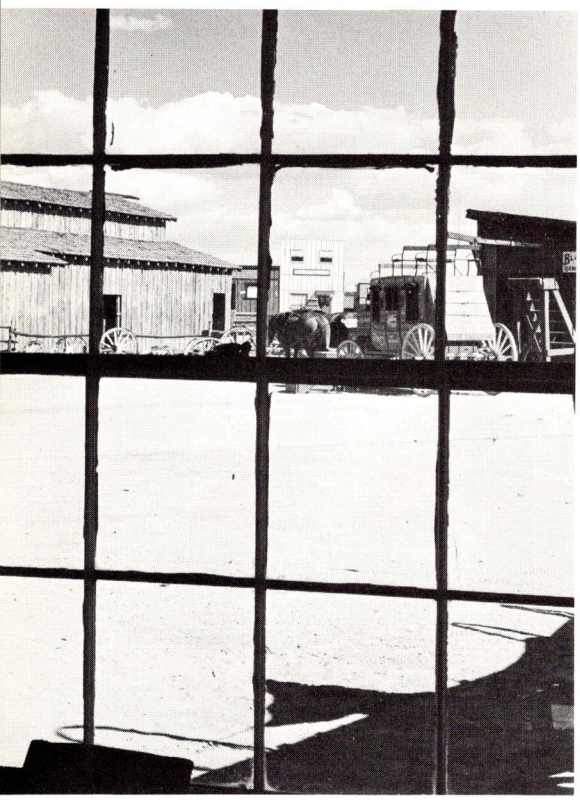
Movement within the rectangular area ordinarily should be inner-oriented. A moving object should not be going off the very edge of the photograph. It would look better if it were coming into the pictorial area from the edge, although it should not be at the very edge. Within the scene, a subject could be approaching from the background



One "rule" of composition is to lead gracefully from the foreground to background along a curved pathway. Nevertheless, most of the people who compared these two pictures taken in the interior of Iceland preferred the one with the straight diagonal path and the figures at the crest of the hill. 35mm *f*/1.8 lens, 1/125 sec., *f*/8, Ilford FP4. Joseph D. Cooper.







Varying approaches to framing subject matter. Standard 55mm lens. Joseph D. Cooper.





The lone figure against a big, empty area, with just enough other props in the picture to indicate that he had been marketing. 100mm, Ilford FP4. Joseph D. Cooper.



Geometric parallelism as form of composition. Railing at top provides necessary "prop" to locate subjects. Cowboy club, snow, Münich. 35mm lens. Graham Finalyson.

The spiral leading into center of picture directs attention of the viewer. Standard 55mm lens, Tri-X. Joseph D. Cooper.



to the foreground, which is most usual, although dramatic effects can be achieved by following pictures from the foreground into the background. When there are two or more moving objects within the scene, dramatic effects are sometimes achieved when they are moving away from each other, but ordinarily there should be some element of unity in the moving interactions of the people or objects.

Pictorial Dynamics

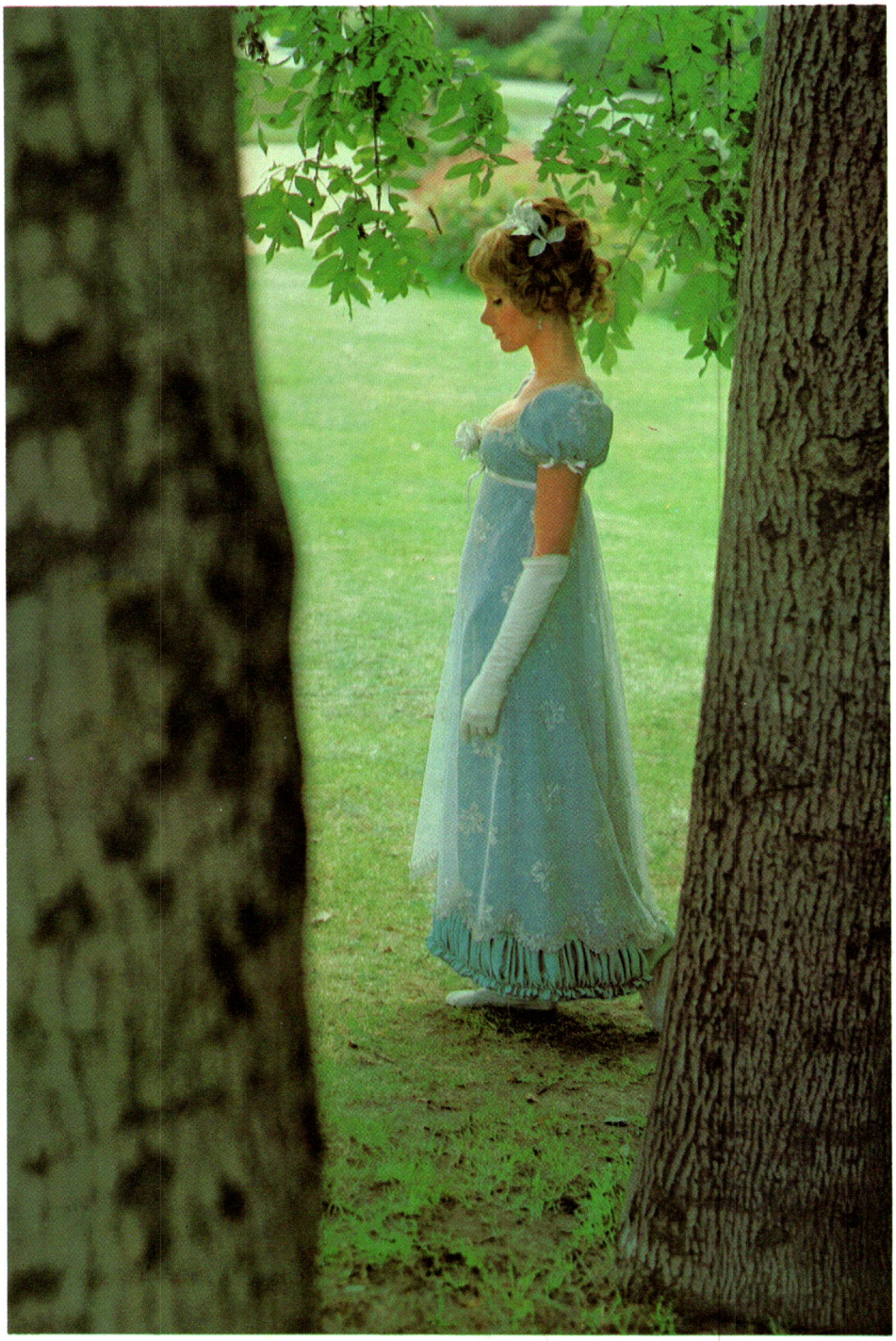
Pictorial dynamics means the element of creative tension. Something about the picture should heighten the interest of the viewer and cause him to identify with the situation or to understand it in some way. This accounts for the great interest, particularly in the early days of 35mm photography, in what was called "the candid camera," for the small unobtrusive instrument enabled the photographer to record many aspects of life in all of its spontaneity. Thereby he generated pictorial energy.

An important way of achieving pictorial interest is to seize upon discontinuity or incongruity. In the first instance, discontinuity pertains to the breaking of a rhythm or an interruption to a line of movement. An abrupt form of this discontinuity is presented when the photographer records a motor racing accident showing parts of the vehicle spreading out in all directions as a result of sudden impact interrupting simple movement. Incongruity pertains to the clash of subject matter—ordinarily the depiction of opposites such as pathos when humor prevails or a young lady in an evening gown being drenched by the rain. Related terms, which may be used to describe aspects of creative tension, are *pictorial contrast* and *opposition.*

The joining of rectangular composition and pictorial dynamics is achieved through a geometry of order and space. The simplest rule for ordering the objects within the subject field is to divide it into thirds both horizontally and vertically and to place the center of interest at one of the inner intersections of the lines. Many subjects fit into this type of arrangement, but it is only one approach to good composition. Sometimes the shading, lines of action, pathways, and other curving or intersecting lines will lead one to centers of interest and suggest good arrangements of pictorial opposition and balance. In some situations, photographers have successfully used a spiraling arrangement of subject matter in which objects seem to be circling toward the center. Quite commonly, the photographer seeks good foreground organization either through a dominant object near the bottom, which has mass and deep tone, or through the use of archways, overhangings, tree limbs, doorways, and other natural framing arrangements.

Color and Tone

The subject of color composition in itself has preoccupied writers throughout entire books. We can touch upon it only briefly in this chapter, mostly by reference to the uses of color as opposed to black and white. With color, a distinguishing feature is that the entire composition can effectively be rendered through the disposition of tonal mass, even if the picture as a whole is not critically sharp. The photographer works with color saturation or delicate pastels to achieve the particular effects he desires. Sometimes he might use a small bit of color to lend accent to a large area of neutral tone. Color is a highly subjective medium. The prevailing notion is that through the use of color films one can depict reality, yet this is not really so. Color films might have relatively high fidelity, but on the



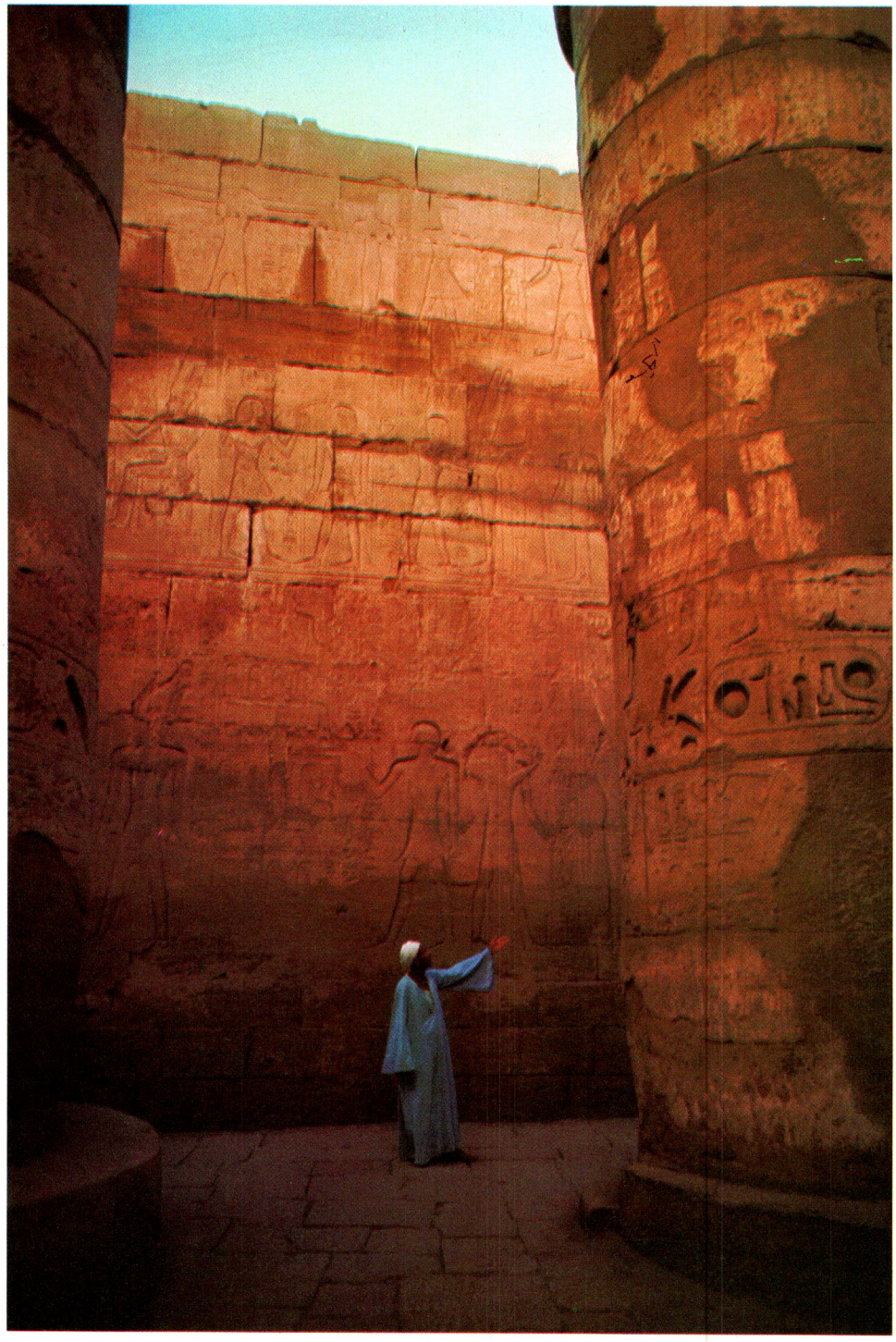
British actress Susan Hampshire posed in costume she was to wear for part in BBC program. Graham Finlayson sought to convey softness suggested by foreground tree, slightly out of focus. The second tree frames and leads viewer toward subject. 35mm lens and Kodachrome II. Courtesy *The Sunday Times Colour Magazine.*



In picture above, prominent foreground objects lend depth to scene, which otherwise would appear barren. Deep blue sky indicates clear day at edge of desert, east side of Nile near Luxor. Gene Vos had to work his shutter quickly. People in exotic countries often object to being pictured. 28mm, Ektachrome-X.

Impression of depth in picture below provided by contrast between clear foreground and and hazy background, which in landscape photography is called aerial perspective. Depth also suggested by pictorial movement from foreground objects to people on top of ridge as well as through sidelighting. Picture from high ground. 200mm, Kodachrome II. Graham Finlayson, courtesy *Daily Telegraph Magazine*.





Small figure was gesturing toward erotic carving. Gene Vos was next to him, sensed this would make the picture, backed off and took it. Human figure lends scale to wall and columns. Spot of blue color breaks up what otherwise could be monotonous effect. 28mm, Ektachrome-X.







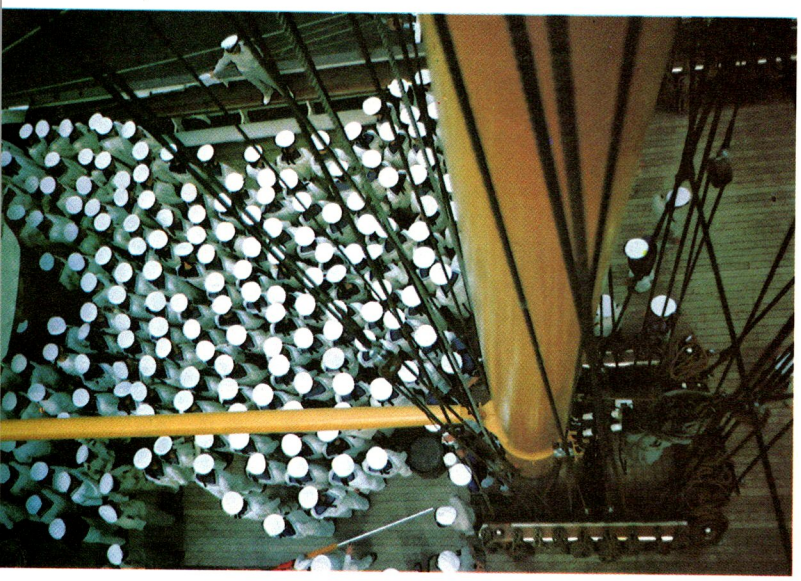
Pictures made with Rokkor Fish-eye 16mm tend to show world as a sphere. Objects fall off in size rapidly toward background and sides. Camera about 1½ feet from all four subjects. Photos by Joseph D. Cooper, High-Speed Ektachrome-X rated ASA 400. Girl unaware that lens had included her, for she was to its side. At bottom, Propylaea of Acropolis by Gene Vos, Ektachrome-X. Note effect of tilting lens upward.







Depth suggested through selective focus; contrast between sharp foreground flowers and out-of-focus objects of background enhanced by aerial perspective. Taken from balcony ledge looking toward Empire State Building. Ektachrome-X, 58mm lens, Suzanne Szasz.

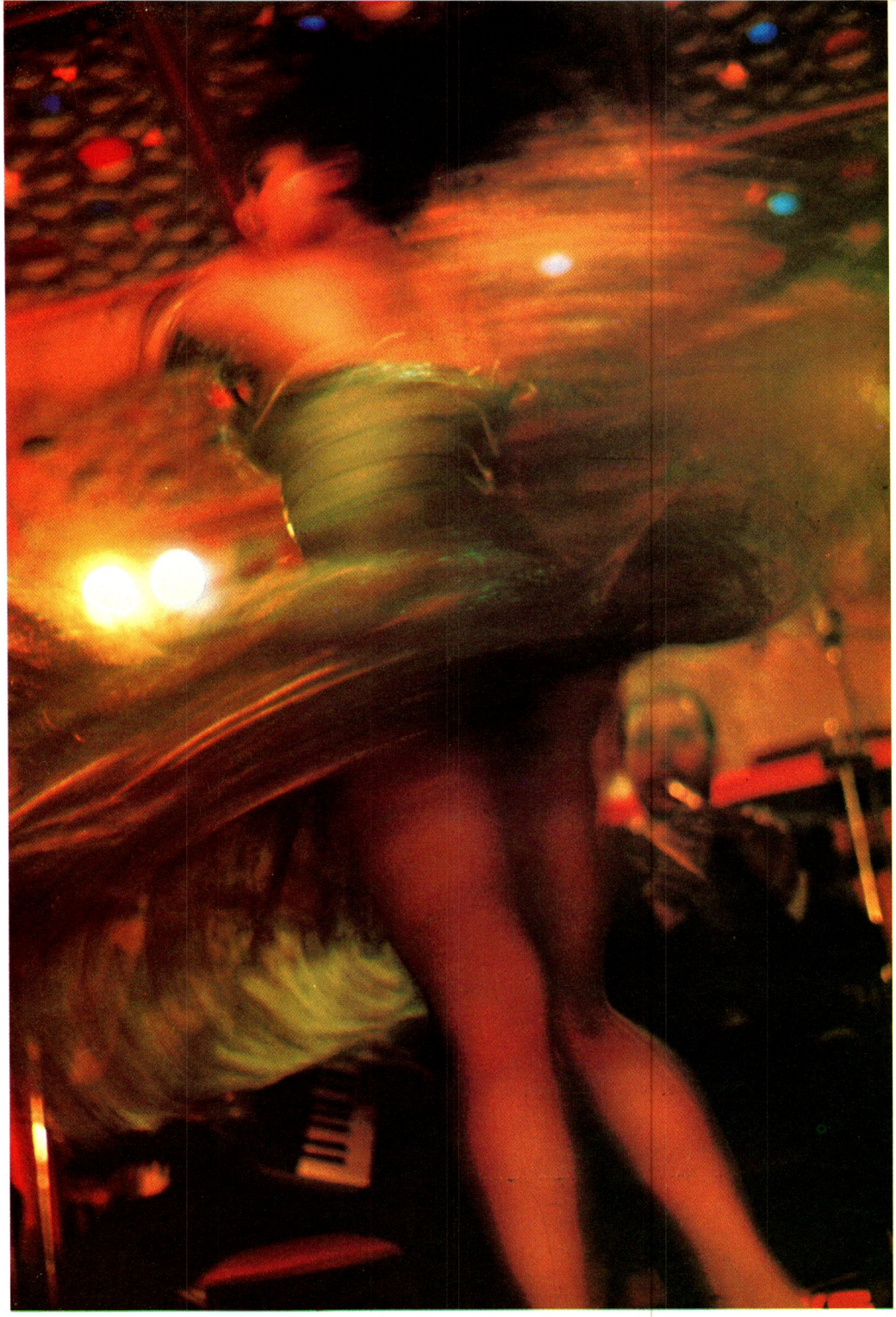


Unusual viewpoints, high or low, help to dramatize simple situations. Gene Vos climbed up the rigging of German training ship to get picture of captain addressing cadets. The 28mm lens took in essential area but exaggerated the perspective effect as seen in mast.





On first impulse, the 100mm *f*/2.5 lens was used for close cropping. A shorter focal length was substituted—the 55mm *f*/1.7—to put the small crowd in the Stockholm public square in geometric setting. Photos by Joseph D. Cooper, High-Speed Ektachrome-X rated at ASA 400.



Subject motion may be good if it conveys action. Gene Vos explained how he made the picture: "There was enough light on the stage of the Cairo night club to shoot the belly dancer at *f*/1.4 with the 58mm lens at 1/60 sec. I decided to use a slower exposure of *f*/4 and 1/8 sec. to capture the spinning of the dancer and did this by kneeling down on front of the stage. Shooting directly into the spotlight added to the mood of excitement."



The geometric patterns make these two pictures. The windmills in Portugal near Setúbal show repetition of pattern; made from a distance, 200mm lens, Kodachrome II. Lower picture, 28mm lens, Kodachrome II, showing sails and fishing gear near shore line at Nazaré, Portugal, emphasizes a diversity of color and geometric form, with foreground and background separation. Graham Finlayson.





Francisco Hidalgo is a talented Paris photographer with a flare for creative interpretation on the esthetic side, influenced probably by his background as an art student. The circular configurations in this picture of the Statue of Liberty made with a 200mm lens on Ektachrome-X at 1/250 sec. result from points of light being badly out of focus and in this case being put to pictorial use. The picture was made shooting through autumnal leaves of a tree.



Extreme depth of field in fashion picture by Graham Finlayson for *Daily Telegraph Magazine* (photographed in Outer Hebrides) achieved through stopping down 35mm lens. Finlayson used natural framing to target subject. Kodachrome II.



Clear, bright object in foreground suggests depth, offset by slightly out-of-focus background, which provides pleasing color contrast. Suzanne Szasz got close as possible with 58mm lens, *f*/2, Kodachrome II.



From the standpoint of composition, usual rule is to have unity of interest. Here, unity is suggested through the "what-do-I-do-now?" appearance of model. Slightly overcast sky ideal for outdoor color. 35mm, Kodachrome II, Graham Finlayson, courtesy *Daily Telegraph Magazine*.



Manhattan and the Brooklyn Bridge, from the Brooklyn shore at dusk. Darkened foreground obscures curvature of 16mm lens, but this can be seen slightly at either end of Manhattan skyline. *f*/2.8, 1/15 sec. Plus-X. Francisco Hidalgo.

Graham Finalyson saw a good composition in the shape and shading of the tree against the patterned wall. All they needed was an opposing form to fill the left side of the picture. His patient waiting was rewarded when the old lady shambled into place. 200mm lens.





Suzanne Szasz sensed the rhythm, patterning, and content and fired away. 100m, Plus-X.

whole they do not faithfully represent all of the real-life colors in a particular scene. For this reason, the photographer may wish to alter the scene through the use of warming or cooling filters or through selection of particular color films that have personally preferred attributes.

In black-and-white photography, one must work with a range of tones completely devoid of color. Effective results are achieved through lighting, shadows, contour display, tonal values, and relationships among all of these. There is also a great deal of opportunity for manipulation of effect in the darkroom as well as in the camera itself—a flexibility not afforded to the same degree in color film. The photographer must concentrate on subject matter and its composition to a greater degree than in color photography. He makes dramatic use of blacks and whites in opposition to other tonal areas.

Forground emphasis was lent through use of the 21mm lens, which spaced out the texture elments of the cobblestones. The "white-out" effect was achieved through slight underexposure of the foreground and contrast printing on Ilfobrom 4. Graham Finlayson.

CHAPTER IV

The Rokkor Lens Guide

This chapter is the basic guide to selection and use of Rokkor lenses. It includes suggestions for building a personal lens kit; the advantages and disadvantages of auxiliary lens converters; characteristics of categories of lenses—wide-angle, normal, telephoto, and zoom; and specific data on each lens in the Rokkor series. In addition, the introductory material covers certain aspects of lens performance governed by considerations of optical design.

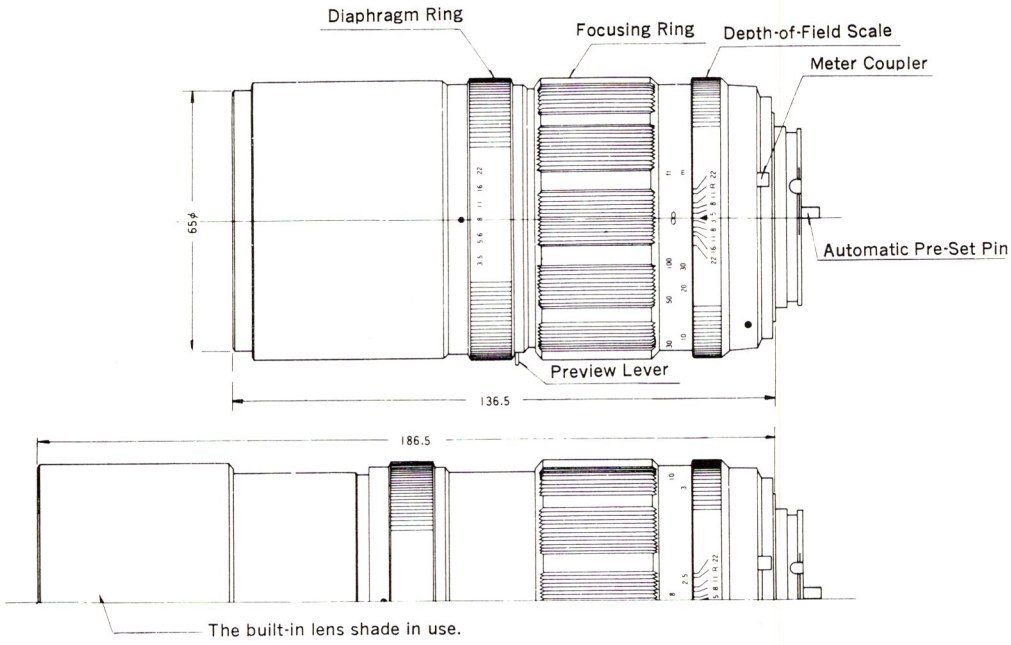
LENS DATA

A data sheet for each Rokkor lens is included in this chapter. It includes optical and mechanical specifications that describe the lens together with reference data on various uses of the lens, whether in terms of working distance or close-up operations. The key descriptions are covered briefly here as they pertain to each lens-data sheet. (See also the explanations in Chapter 2.)

Focal Length (F) and Angles of View

Focal length, expressed as *F*, and angles of view are different ways of describing the scene coverage, or image-sizing capabilities, of a lens. A long focal length has a narrow angle of view, whereas a wide-angle lens (wide scene coverage) has a short focal length. Focal lengths are considered long or short by reference to whether they are greater or shorter than a norm of the angle of coverage corresponding to 43.4mm, which is the diagonal of the image area of 24 × 36mm. In practice, lenses of focal lengths 50mm through 58mm are considered normal. Their range of coverage for the diagonal is 46° through 41°.

The term *telephoto lens* is used to refer to all long focal length lenses, although in the most literal sense a telephoto lens is one whose physical length is shorter than its focal length. This is accomplished optically through design with a negative diverging lens at the rear of the lens complex.



Mechanical components of a typical Rokkor lens.

Lens Apertures (*f*)

The lens apertures that govern the amount of light entering the camera and therefore influence exposure are stated as ranges from widest to smallest; for example, the 55mm $f/1.7$ lens has an aperture range of $f/1.7 \sim 16$. The smallest aperture number is the largest opening, stated first, while the greater number stands for the smallest opening. The problem of diffraction limits, explained below, is governed by the size of the smallest aperture designed for the lens. Theoretically, each lens aperture value is computed for the ratio of aperture to focal length when the lens is focused at infinity. When the lens is focused for closer objects, it is extended from the film plane and thereby acquires a different (smaller) aperture value expressed by larger aperture numbers. In practice, so long as you work within the focusing ranges of your lenses, other than the close-focusing ranges of the two Macro Rokkor lenses, you need not make adjustments for changes in lens extensions.

With extension tubes or bellows extension (but not close-up attachment lenses) significant extensions are made in the distance of the lens from the focal plane, calling for adjustments in exposure, because the nominal f/numbers become higher in effect. With the built-in metering system, such adjustments are made automatically, but for meterless cameras and for other computational purposes you can use the formula:

$$\text{Effective } f/\text{number} = \frac{\text{V}f}{\text{F}}$$

where V = focal length plus lens extension from infinity focus
f = f/number indicated on lens aperture scale
F = focal length of lens

Lens apertures for any given lens have the same light-transmitting values, regardless of focal length.

Focusing Distances

The closest focusing distance of each lens is stated as a guide to performance characteristics. Each lens focuses to infinity—a distance beyond which everything is in focus and fine focusing adjustments can no longer be made.

As convenient measures for selection and use, approximate focusing distances are given on the lens data pages for each lens for portraits and full figures. These are subjective guides for such framing space as the photographer considers appropriate. With short focal length lenses permitting close focusing it must be remembered, however, that portraits are not recommended—at least to fill the image frame. At close range, perspective distortions are introduced, which are not desirable except as special effects.

Close-Up Guides

Information is provided for each lens for the use of the various close-up devices and attachments. Knowing the image magnification attainable under each arrangement, together with the necessary working distances, the photographer can plan for the appropriate combination of lens and close-up accessory.

Depth-of-Field Tables

The depth-of-field table for each lens provides the ranges of apparent sharp focus for each *f*/stop at selected focusing distances. You will sometimes find depth-of-field tables given in meters only. For conversion from metric dimensions to feet and inches and to make other conversions the following dividers can be used:

For converting	*Divide by*
millimeters to inches	25.4
millimeters to meters	1000
centimeters to meters	100
inches to meters	39.4
feet to meters	3.28

Minolta depth-of-field tables have been computed on the basis of a circle of confusion of 0.03mm.

With lenses of short focal length the effect of a fixed focus lens can be achieved by setting the focus at the hyperfocal distance. At this setting, objects from half the hyperfocal distance to infinity will appear to be sharply focused. While optical formulas can be used to find the hyperfocal distance for each lens at a particular aperture, a simpler way is through use of the lens scales. First, set the lens at infinity and at the desired lens aperture. The depth-of-field bracket marks will show the distance beyond which everything will be in focus. Then set the focusing scale at that distance. A 35mm lens set at infinity and *f*/11, as an example, will show that everything will be in focus from 11 feet on. The focusing scale should be set at 11 feet, whereupon everything from 5½ feet to infinity will be in focus.

Lens Illustrations and Diagrams

In order to show scale, a picture is included of each lens mounted on the camera. In addition, a dimensional drawing is given with the lens elements and groups drawn in to show their positioning. The meaning of the optical diagrams is suggested by the accompanying examples and captions.

PERFORMANCE OF LENSES

All lenses used in photography, regardless of who makes them, are compromises in design. The lens designer knows, for example, that the wider the angle of coverage, the greater will be the curvature of the front elements and that this will introduce optical problems because of the oblique directions from

which light rays strike the front lens surface. Accordingly, he utilizes glasses that have high refractive indexes—glasses that enhance the transmission of light. The wider the angle of coverage, the greater are the optical aberrations and distortions he must overcome or minimize through adding lens elements and spacings into his formulations. At the same time, he must balance each advantage and improvement off against increased size, weight, compatibility with screw-in filter sizes, and cost. This pertains to lenses of all focal lengths, each of which has its own problems. The achievement of optimum lens performance is, in the first instance, a responsibility of Minolta's lens-making organization, but it also depends on how well the photographer makes use of film, light, and shade, among other factors, in taking his pictures.

Critical Factors in Optical Performance

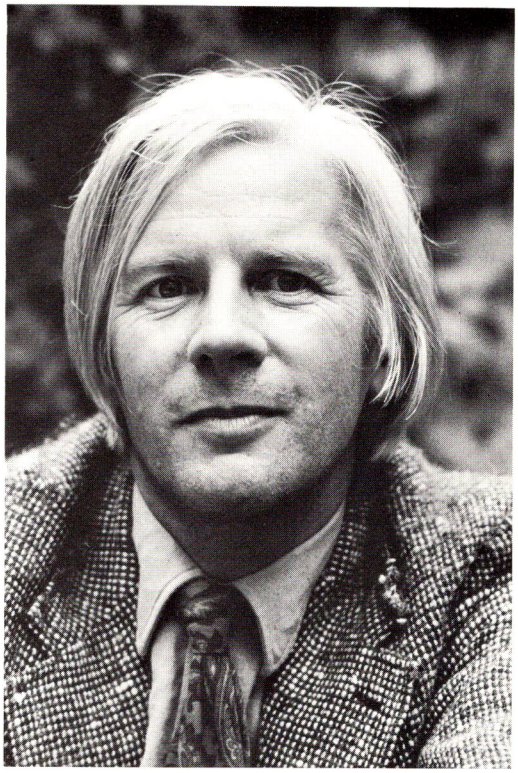
In the early days of 35mm photography, emphasis was placed on fine optical resolution, fine film resolution, and fine-grain development of films. This combination, it was believed, would enable the photographer to make maximum enlargements from the tiny films. Image resolution, whether by lens or film (or, more appropriately, by both), is the ability to form distinct images of fine details. This is usually expressed as the number of lines per millimeter that can be distinctly or clearly seen as separate lines.

The more modern view is that optical contrast is at least as important as resolution and that for best performance both attributes must be well represented in lens design. Optical contrast is the ability of the lens to form sharply delineated image contours, so tonal areas are clearly separated without overlapping each other. This property in film is referred to as *acutance,* or contour sharpness. Optical contrast lends snap to an image; without it a picture might appear soft or flat. The attainment of good contrast is enhanced through anti-reflection coatings on the surfaces of lens elements, mainly to control flare. Flare is a local or generalized fogging of the film as a result of light bouncing off the many glass surfaces inside the lens.

Minolta lens engineering seeks to achieve maximum resolving power and optical contrast with a minimum of flare, with particular attention to performance at wide apertures. A problem of fast or wide-aperture lens design is that quality in the center of the image can be very high, but the tendency is for performance at the edge to fall off. Minolta lenses undergo continual improvement in this regard so as to achieve maximum uniformity over the image area. A slight stopping down of the lens —say two stops—should eliminate residual variations in resolution from center to edge. Although a two-stop reduction in aperture has been a rule of thumb in photography, for correction of some optical defects, this does not necessarily hold true for all lenses. There has been an increasing tendency to design lenses for optimal performance at the widest apertures. The important thing is that you learn the performance of your own lens.

Another quality problem that has been highlighted by the greater popularity of color film is the tendency for lenses, especially the wide-angles, to project less light to the corners than to the central image. With black-and-white films, exposure latitude and darkroom control can compensate adequately for density variations. Color films cannot tolerate these differences very much, for they do not offer much exposure latitude. The effect, unless corrected optically, is for the corners to darken. This problem, like the others mentioned above, has been largely corrected in the current Rokkor design program, although for optical reasons, slight fall-





An afternoon with the George Teeling-Smiths and two lenses, 35mm f/1.8 and 100 f/2.5 in London. Light was hazy bright. Portraits made with 100mm lens. Girl feeding pet dog with 35mm. Indoor first-aid operation 35mm and bounce flash. Note selective focus on dog at master's feet. Ilford FP4. Joseph D. Cooper.











Above, the street market transaction presents a confusion of detail accentuated by the moderate telephoto 100mm *f*/2.5 lens. The extreme wide-angle performance of the 16mm lens concentrates attention on the foreground transaction while suggesting the overall background in diminished detail. At 1/125 sec. between *f*/8 and *f*/11, Ilford FP4. Joseph D. Cooper.



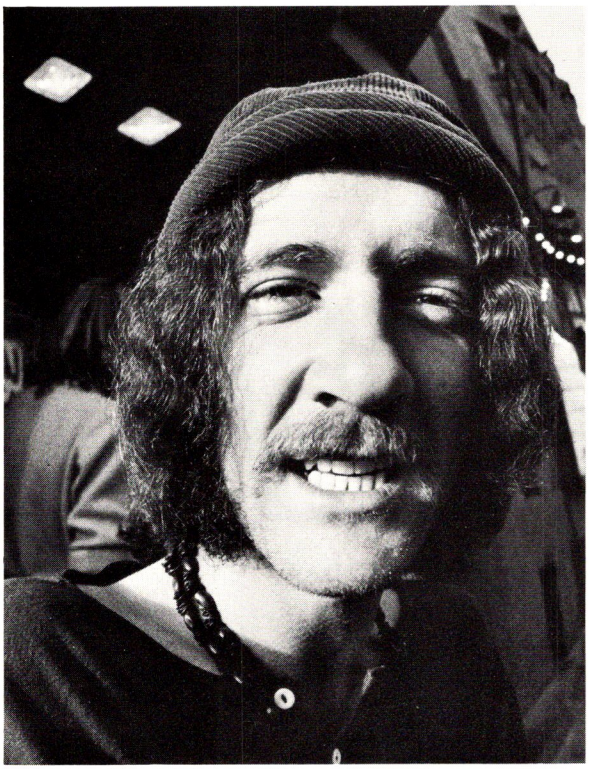
offs in light at the corners cannot be totally avoided. For instance, at the edges of pictures made with the 16mm fisheye lens, which is an extreme case, you will notice some darkening, especially at wide apertures.

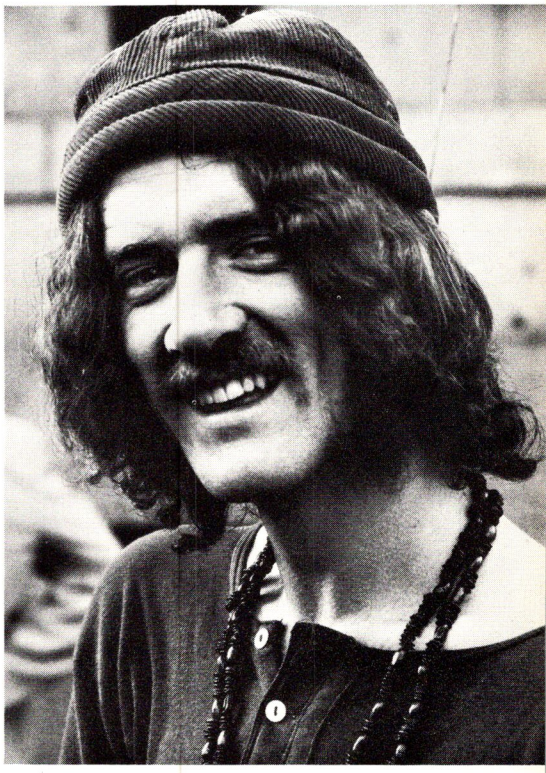
Individual lenses vary in their performance because of minute differences in manufacturing tolerances. These differences are minimized by top quality lens makers through rigid quality controls. Minolta is one of the leading optical firms that practices rigid quality control. Nevertheless, you may discover the minute variations in performance of your lens through actual experience. Such variations may be expected to be inconsequential. If you should use lenses of independent make, you would need to be assured that a high order of quality control has been maintained in order to hold quality to minimum tolerances. As there are many different makes of independent lenses and as reject quality control is expensive, this assurance cannot always be provided by the camera dealer.

Optical Aberrations and Distortions

The theoretically perfect lens image consists of a round point of light that, when sharply focused, is registered as a similar point on the focal plane (or film plane). A truly perfect image is not optically possible. A microscopic view of the "point" would show it as a central dot or diffraction disk surrounded by narrow rings or circles of light. About 86 per cent of the light is centrally concentrated. The dot and surrounding rings are at their smallest when the lens

The fisheye picture, below left, exaggerates what happens when using lenses of short focal length in full-face portraiture. Ideal lens for portraits is 100mm *f*/2.5 used to make picture at right. At 1/500 sec., *f*/11. Tri-X.





is used at its widest aperture. Stopping down the lens aperture tends to increase the size of the diffraction disk to the point where a tiny aperture causes a softening of image quality. Practically, this is no problem when working up to $f/16$ and perhaps $f/22$.

Spherical aberration is caused by the curved surfaces of the lens. Light rays passing through from different points on the lens tend to come to a focus at different planes, thereby causing softening of the image and color fringing at the edges of objects. Stopping down the lens about two stops overcomes this problem somewhat.

Zonal spherical aberration is a fault common to fast, wide-aperture lenses. Light rays passing through the center and rim of the lens come to a common focus, but rays from the intermediate zone come to focus in a different plane. The effect under microscopic view is that of a clearly formed central dot, a blurred area surrounding it, and a clear outer ring. When the lens is stopped down one or two stops from full aperture the blur is eliminated, but the focus is shifted.

These shifts in focus do not constitute a problem in ordinary photography, but they do indicate that the very wide-aperture lenses should not be used in extreme close-up work where shifts in focus cannot be tolerated.

With the aid of the computer, the development of new glasses, and advances in optical science, lens designers continue to minimize optical faults, although they will never succeed in overcoming them all, for the bundle of glass in a mount can never have the flexibility of the human eye and brain.

Obtaining Optimum Performance

Notwithstanding all that has been said about the fine points of optical faults, the proof of a good picture is in the beholding. Modern lenses, as typified by the Rokkors, do an amazingly fine job. The pictures included in this book offer ample testimony to the optical excellence of these lenses. Technical tests of how lenses record optical targets in the laboratory do not stand up against actual picture results.

Softness of images is caused by many different conditions, all of which can be cumulative—pushing of film ratings, inaccurate developing procedures, faulty lens performance, flat lighting, camera movement, dirty lenses, and sloppy enlarging techniques.

For total pictorial excellence the photographer must take account of all relevant techniques and procedures. Non-optical mechanical techniques are taken up in the chapter on basic camera operations. The appearance of sharpness, attributable to light and shade manipulation, is covered in the chapters on image management, artificial lighting, and close-up techniques.

For critical close-up work, the 50mm or 100mm Macro Rokkors are best. They are specially corrected for close ranges—less than three feet. General-purpose lenses of the various focal lengths are designed for photography of more distant objects.

CHOOSING YOUR PERSONAL LENS KIT

Guidelines for building your personal kit of interchangeable lenses are meant to be used only as points of departure. Start with an understanding of effects to be achieved with each category of lens. Then inventory the kinds of pictures you would like to be taking most frequently. This can help you decide the next category from which to select a lens. Having gone through the lens availabilities and studied the pictures made with them and the special effects

achieved, you will be better able to make your own selections.

Color-slide photographers have less flexibility than do black-and-white photographers. At comparatively little expense, the latter can vary image sizes in the darkroom. Color photographers have the same theoretical advantage, but at a greater cost and inconvenience. For the most part, color slide photographers base their lens selection on the size of image rendition in the original slide.

The categories offered here include general photography, existing light photography, general daylight photography, portrait photography, architectural photography, and sports photography. All references are to Rokkor lenses except for the general discussion of focal length converters and their uses and limitations.

General Photography Kits

This category covers the greatest variety of equipment and offers the greatest flexibility for both professional and amateur. Specialized uses of extreme wide-angle and telescopic lenses are omitted. Photographers interested in the 16mm fisheye lens or the 300mm or longer lenses should refer to the relevant categorical discussions in this chapter.

The *one-lens photographer* can use any lens he wishes if his needs are specialized, but for general photography he might choose one of the normal lenses in the range 50~58mm or one of the moderately wide 35mm lenses. In fact, some years ago, 35mm lenses became rather prominent among those most used by photojournalists. Among the standard lenses—55mm *f*/1.9 and *f*/1.7, 58mm *f*/1.4, and 58mm *f*/1.2—choice depends on the extent to which you expect to work under adverse light conditions. The light transmission ratios are given under the discussion of normal lenses. A third possibility is the 50mm Macro Rokkor, which, as explained under the normal group, can focus close enough to reproduce images in their original sizes.

The *two-lens kit* could include lenses within the range of 28~135mm for most purposes, subject to exceptional needs. A combination could be one normal lens plus one wide-angle such as a 28mm or 35mm or one tele such as the 85mm, 100mm, or 135mm. Some photographers prefer to bypass the normal lens on the grounds that they want pronounced perspective effects only. They could have two wides or one wide and one tele.

The *three-lens kit* introduces the oft-debated notion of more or less equal spacing of focal lengths. From the wide group of 21, 24, and 28mm (as available) either the 24mm or one of the 28mm lenses would be regarded as approximately double the angle of coverage of one of the normal lenses. Then, the normal lens chosen would be regarded as half the focal length of the tele lens next in line. You could have a sequence of 28, 58, and 135mm (there being no intermediate lens between 100 and 135mm). The long lens would take in about one-fourth the image area of the normal lens, which in turn would cover only about one-fourth that of the 28mm lens.

You might prefer a more gradual shift in coverage and perspective effects. Your three-lens kit might then be 35mm, one of the 50mm series, and the 85mm *f*/1.7.

The Compact Inexpensive Kit. Most of the Rokkor lenses have screw-in, 55mm filter mounts. Some few have 52mm mounts: the 35mm *f*/2.8, 55mm *f*/1.9 and *f*/1.7, 135mm *f*/3.5, and 200mm *f*/4.5. If the additional light-gathering capabilities of the wider apertures are not important, then these less expensive but optically fine lenses have the advantages of compactness and of accepting common filter attachments with diameters of 52mm.

Although the filter mount consideration might not be involved, you do have



Bob Collins went out to Brontë *Wuthering Heights* country with a 35mm lens and a 135mm companion to do a mood picture story. Mostly he used the 35mm; the 135mm served as an accenting lens. All pictures made with Ilford FP3, since superseded by FP4.



Above, the detail of the worn, smooth paving stones on a street corner in Haworth is isolated by the 135mm lens. Note the very gradual fall-off in size of the stones. At 1/60 sec., *f*/8. Right, for the long expanse of pavement, the 35mm lens emphasizes foreground detail and links it to the receding distance. At 1/125 sec., *f*/11.





Above, looking down Haworth main street over the rooftops and into the hills beyond, one senses the mood of Brontë country. At 1/60 sec., *f*/5.6. Left, the slightly wide 35mm lens encompasses the foreground well, while maintaining reasonably good size of background details. Below, the green grazing land is rendered light through use of an X-2 green filter. 35mm lens, 1/125 sec., *f*/8.



a choice of lens apertures with some of the focal lengths. Your choice then will depend on whether you are likely very often to need that extra ounce of light-gathering capability. If you extend this thinking to several Minolta lenses, you might save enough for an additional lens, which you might not otherwise be able to acquire.

The Available Light Kit

First, we should understand that a wide aperture is relative to what otherwise has been available. If the fastest 21mm lens has been *f*/4, then the advent of the Rokkor 21mm *f*/2.8 makes available a relatively fast lens for such a focal length. Nevertheless, it would be outpaced by the really fast performers in the existing light kit: the 35mm *f*/1.8, 58mm *f*/1.4, 58mm *f*/1.2, and 85mm *f*/1.7. For comparison purposes, an *f*/2.8 lens has 1/5 the light-gathering power of the 58mm *f*/1.2, whereas the 100mm *f*/2.5 (fast for its class) has a little more than 1/4 the light-gathering power of the 58mm *f*/1.2.

Daylight Photography

Generally, you would not need wide-aperture lenses for daylight or outdoor pictorial work unless you tend to favor fast action with relatively slow films under difficult lighting conditions or want to blur out pictorial backgrounds. Otherwise you can favor the compact, inexpensive group described above, supplemented as necessary.

Portraits and Candids

This range covers 85~200mm. Within the portrait group, the range is 85~135mm with the preferred choices being the 85 and 100mm lenses. These latter afford convenient working distances under any conditions, but especially indoors. In large halls in which a longer reach may be needed, either the 135 or 200mm lenses might be chosen, depending on lighting conditions to be encountered. The "candids" are usually lenses long enough to separate the photographer from his subject matter, such as the 135 or 200mm. In some circumstances they could be longer; however, much depends on the technique used by the photographer to grab pictures unobtrusively, and often this may be done with wide-angle lenses used in blind or hip shooting.

Architectural Photography

Where you wish to take in all of a building or statue and cannot withdraw sufficiently to gain working space with a normal lens, you may use the broadened view of one of the wide-angle lenses. Some edge distortion may result with one of the wider lenses, covered below in the treatment of this category. This is unavoidable with lenses of any make. Longer focus lenses are also useful in architectural work in order to pick out particular details for accenting. If you tilt a lens with an angle of view insufficiently wide to cover the height of a building, you may be able to squeeze in all of its height, but the effect then will be one of converging lines, a form of apparent perspective distortion.

Sports Photography

Focal length and aperture in sports photography must depend on many different circumstances: distance of the area to be covered, pace of action, and lighting conditions. In some sports, the photographer who anticipates the probable plays sets his long focus lens on a tripod and waits for the action to pass his field of view. In other sports it may be more important to see a broadened field of view using a shorter focal length lens in order quickly to be able to center the action. Long zoom lenses are best used with tripods, as discussed below.

FOCAL LENGTH CONVERTERS

An interesting accessory is the independently available lens converter. It is an inexpensive device that can be used to "stretch" focal lengths. Several makes are available for use with leading cameras. Minolta neither manufactures nor endorses any of these; nevertheless, since they have some interesting properties, you ought to know about their uses and limitations and determine for yourself whether there are any conditions under which you might want to use converters. You should also know about possible damage, which might be caused by poorly engineered and manufactured converters.

What Focal Length Converters Do

Focal length converters are independent optical devices which multiply the focal lengths of the camera lenses to which they are attached. They have advantages and disadvantages. Optically, they are negative lens attachments, which fit between the rear of the camera lens and the camera body. Lens converters are most commonly available in 2× and 3× amplifiers. Zoom converters are available in the same range of 2~3×. What of the focal length changes and *f*/stops? For each focal length magnification there is a corresponding drop in relative lens aperture or light transmission. The original 135mm *f*/2.8 becomes 270mm *f*/5.6 at 2× magnification and 405mm *f*/8.4 at 3×. Converters are available that are both automatic-diaphragm coupled and meter coupled for the MC Rokkor lenses and the Minolta SR camera bodies.

A single lens converter can be used with more than one lens, ordinarily with lenses in the moderate telephoto range, but also with standard lenses.

An interesting property of the converter is that while it may double or triple the focal length of an original lens, it does not change its nearest focusing distance.

What of Converter Quality?

Can a lens-and-converter combination yield the same performance as a lens by itself of equivalent focal length?

Tests of different makes of lens converters have shown wide variations in performance. The best are naturally to be found among the more expensive models containing four or five lens elements. At best they yield a satisfactory performance, which cannot fully match the quality of an originally designed lens. Performance of the converter combination is naturally best at the center. With the best converters there is image degradation at the edges. The basic overall problem is that the converters amplify residual aberrations of the original lens and add some of their own. Some optical contrast may also be lost.

From a mechanical standpoint there may also be slippages or deviations in the accuracy of the automatic-diaphragm and meter-coupling linkages. These can cause malfunctions in the camera-to-lens coupling mechanisms.

How Best to Use Converters

The following rules of usage of converters should be followed:

1. Confine important details or features to the central portion of the image area.

2. Choose subjects whose lighting is at least moderately contrasty.

3. Stop the lens down by at least two additional *f*/stops to improve optical performance.

4. Because of reduced lens apertures (for example, a two-stop reduction with a 135mm *f*/2.8 lens used with a 2× converter produces a working aperture of *f*/16) and longer focal lengths, use fast films and suitable camera supports.

THE WIDE-ANGLE LENSES

The Rokkor wide-angle lenses offer unusual versatility in achievement of creative effects. Technically, a wide-angle lens is one that has a broader angle of view or coverage than a normal lens. A normal or standard lens has a focal length that approximates the length of the diagonal of the image or film frame (24 × 36mm), which is 43.4mm. A lens of this focal length would have an angle of view of approximately 53°. In practice, however, lenses in a range of 50 through 58mm are considered normal, even though their angles of coverage range from 45° through 41°. At one time, Minolta had a "semi-wide-angle" lens designated as 45mm *f*/2.8, which had an angle of coverage of 52°, coming within the "normal" scope. As a practical matter, lenses that have a 35mm focal length or less are considered wide-angle lenses, while lenses in excess of 58mm are considered telephoto or long focal length lenses.

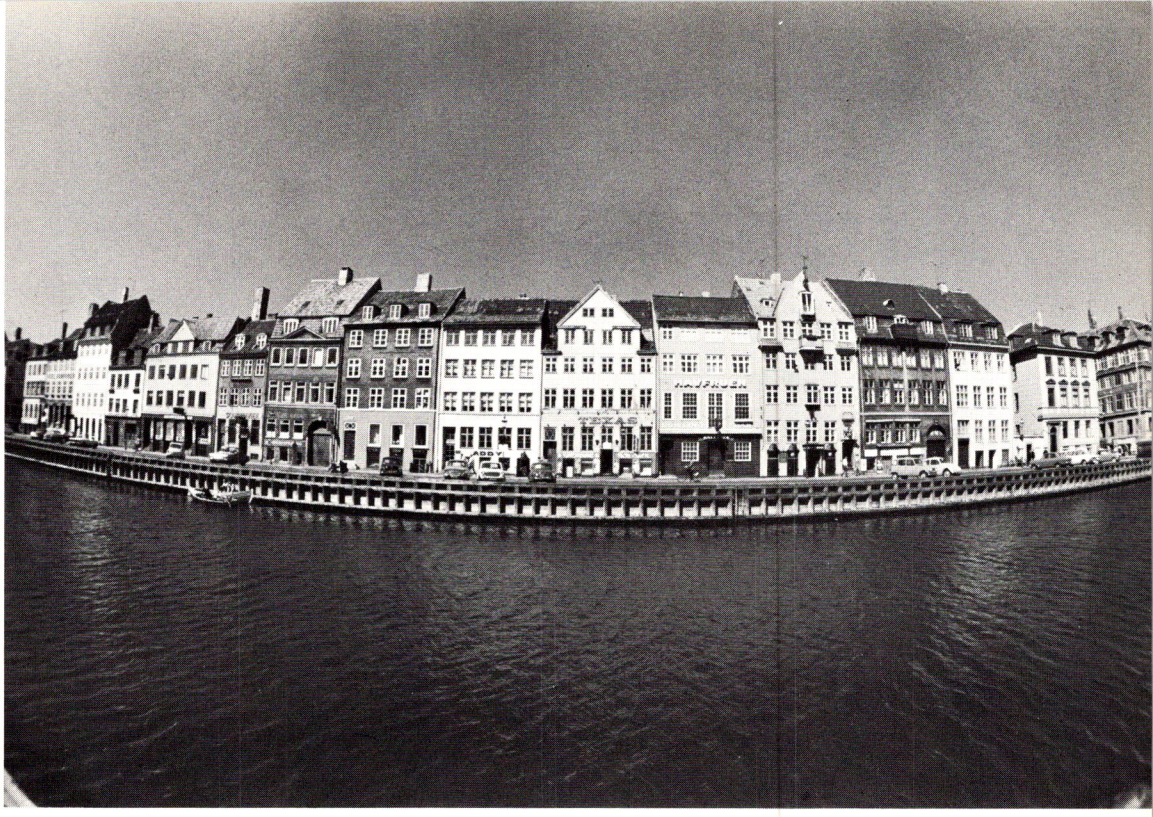
The range of Minolta wide-angle lenses extends from 21 through 35mm in small increments, which, however, are quite significant in the effects they enable you to achieve. The 16mm *f*/2.8 fisheye may also be classified as a wide-angle lens, but it has special properties, which will be discussed separately at the end of this section inasmuch as unique perspective problems present themselves with this lens. Although technically the 35mm lens is used by some photographers as their normal lens, particularly in photojournalism in order to accommodate the widest range of situations, especially when using black-and-white film, it still remains technically a wide-angle lens.

Uses of Wide-Angle Lenses

The most obvious uses for wide-angle lenses, particularly as bread-and-butter lenses for professional photographers, are in crowding more material into the picture area than is feasible with the normal lens. This includes indoor pictures, outdoor building-front pictures where you are limited by the depth of the street, and architecture in which a wider angle is needed to avoid the common error of tilting the camera just to get in the top of a building or monument. Wide-angle lenses are used rather commonly, also, in close-in sports photography and in photography of children and pets when there is a likelihood of substantial movement, which is hard to follow. Another category of conventional uses for wide-angles is in documentary photography and in pictorial essays in which it is important to have establishing pictures of a total scene in order to put all components into mutual relationship so that individual elements can be given separate emphasis or accent in other pictures using lenses of more limited coverage. Thereby, key subjects can be put into their broader context.

Photojournalists find wide-angle lenses particularly useful in "blind shooting" in which one is unable to hold the camera to the eye, whether for reasons of candid photography or because of crowding around important journalistic targets. The camera might be held at the waist or side or, more typically when photographing celebrities or news subjects, above the head. For this purpose, one of the 28mm Rokkor lenses is a good compromise.

Wide-angle lenses are used when greater depth of field is desired for the overall scene or parts of it, but as previously explained, this is relative to the total image area. If you are taking color slides, for example, those made with wide-angle lenses will generally appear to yield greater depth of field. Bear in mind, however, that if portions of color slides or black-and-white pictures are enlarged selectively, then, all other factors being equal, images reproduced to the



The Rokkor Fish-Eye 16mm *f*/2.8 lens is a special-purpose optical tool whose unique properties must be understood if it is to be used creatively. The fisheye lens tends to see the world in front of it as a sphere with the result that as objects move away from center they tend to curve around the sides, diminishing in size. The effect is most pronounced at close distances, but can be observed in familiar geometric figures in the distance. This is most evident in the long row of houses on the other side of the canal. Note good square format of building in center marked "Texas." Copenhagen. Taken at 1/125 sec., *f*/8, Ilford FP4. In picture below, a river in Iceland, the absence of familiar rectangular structures conceals curving tendency. Orange filter. At 1/125 sec., *f*/5.6, Ilford FP4. Joseph D. Cooper.







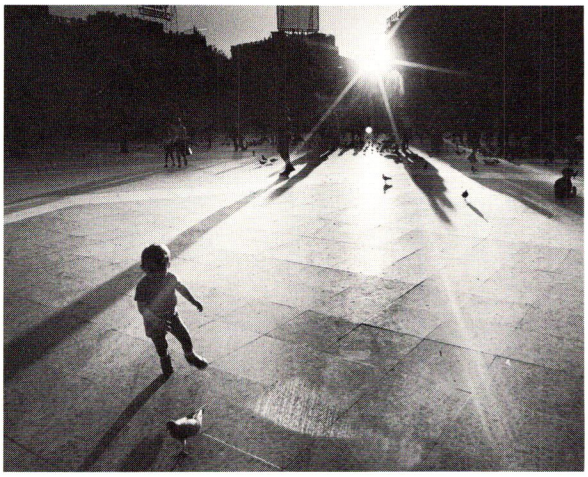
The curving effect is seen most pronounced in this close-in picture of the luncheon table, which to the eye would be long and straight. The picture at right shows part of the same scene blown up to show that central portion of fisheye picture can be used with minimum distortion effect. Copied from High-Speed Ektachrome color transparency.

same size will have the same depth of field.

Some of the most interesting and creative uses of wide-angle lenses derive from their capacity for work fairly close to the subject. It is not the "wide-angle look" that is desired, but the "close-in look" that the photographer seeks. Through the use of wide-angle lenses, particularly those in the range of 16 through 28mm, the photographer is able to inject himself into the scene and to relate to his living subject quite intimately. It has been said so often—and in this book as well—that perspective effects are governed solely by distance of subject from lens. This is partly true. The modifying factor is that the image size produced by the lens tends to govern the working distance of the photographer from his subject. With wide-angle lenses the tendency is for image detail to be rendered small unless the photographer moves closer to the principal objects. Conversely, with telephoto lenses the magnification or image ratio of objects tends to be rather great, thereby impelling the photographer to back away from the subject.

Once, while taking pictures with the Rokkor 16mm *f*/2.8 lens in the public square in Stockholm, Sweden, I was asked by another Minolta SR photographer to let him use the lens. Although he was a professional, he tended to work mainly in the range of normal to moderate telephoto lenses. (He was a wildlife photographer visiting from Kenya.) With the 16mm lens bayoneted to the camera he began stalking his living quarry. It was interesting to observe that as he snapped away excitedly he kept getting closer and closer to the subjects that interested him until in some cases he was only about one foot away.

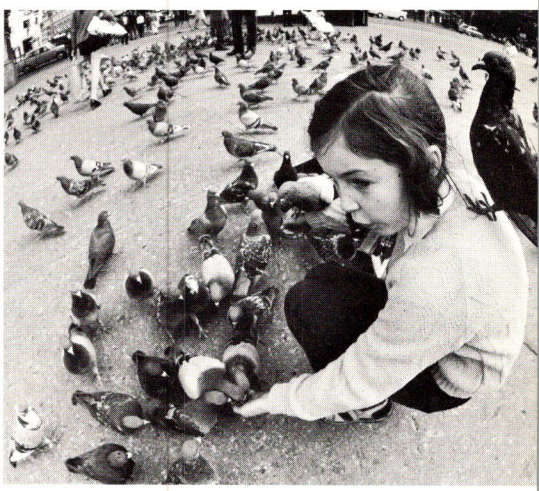
One important effect of close-in photography with wide-angle lenses is that the nearest objects are separated in depth from those behind them. Along with this separation effect is a rapid diminution in relative size of objects. Thus, one way of knowing that a wide-angle lens has been used to photograph a small group of people is to compare sizes of heads. If the heads are of about equal size, you can assume that the picture was made with a telephoto lens requiring some substantial separation of





Above, pointed downward, the extreme wide-angle lens stretches the immediate foreground. Note the differences in size of the paving squares as they recede from the immediate foreground. Otherwise, there is a minimum of distortion toward the sides and into the corners. Bob Collins took these pictures in the early evening against the setting sun with the 21mm *f*/4 lens at *f*/5.6, 1/250 sec. Ilford FP4 in the Cataluna Square, Barcelona. Below, apart from differences in lighting conditions, the pronounced fall-off in body size approaching the ground is noticeable. In the picture of the boy, see the differences in size among the first, second, and third paving squares. Trafalgar Square, London, 16mm *f*/2.8 lens, at 1/125 sec., *f*/5.6. Ilford FP4. Joseph D. Cooper.



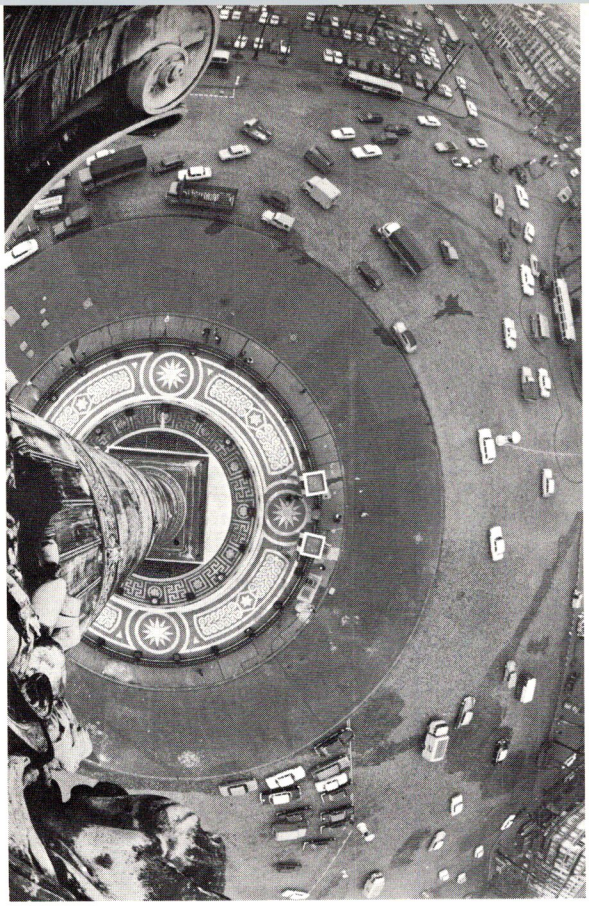


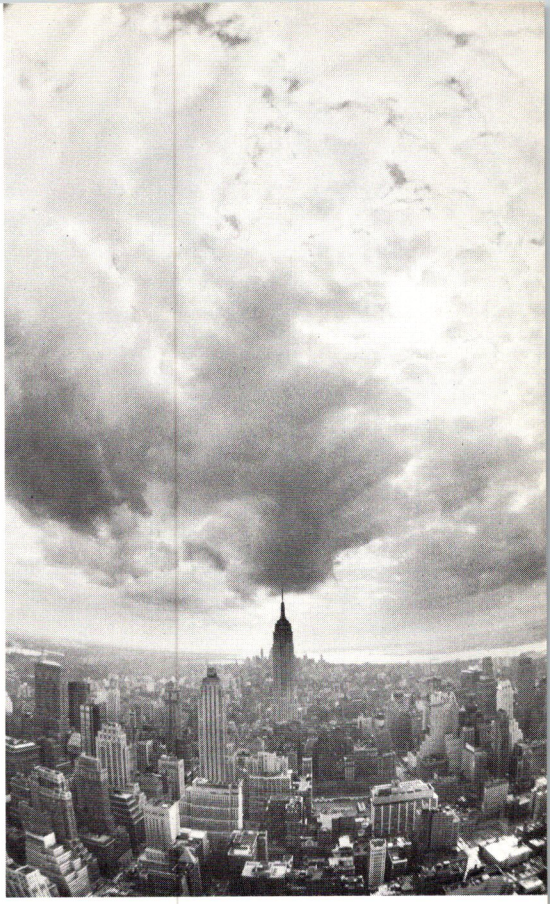


Bullfight at Arles. The 16mm fisheye presents a panorama-like view of entire arena while giving emphasis to the group of onlookers in the foreground. Lucien Clergue.

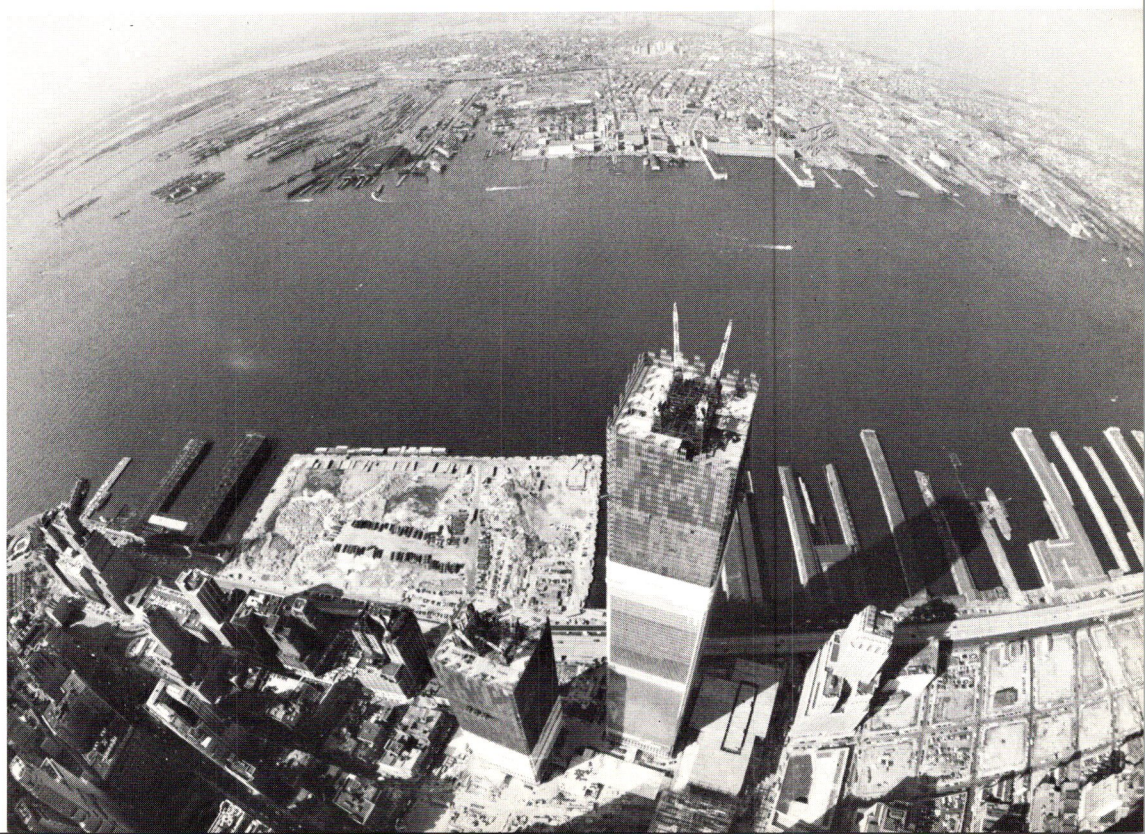
This otherwise barren place becomes strikingly filled through the dominance given the cross in the foreground. Earlier 18mm version of Rokkor Fish-Eye. From the book *Portugal*, Graham Finlayson.





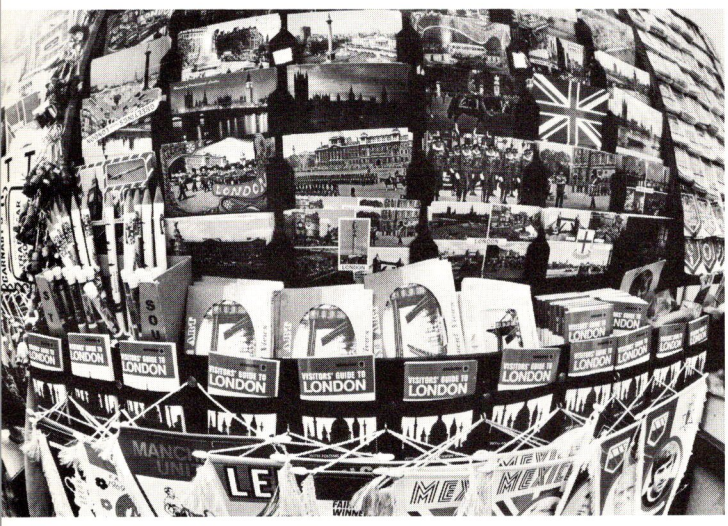


More angles of view for the fisheye 16mm lens. Upper left from top of monument in Place de la Bastille, Paris *f*/8, 1/30 sec., Plus-X; upper right Empire State Building in distance taken from building in Rockefeller Center, New York, morning, red filter, 1/1000 sec., *f*/2.8, Plus-X; both by Francisco Hidalgo. Below, New York World Trade Center from helicopter. SR-T 101 with 16mm *f*/2.8 lens; orange filter, *f*/16 at 1/500 sec. Carl D. Piazza.





To see around the corner, get a fisheye lens! Francisco Hidalgo.



Pointing the fisheye lens straight ahead at a vertical surface would give you the typical global effect, as in this picture of a London souvenir stand. (1/250 sec., f/8, Ilford FP4). Tilting the camera slightly upward makes this Washington, D.C., building lean backward. Tri-X, 1/500 sec., f/16. Joseph D. Cooper.



the photographer from his subjects or that at an equivalent distance a wide-angle lens was used together with a fine grain film and that the relevant portion of the picture was enlarged substantially.

Both the rapidly diminishing separation between foreground objects and their relative size are variations of perspective effects at close viewing distances. These phenomena of dramatic convergence have been translated into arresting and even bizarre effects, which have had great appeal in fashion and advertising where there is a continuing search for the unusual. Some photo critics have alluded to the use of wide-angle lenses for these purposes as reliance upon crutches and have lauded the creativity of the photographer using more normal lenses. It would seem that a more reasonable attitude is to evaluate the effects achieved: if they are effective or pleasing for the purposes intended, then the technique should be regarded as a satisfactory one. What should be avoided is ugly distortion *per se,* especially where offensive to human dignity.

Management of Optical Problems

The several problems to be taken up here are those of critical focusing, management of perspective distortions, treatment of edge distortions, and the problem of light fall-off at the edges when using extreme wide-angle lenses. These are problems inherent in the use of wide-angle lenses regardless of who makes them, but there are corrective procedures that can be followed to minimize the difficulties that might be encountered under some circumstances.

First, it should be said that with the microprism focusing screen, you should have little difficulty in focusing on the near and intermediate focusing distances with any of the wide-angle lenses from the 16mm $f/2.8$ lens on through the 35mm. It is easier to focus under bright illumination than under dark lighting conditions. Where there is a choice in lens apertures for the same focal length —as in the case of the 35mm $f/1.8$ compared with the 35mm $f/2.8$—the wider aperture will make it possible to focus more selectively, since it presents a narrower zone of sharpness for a given plane of focus.

In good lighting there should be no difficulty in focusing at intermediate distances, and at close distances the narrow depth of field should eliminate practically all problems. At greater distances, short of infinity, focusing is more difficult, but then it does not really matter too much if you stop the lens down because of the wider zone of sharpness, or depth of field. If, however, you expect to make rather big enlargements and wish to be critically certain of the sharpness of your focus, a useful device is the Minolta Magnifier V. Since it magnifies the image on the groundglass by a factor of 2.5×, this has the apparent effect of showing a depth of field equivalent to that produced by a lens whose focal length is 2.5× longer.

Two types of apparent perspective distortion are encountered: rather wild angles of convergence due to the tilting of the camera; and gross disproportions in the size of objects very close to the camera as compared with objects only slightly further away. When the camera is tilted, the normal 90° intersection of horizontal and vertical lines is perceived through the camera lens onto a two-dimensional surface without the benefit of the interpretation of shape constancy provided by eye and brain. Obtuse angles are perceived variously, depending upon whether the camera is pointed downward or upward and upon whether it is close to the lines of intersection or not. Many of the upward-tilt situations appear to be more normal than the downward ones. We've all become accustomed, for example, to the receding lines of skyscrapers and buildings.

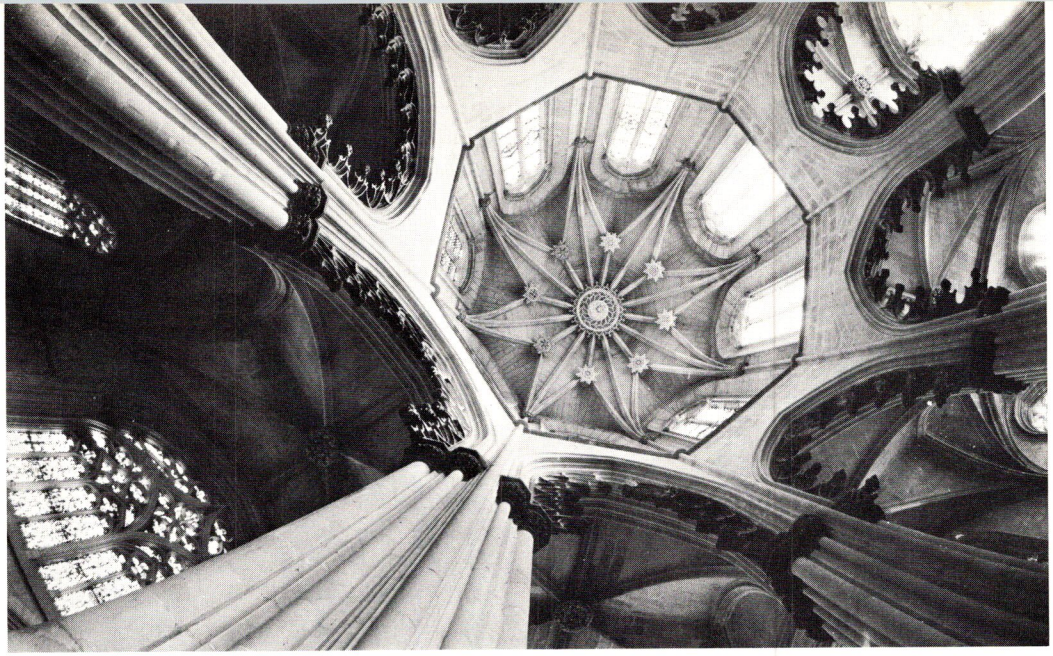
In situations in which you wish to avoid distracting lines of convergence, you have the choice either of making sure that the camera is level—if you wish to be absolutely sure of this you can buy a Spiratone or other spirit-level accessory for the accessory shoe of the camera—or you can simply position yourself or remove verticals from the scene so that you eliminate the distraction. Incidentally, if you were to take the same scene with a 21mm lens and one of longer focal length and then enlarge the central portion of the picture made with the 21mm so that it corresponds to the latter, you would find that the convergence effect would be the same. All that the wide-angle lens does is cover more area.

The problem of gross distortion of close objects is typified by protruding features in portraiture. It is best not to take frontal views of people unless you back away to some reasonable distance. Doing the latter will give you reduced image sizes, but you will avoid distortion. Alternatively, you can position yourself or your subjects or both to the same effect, so that you avoid having leading features such as the nose, lips, or dominant forehead or chin seemingly being pulled forward toward the lens.

Minolta wide-angle lenses are remarkably free of edge distortions due to optical design, but the extreme wide-angle lenses cannot avoid bringing in certain elliptical distortions at the edges of the image, especially along the 36mm dimension of the image frame. The objects at the edges or extremes of the image area are seen from a different angle as compared with those in the middle of the scene. Imagine, for example, that you have a row of people lined up for a group picture. The camera will see those toward the center of the picture straight on while those toward the edges will be seen from an angle. Stated otherwise, those toward the center of the picture will be seen with both ears showing, while those at the edges are likely to be seen in three-quarter profile, with only one ear showing. Because of the greater distance the light rays have to travel, one also perceives the elliptoid effect in round objects or in other known symmetries at the extremes of the image area.

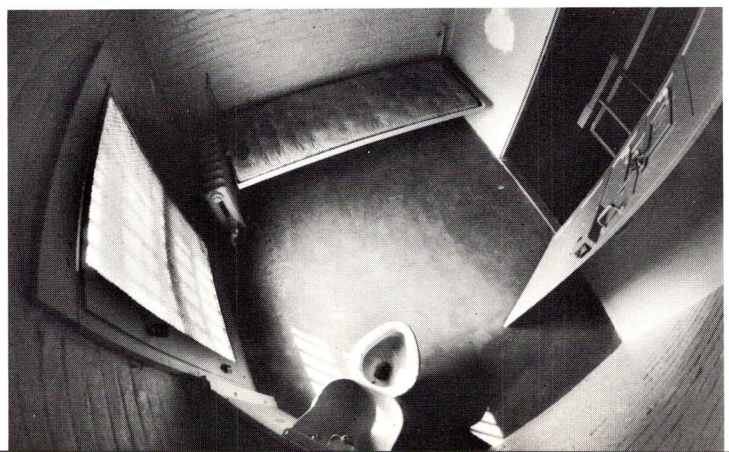
When photographing a row of people or a row of symmetrical objects, subjects appearing at the edges of the image area should be turned so that they more nearly face the camera squarely. Look through the viewfinder to make sure that both ears are showing, for example. Also, heavier or slightly larger objects should be spaced toward the extremes to avoid the slight diminution in size that occurs because of the longer travel of light rays, as shown in the accompanying diagram.

With extreme wide-angle lenses, one of the problems of optical design is to avoid the falling off of light toward the corners. Minolta lenses are remarkably free of this defect, which is most noticeable mainly with the special-purpose 16mm *f*/2.8 lens. In black-and-white photography the slight differences in light falloff in the corners of the extreme wide-angles will scarcely be noticeable because of the latitude of both film and paper. In color photography, however, where exposure must be much more precise, you may notice some slight diminution in the intensity of the lighting. You may also notice that the sharpness of images toward the corners may not be quite as great as in the center. This, too, is a characteristic of lenses of all sources of manufacture. In portraiture, neither condition presents any special problems, since the principal subject is usually centered with a fair amount of neutral area surrounding the head. In most general photography as well the very slight loss of edge sharpness should not present any particular problem. In fact, the edge sharpness of many or most modern lenses is superior





Above, Graham Finlayson put the camera with the 18mm fisheye on its back on the floor. Ilford FP4. From the book *Portugal.* Right, looking up at a horse's mouth through the 16mm fisheye. The hexagonal spots are reflections of the sun from each of the lens components. Joseph D. Cooper. Below, looking down into a detention cell with the 16mm fisheye. Stuart Davis.



to the central sharpness and overall performance of many older lenses.

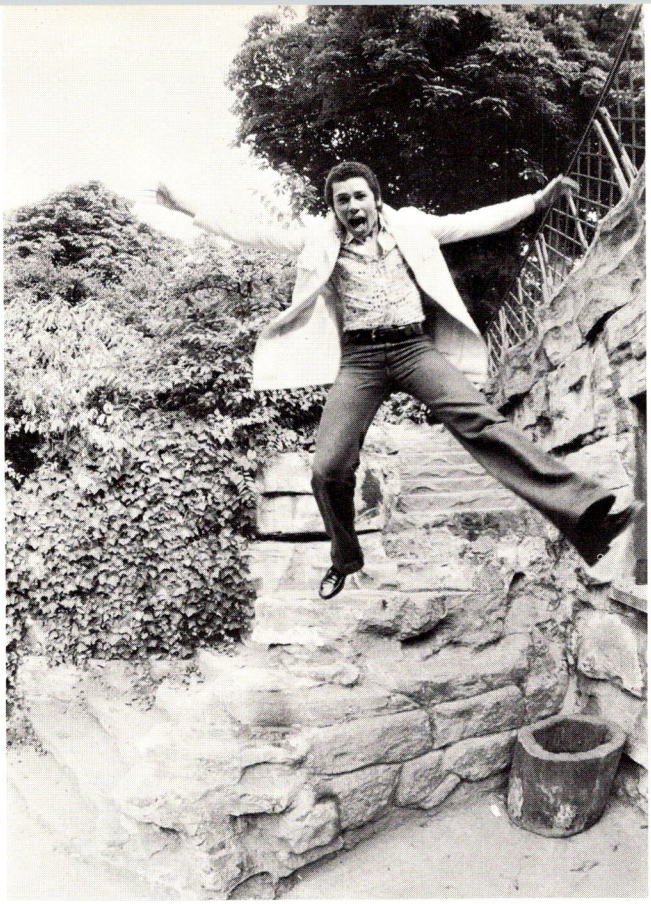
The Rokkor Fisheye Lens

Of all the wide-angle lenses, the Minolta Rokkor Fisheye 16mm *f*/2.8 lens is probably the most flexible for the achievement of creative effects, whether for pictorial purposes generally or for use in advertising or fashion media. The Minolta fisheye lens is unique in that it can be used, if its properties are well understood, either to produce special perspective effects at close-in working distances or apparently normal wide-angle effects with certain kinds of subjects perceived from a distance. The fisheye lens is best known, however, for the special kinds of distortions it produces when working at distances as close as one foot, at which it will cover a vertical field equivalent to that of a six-foot man when the camera is held at waist-level. All that has been said about perspective distortions attainable with extreme wide-angle lenses is pertinent to the fisheye, only more so, and with additional unique elements of distortion added.

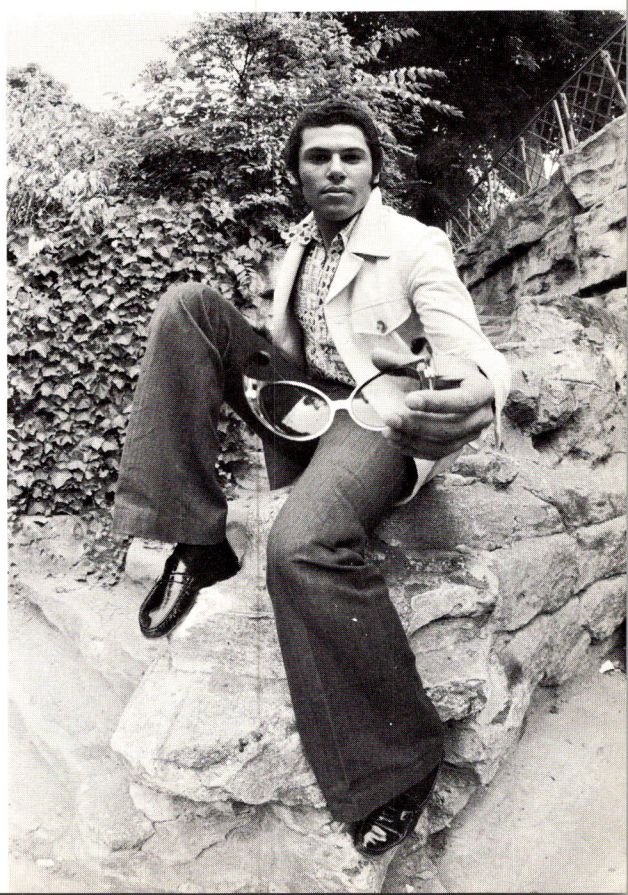
The fisheye lens is so named because it covers an angle of view of at least 180°, thereby simulating the extremely wide vision of a fish. One type of fisheye lens of extremely short focal length produces a round image of slightly less than 24mm in diameter. Another type of fisheye lens of longer focal length—the type offered by Minolta as the 16mm *f*/2.8 lens—covers the entire image area from corner to corner.

The fisheye has a tendency to see everything in front of it as a globe. This effect is most pronounced at the closer ranges and least apparent when photographing more distant objects. Because of the global effect at close distances, objects at the edges of the long (or 36mm) dimension tend to be distorted in the manner of images fading out of sight when wrapped around a cylinder. If you point the fisheye at an angle toward the ground it would represent the ground as though you were standing on top of a very large sphere. If you point the lens straight forward, parallel to the ground, the same objects in the center would appear to be much larger than if they were placed or photographed at the edges. As mentioned above, this phenomenon is more pronounced at close ranges than at more distant ranges. If you point the lens upward, depending upon the subject matter and the height of the camera, you are likely to get a bowl effect. The lens merely sees the globe higher in the air or sky. Since horizontal lines or surfaces are most involved, these tend to take on a saucer-like or bowl-shaped characteristic with the ends pointing upward.

If the background does not contain familiar objects, which can be related in size and shape to the foreground and central areas, then it is sometimes difficult to know that the picture has been taken with a fisheye lens. It is important, however, for the lens to be pointed in such cases toward the horizon line. If you want to preview the effect to be achieved at close-in working distances without attaching the lens to the camera —as a matter of deciding whether or not to select it for particular use—a handy gadget for this purpose is a common wide-angle door viewer. This is the familiar optical device that enables you to see from inside the house a wide area outside your front door. It can be purchased inexpensively from hardware stores or it may be ordered from Edmund Scientific Company, Barrington, N.J. 08007. It is identified by Edmund as the Observ-O-Scope, catalogue no. 40,582, $3.30, postpaid in the United States. This device is useful only



Objects in the same plane in the center of a fisheye picture will show little or no distortion. In the lower picture, when the subject's legs and arms are closer to the camera than his body, gross distortion results. Robert Dehesdin, Ilford FP4.





Side view of model avoids distorted effect, but when model swings around, legs become disproportionately large. Robert Dehesdin, Ilford FP4. 16mm fisheye.



for observing effects at close working distances, where perspective distortions are most apparent.

In ordinary wide-angle use, with objects effectively centered and the camera held level at the horizon line or against a neutral background, the 16mm lens is particularly effective—dramatically so—in separating foreground objects from middle ground and background ones. Apparent perspective distortions in figures or features can be avoided through proper positioning. One should avoid having the two arms, hands, legs, or feet at noticeably different distances from the lens. The 16mm lens has an unusually deep zone of sharpness. With the lens focused at two feet and the aperture set at $f/16$, everything will be in focus from about 13 inches to infinity. The lens also has four built-in filters, including the 1A, Y48, O66, and 80B. If you do not wish to have any filter effects, the filter turret ring should be turned so that the filter index mark is halfway between the 1A and Y48 filters.





The original and simplest use of the wide-angle lens was to cover more area, particularly in cramped quarters and when taking pictures of building fronts as in this comparison of the coverage of 58mm and 28mm (right) lenses.

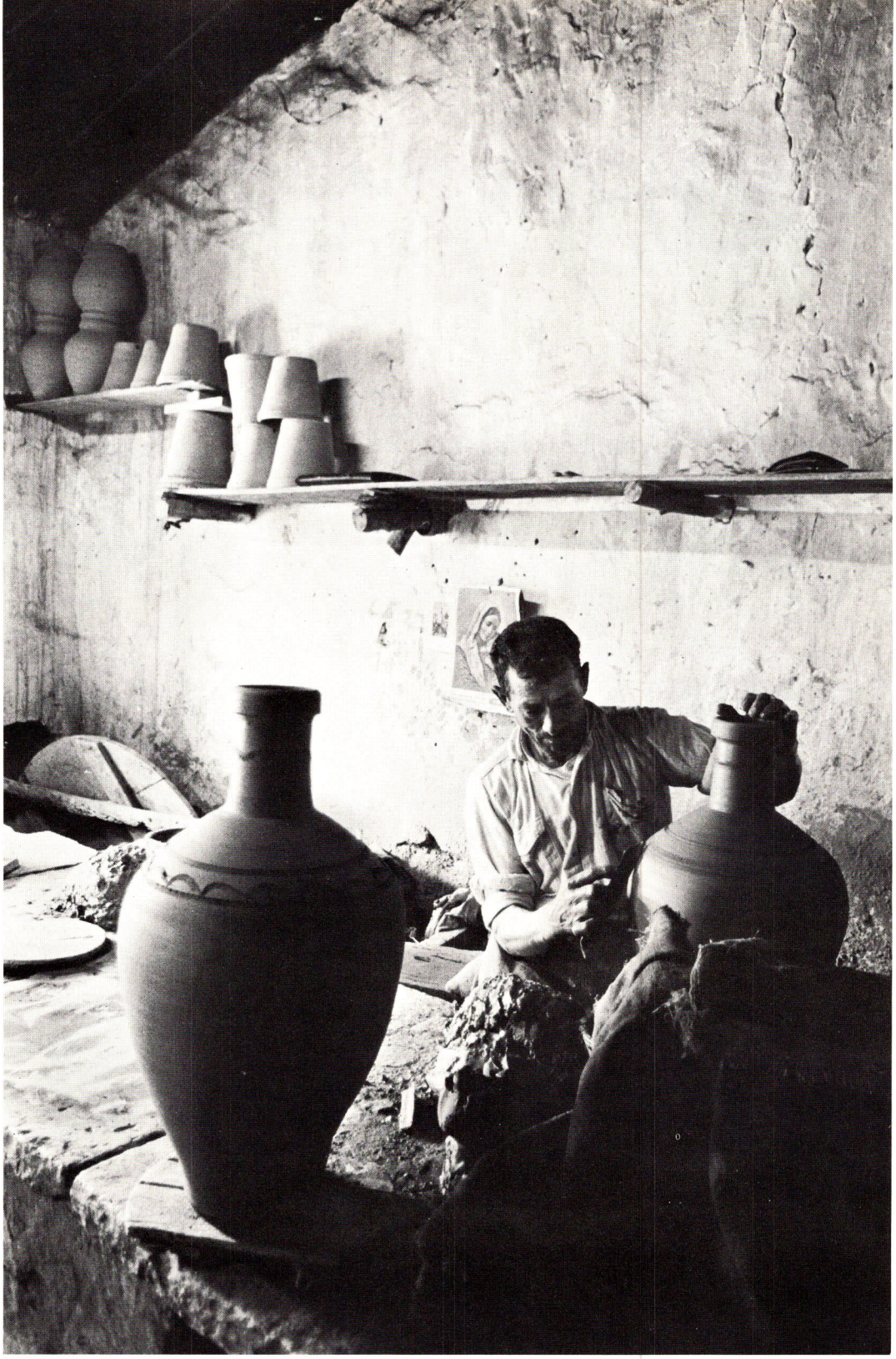
Wide-Angle Lens Selection in Summary

The fisheye lens should be considered as something apart from the normal range of lenses extending from 21 through 35mm. Where there is more than one lens of the same focal length, your selection ordinarily would be on the basis of what you can afford and whether or not you feel that the wider aperture is essential for the kind of pictures you will be taking.

The 35mm lens is one of the most popular of the wide-angles because it can also serve as a general-purpose lens, particularly with black-and-white film, which readily permits you to enlarge sections in the darkroom. The 28mm lens is probably most suitable for the greatest number of wide-angle situations you will ordinarily encounter. When you go to the 24 and 21mm lenses it is because you wish to be able to achieve special effects, particularly in professional usage, or because you have unique needs for wide coverage. Although only a few millimeters distinguish these lenses from each other, they account for much greater differences in angles of coverage.



A more creative use of the wide-angle lens is in management of perspective and foreground effects. Note prominence given to foreground objects on village festival day, subordinating background. 28mm lens. I. Fuma.



The potter from the book *Portugal*, window illumination. "28mm used for spatial arrangement," said Graham Finlayson.

THE NORMAL LENSES

Normal lenses are sometimes referred to as *standard lenses,* because they are original equipment furnished with the camera. In the case of the Minolta SR cameras, the purchaser usually has a choice of selecting a camera body together with one of three standard lenses—the 55mm *f*/1.7, the 58mm *f*/1.4, or the 58mm *f*/1.2. The SR-T 100, however, comes only with the 55mm *f*/1.9 lens. Other SR bodies can be purchased with any other lens, but contrary to what some photographers might think, I believe the normal lens has a very important place in picture-taking and should be part of the photographer's original equipment.

Traditionally, the normal lens is one that has a focal length ranging somewhere from 50 to 58mm. This has historical antecedents going back to about 1925 when 35mm still photography was first introduced successfully through the advent of the Leica. The norm for that camera was 50mm. Bob Schwalberg of *Popular Photography* magazine has written extensively and conjecturally on why that particular focal length was chosen. Its angle of coverage of 45° approximates the diagonal dimension of the 24 × 36mm image area, which is about 43.4mm. Theoretically one could say that a 45mm lens should therefore be the standard, but this would violate historical precedent; moreover, certain lens design considerations have predominated. For example, the 58mm lens, focused at infinity, provides a 1:1 viewing-to-actual-image ratio. Accordingly, if you were to look through the viewfinder with one eye while holding the other eye open, you could expect the details within the viewfinder to be reproduced to the same scale as you perceived them in real life with the other eye. One could also consider the Macro Rokkor 50mm *f*/3.5 lens to be usable within the normal group, although it has unique properties, which will be discussed below as well as in the chapter on close-up equipment.

We will consider here the scope of use of the normal lens and also make some suggestions on selections from among those available. Unlike the discussions of the wide-angles, the telephotos, and the zooms, in which problems of management of perspective and other special considerations are discussed, the normal lenses need no special qualifications. They handle just about all the problems of optical design and photographic usage in the best way.

The Uses of the Normal Lens

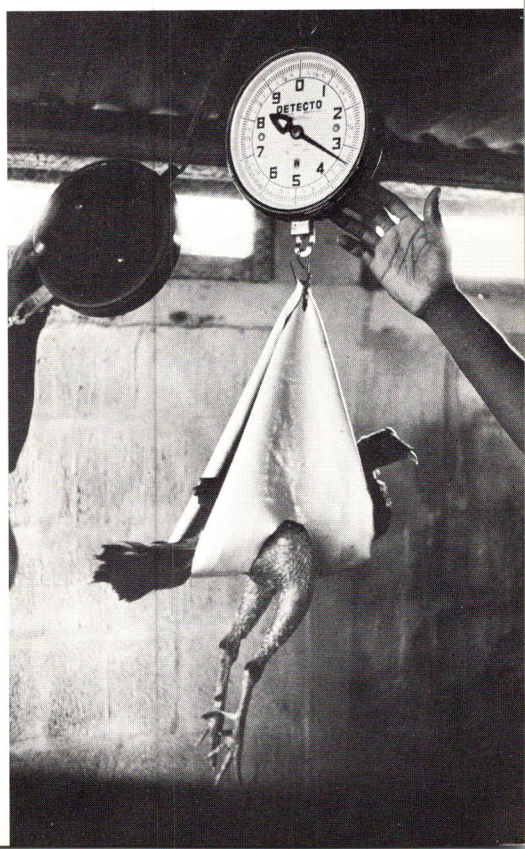
If you limit yourself to only one lens, it ought to be the normal lens. As discussed above, some people would define the normal lens as a 35mm wide-angle lens because of its ability to cover so many different situations, including those occasionally tight corners in which you might find yourself. With the growing popularity of color film, however, the tendency is to compose for the image frame and not to rely upon the darkroom for image-sizing except in special circumstances.

With any of the Rokkor normal lenses you can approach very close to the subject without use of intermediary accessories. For example, the 55mm *f*/1.7 or *f*/1.9 focuses as close as 5.5cm (about 1.75 feet) to cover an area of a little less than 11 × 27mm (about 7 × 10½″); the 58mm lens focuses down to 0.6cm and covers about the same area of subject matter. Thus, when you are traveling, you can take pictures of most of the subjects you will encounter, and if you should desire, you could move in close for interesting details. Of course, the area of coverage when working close would not be as great as when using a wide-angle lens nor would distant details



The potter at work. Standard 58mm lens used close for selective focus and good compromise between shaping effects of wide-angles and telephotos. Graham Finlayson.

Weighing-in for a cock-fight in Haiti. The standard 58mm lens was used because it afforded the best cropping under the circumstances. Graham Finlayson.



be as great as when using a telephoto lens. You are, in effect, using a lens for all seasons, which must make compromises that can be offset only by switching to other focal lengths.

An interesting feature of the normal lenses is that they can be used by business travelers and others to take pictures, either hand-held or on a stand, of books, magazine articles, and ordinary letter-size documents. Some people prefer the Macro Rokkor 50mm *f*/3.5 lens as their normal one, because they can use it outdoors for a variety of pictures in the normal course, but if they should encounter some small object, which they want to photograph in great detail, they can focus with the lens alone so close as to obtain an image on film one-half the size of the subject; with the aid of a meter-coupled extension tube furnished with the lens, they can make life-size photographs of tiny objects or portions of larger ones.

In addition to not presenting any particular problems of perspective distortion, the normal lens requires a minimum of external or tripod support except under adverse light conditions when you might be using shutter speeds slower than 1/60 sec. With care, slower, hand-held exposures can be made, although doing so entails some risk of camera movement.

As with any lens, when working close to three-dimensional objects you must be conscious of shallow depth of field and the potential distorting effects of close camera-to-subject distances. Your main problem will be in taking portraits. Ordinarily you should not work closer than three feet unless you position the subject so that protruding features do not face directly toward the camera. Some people can be photographed at closer distances than others, depending upon the structure of their facial features.

Standard 55mm lens puts both background and foreground into proper size perspective when both are to be given due emphasis, as in this accident scene. Ilford HP4. At 1/250 sec., *f*/11. Joseph D. Cooper.





Photograph of a photograph. Richard Gee recorded this scene at an exhibition of the biennial Photokina entitled "Girls—by Masters of Erotic Photography." The Rokkor 58mm f/1.2 lens was used at full aperture with Tri-X film at 1/60 sec.

How to Select a Normal Lens

For all practical purposes, differences in focal length within the normal lens group are insignificant. Your chief concern, apart from cost, will be lens aperture. (The use of the Macro Rokkor 50mm lens has already been discussed.)

In the sequence *f*/1.2, *f*/1.4, and *f*/1.7, there is approximately one-half stop difference from one lens to the other. This means that from 1.7 through 1.2 there is about one full stop difference in light-gathering and transmitting ability.

If you expect to do very much picture-taking under adverse light conditions, you should seriously consider either the *f*/1.4 or the *f*/1.2 lenses. On the other hand, if most of your work is to be done under daylight conditions or with the use of artificial lighting than your best buy would be the *f*/1.7 or f/1.9 lens. The savings in cost could then be put toward the purchase of an additional lens for your camera. If much of your work is to be done at close distances using the normal lens, with or without the use of extension devices or close-up lens attachments, your best selection again is probably the 55mm *f*/1.7. Then there is the question of compatibility of screw-in filter mount diameters. You should refer to the early part of this chapter in which lenses are mentioned that have 52mm filter mount diameters as compared with the 55mm diameters, which are found on most other Rokkor lenses. Finally, there is the question of cost. Although there is not a great deal of difference in cost between the *f*/1.7 and the *f*/1.4, the step up to *f*/1.2 is rather substantial. In the final analysis, you can buy only what your means permit, and as mentioned above, an economy on one lens might enable you to buy a second one.



On the Copenhagen Canal. A long lens originally found use in bringing distant scenes in close. 200mm lens, *f*/16, Ilford FP4. Joseph D. Cooper.

THE TELEPHOTO LENSES

Generally speaking, a telephoto or tele-lens is one that has a focal length longer than that of a normal or standard lens. If the focal length is longer, then its angle of view is narrower. The effect of using a long focal length lens with a narrow angle of view is to bring in details from a distance.

Rather commonly, lenses of long focal length are referred to as *telephoto lenses*, although this term has a particular technical meaning. A telephoto lens is one that by special design is physically shorter than its focal length, not counting some of the protruding metal work on the front of the lens mount. Optically, a telephoto lens is shortened through the use of rear negative components, which have a diverging effect that expands the image gathered by the front elements.

Another type of long focal length lens that will be covered in this section is the mirror-reflex lens. This is a fixed-aperture lens of rather short physical length which uses internal mirrors to "fold" the light and thereby reduce physical dimensions greatly.

The Uses of Telephoto Lenses

In the conventional sense, telephoto lenses are used to achieve close-up views of distant subjects either because you cannot approach them physically or because you do not wish to for reasons of unobtrusive surveillance. Telephoto lenses are super-candids because they enable you to take pictures from a great enough distance not to be observed. When you use them for candid photography and people are not aware that you are photographing them, your subjects do not interact with you and do not in any way show awareness of you through expression or behavior.

In some kinds of spectator sports and wildlife photography the telephoto lens is also invaluable. An important role for the telephoto is to help fill the image frame selectively. And, of course, there are many pictures in which the effect of distance is desired, attainable through the unique attributes of pictures taken with long lenses as explained in the chapter on image management and below.

The 200mm lens was used for simple emphasis on the boot-black and his cruelly crippled foot. From *Portugal*. Graham Finlayson.



The 200mm picking out a detail of a Manueline decoration high on a pillar. From *Portugal*. Graham Finlayson.



The more creative uses of the telephoto lenses pertain to taking advantage of optical and aerial perspective effects. As discussed in the preceding chapter, the optical perspective effects relate to the compression of space between objects—a kind of pancaking effect, a closing up of distances between objects, such as between automobiles photographed at a great distance in a traffic jam or marching troops photographed from a distance. A related optical perspective effect of telephoto lenses is the maintenance of the relative sizes of objects so that one person standing a little behind another will be seen in the same size relative to the person in front of him. One of the most common uses of the moderate telephoto is in portraiture, in which relative size of features is maintained within the structure of one individual's face. Through use of a lens in the range of 85 to 135mm, the photographer is able to get back just far enough so that he does not permit frontal distortions. Probably the 85 and 100mm lenses are best for this purpose.

The creative use of aerial perspective lies in taking advantage of the haziness or clouding and loss of contrast that occurs when taking pictures at some distance. The person who views the photograph automatically gets the feeling of distance through observation of these characteristics. Sometimes it is important to minimize these effects, but when the effects associated with distance are wanted, it is desirable to maintain the slight clouding and contrast-reducing phenomena. In fact, they cannot be completely avoided.

Just as the wide-angle lens tends to nudge you toward working closer to your subject in order to have larger image details, the telephoto lens works in the opposite direction psychologically, encouraging you to work at some distance. In fact, the focusing mounts themselves oblige you to work at greater distances. The closest working distance for the 300mm lens is 15 feet. The closest working distance for the 1000mm lens is 100 feet. Some photographers have used 200 and 300mm lenses with intermediate rings borrowed from their macro lenses. The advantage of the intermediate rings is that they retain diaphragm and meter coupling while enabling the photographer to work somewhat closer to the subject with desirable scale magnification. In effect, the lens becomes a long distance close-up device.

Selection of Tele-Lenses

The current Minolta range of long focal lengths is in the sequence of 85, 100, 135, 200, 300, 800, and 1000mm. We can quite easily distinguish between the uses of the 800 and 1000mm lenses on the one hand and those in the range of 85 through 200mm. The 300mm is in between. When we try to distinguish among the 85 through 135mm lenses, the differences are much more subtle. Apart from focal length as a consideration in itself, you must take account of lens aperture and the steadiness problem —the avoidance of camera movement— encountered when using longer focal length lenses. These operational problems will be discussed below, under the next heading.

The 85 and 100mm lenses find their greatest use in portraiture, intimate group photography, close-in sports photography, child studies, group photos, architectural details, accent pictures in photo essays, amateur theater, and nightclub photography. The choice between the 85 and 100mm is partly a matter of lens aperture and what one prefers in working distance. Clearly, where adverse lighting conditions might prevail, as when taking indoor photographs, the 85mm $f/1.7$ lens is to be preferred. When using these lenses, as with all the other telephotos, you begin sensing that you are eliminating distracting foregrounds and backgrounds selectively



Removing a cyst from a camel's eye in South Yemen with a razor blade. Graham Finlayson used the 200mm lens to focus on camel's eye. Courtesy *Daily Telegraph Magazine*

and that you are making greater use of the narrower field of sharpness of the longer lenses. Both as a matter of size and of focal length, the 85 and 100mm lenses offer no problem in hand-held camera work, presenting a minimum risk of image displacement due to camera movement at the moment of exposure.

Although the 135mm lenses are fairly close to the 100mm's, they really should be considered from an operational standpoint as being closer to the 200mm lenses. The 135mm lens represents a 35 per cent increase in focal length over the 100mm, while the 200mm constitutes somewhat less than a 50 per cent increase over the 135mm lens. It is not merely the percentage of increase in focal length that should be considered. Rather, it is the fact that with the 135mm one begins introducing a greater separation of self from subject, which increases working distance and reduces intimacy. With both the 135mm and 200mm lenses, hand-holding is still possible, but one must be just a little more aware of the problem of camera movement, partly because of the greater weight of the lens and partly because of the magnification of image displacement. At the working distances of these lenses, particularly with the 200mm ones, the effects of image compression of distant objects become more apparent. Both lenses should be considered if it is important that you maintain relative size of objects in depth. Also, whether in themselves or through use of the automatic coupling devices, both of these lenses lend themselves quite well to telephoto close-up work. With the 200mm lens, you begin entering that fascinating, magical world of huge suns and moons at the horizon with terrestrial objects centered in front of them. Of course, this is an extreme application of the problem of maintenance of rela-

tive size. These lenses are ideal for sports photography, especially when you are confined to the stands rather than to the sidelines. Even in the case of the latter, you might want to pre-focus on selected areas of the field and wait for action to occur in those places.

The 300mm lens opens the range of truly long distance photography. It is also at the limit of hand-holdable lenses, although the shortest possible exposure —preferably 1/500 sec.—should be used along with a rather fast film. The 300mm lens will be particularly useful in bringing in inaccessible objects, unobtrusive surveillance activity, landscape photography where distant details are important, sports photography, accentuating the effects of optical and aerial perspective, and wildlife photography. With the extension tube from one of the macro lenses, it can be used creatively as a tele-close-up lens that conserves front-to-back size relationships of small three-dimensional objects.

The 800mm and 1000mm Rokkor RF lenses are of the mirror-reflex, or catadioptric, design. As shown in the diagrams in the lens data sheets, this means that the light rays entering the lens are reflected off internal, mirrored surfaces back and forth so as to reduce the overall physical length of the lens. Many of the most advanced telescopes are made according to this concept. An optical advantage of the mirror-reflex lens is that it eliminates chromatic and spherical aberrations due to the use of front-surfaced mirrors. There is, accordingly, no prismatic dispersion of light rays that come into focus at different distances nor are there other problems caused by refraction of light *through* glass. As an offset to these advantages, the mirror lenses have fixed apertures; "stopping down" the lens is done with neutral density filters. Both lenses have filter turrets at the rear for use with these filters as well as for the accommodation of black-and-white filters and color compensating and color converting filters. As specialty lenses, these are intended for unapproachable long distance subjects. They will be useful in sports stadiums where the photographer desires as high an elevation as possible for maximum field surveillance.

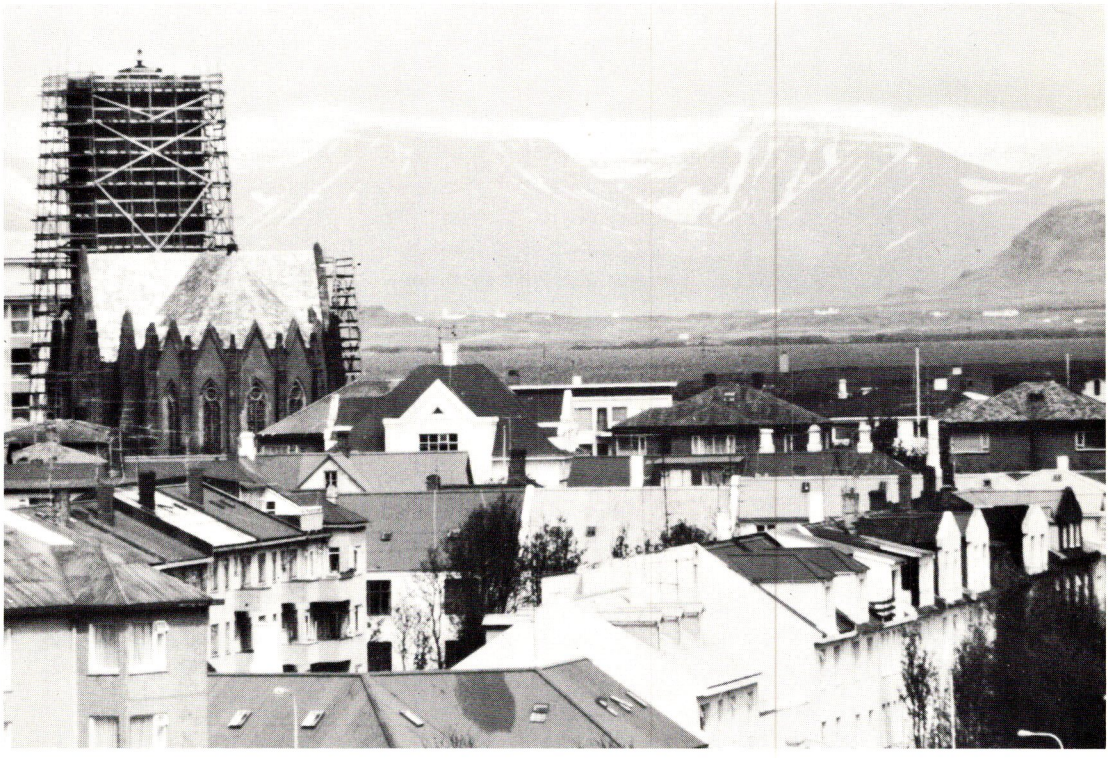
Operational Techniques with Long Lenses

The single most important source of unsatisfactory results with long lenses is camera movement, which shows up on film as a slightly blurred or double image, depending on the degree of movement. The general rule is that the longer the focal length, the greater will be the magnification of movement, which occurs regardless of focal length but which is made more evident by magnification. This is only part of the story, for movement may also be attributable to the added weight and length of long lenses. The reader is referred back to Chapter II, in which the use of camera supports and appropriate shutter speeds is discussed in some detail.

Briefly, the rule of thumb for minimum exposure with long lenses is that the focal length should be the denominator of the shutter-speed fraction. For example, if the lens is 100 or 135mm, the shutter speed should be that which is closest to either of the two focal lengths—in this case 1/125 sec. The same shutter speed ought to be the minimum for the 85mm lens, because the only other option would be to go to 1/60 sec., which might be used quite successfully but which is on the edge of risk.

Another general rule is that the tripod should support both camera and lens at the balance point of the two. With short lenses, which do not add substantially to the weight of the camera, it is satisfactory to attach the camera base itself to the tripod, but with the longer focal lengths, where the weight of the lens would throw the camera off balance if mounted on a





Comparative coverage of 100mm and 300mm lenses looking toward the hills beyond Reykjavik, Iceland. Reproduced from High-Speed Ektachrome color transparencies.

tripod, the tripod socket will be found on the lens itself.

Focusing with the aid of the rangefinder prisms presents no problem until one begins to get into the 200mm and longer range of focal lengths. The rangefinder prisms darken so that it is difficult to discern the outlines of the subject covered by the inner circle of microprisms. Although some darkening will be noted with the 200mm lens, it is not too objectionable. The problem becomes a little more noticeable with the 300mm lens, but the microprisms can still be used for focusing. Beyond 300mm, the collar surrounding the microprisms should be used for focusing. Focusing at great distances with the longer lenses will be difficult in any event because of the aerial interferences discussed below. Except at infinity, the focusing problem is further complicated by the fact that depth of field at the larger apertures may be tissue thin. The use of the Magnifier V may be helpful in further accentuation of the plane of critical sharpness within the viewfinder.

The aerial interferences are of both positive and negative value. The problem is most apparent when working at great distances with the long, long lenses such as the 800 and 1000mm mirror reflexes, but even with the 200 and 300mm lenses you must be conscious of the veiling over of details, loss of contrast, and superimposing of a bluish or grayish cast over the subject matter. This is not a characteristic of any of the long lenses in themselves. Rather, it is a matter of their amplifying or blowing up a small section of a scene and thus magnifying the atmosphere's normal load of particulate matter consisting of dust, moisture particles, and air pollutants. Under ideal conditions, a mountain landscape will show a blue haze through which bluish mountains become visible; however, you must be aware that the tree and vegetation cover consists of green matter. The bluish cast is due to the abundance of ultraviolet light, invisible to the eye but not to the film, and to the reflection of blue from the sky. In hot weather, particularly, you are also likely to encounter the *schlieren effect*, which refers to the turbulence of the air as it circulates upward and downward. This causes some distortion for which there is no correction.

When using color film, the only possible correction for aerial interference is to screen out excessive ultraviolet radiation through the use of a skylight or UV filter. In black-and-white photography, when you are not concerned with altering monochromatic rendition of color and are more concerned with improving contrast, you can use a yellow, orange, or red filter, which provide successively greater contrast rendition in that order. The orange and red filters are particularly known for darkening the sky and sharpening of contrast. They do not actually eliminate haze; they simply make it less apparent through contrast improvement.

Exposure presents no special problem when using the built-in CLC meter. If, however, you are using a meterless camera, an external exposure meter should be used, preferably a spot meter such as the Minolta Auto-Spot 1°. The use of the lens hood, furnished with all Minolta Rokkor telephoto lenses, is essential in order to eliminate ambient light, which might strike the surface of the lens and impair the quality of the image as a result of flare, referred to earlier in the chapter.

The use of flash with telephoto lenses offers some interesting possibilities, particularly with color film. Pictures taken at close distances with flash or other artificial lighting call for special attention on the part of the photographer to avoid disparities in light intensity or reflectivity of objects at varying distances from the camera. The applicable principle, discussed in the chapter on artificial lighting, is the inverse square



The 300mm *f*/4.5 lens from the fifth floor of a hotel brings in a distant ground scene of the nearby railyard. Reproduced from a High Speed Ektachrome color transparency.

law, which holds that the intensity of light varies inversely with the square of the distance of the light from its source. Hence, if you should be working fairly close to a group and using a normal or wide-angle lens, the foreground subjects might be suitably exposed while the middle ground or background people would be progressively underexposed or vice versa depending upon the choice you make in setting the lens-aperture controls. With a moderate telephoto lens in the range of 85 to 135mm, you can back far enough away from small groups or other three-dimensional situations to deepen the zone of even light distribution. There is some practical limit to how far away you can get from subjects within a large room using ordinary reflectors, because the lighting tends to flatten out because of the great deal of bouncing around that occurs by the time the light reaches the distant subject. Some special parabolic reflectors have been made available for long range flash photography. These concentrate the beam of light to retain brilliance and contrast.

THE ZOOM LENSES*

A zoom lens enables the photographer to take pictures of the same subject at different magnifications altering his distance from the subject. The photographer focuses on the subject and manipulates the magnification control of the lens mount so that the focal length may be varied as desired throughout the range applicable to the particular lens.

A zoom lens has a minimum focal length and a maximum focal length, stated as part of the lens nomenclature.

* Data sheets for specific Rokkor zoom lenses are not included in this edition inasmuch as the entire range of such lenses has been undergoing optical redesign by Minolta engineers and scientists. The general tendency in design and manufacture of such lenses will be toward greater compactness and improved optical performance at all apertures.

It is also expressed as a zoom ratio. Thus, a lens with the range of 50 to 100mm would have a ratio of 1:2, whereas a lens with the range of 160 to 500mm would be reduced to a ratio of 1:3.125. The zoom lens, therefore, is one which offers continuously variable focal lengths together with a continuous range of magnifications of the subject and angles of view. A disadvantage of the zoom is that at the minimum focal length the lens is heavier and bulkier in use than a comparable lens of fixed focal length and also offers a maximum aperture of smaller size, which limits focusing and picture-taking flexibility. At the longest focal lengths, these disadvantages are somewhat diminished, although not as much with the shorter zooms as with the longer ones. Nevertheless, they are increasingly attractive to photographers, especially when used in bright daylight conditions.

Uses of the Zooms

One of the more obvious uses for the zoom lens is in sports or action photography in which the target subject is moving around, changing his relative size within the image area depending upon his distance from the camera. With the use of the zoom, the photographer can make the adjustments needed to assure that relative size is maintained. Another advantage is in selective framing to fill the viewfinder, thereby performing "optical cropping." This is an attractive advantage whether color or black-and-white film is used, although it is more important with color, where precise framing is desirable when slides are to be produced for projection. In comparison, when using lenses of fixed focal length, the photographer has a choice of changing his position, or that of his subject in relation to the camera, or the focal length of the lens. Alternatively, he can fiddle around in the darkroom to control image sizes through enlarging or through selective copying of portions of slides.

When the zoom lens is used, the size relationships among foreground, middle ground, and background objects remain constant regardless of the particular focal length selected from the available range. All that is changed, when you zoom in or out, is the size (and section) of the field being photographed. If you want to change size relationships among objects within the field of view at varying distances from the camera, or if you want to achieve particular perspective effects, you must alter the distance relationships between lens and subject as discussed in this chapter and the preceding one. The operation of the zoom lens, in fact, is excellent for teaching the fact that, apart from influence of focal length upon photographer behavior, the only other thing that changes perspective effect is distance between object and lens.

In motion-picture work the zoom is particularly advantageous in that you can perceive the gradual broadening or narrowing of the field of view—especially by zeroing in on the principal subject. In still photography, of course, this cannot be accomplished except by taking a series of pictures with the aid of the motorized Minolta or by rapid-sequence picture-taking with a standard camera.

One novelty technique with the use of zooms is making slow-speed exposures while zooming in or out. The center of the picture, when the camera is held steady on a tripod or other solid support, usually has one small area of relatively sharp, identifiable character while the rest of the picture seems to be exploding away from the center. For best results, the camera on tripod should be set for an exposure of about ½ sec. or more. You need to use a relatively slow film during the day or to stop the lens down considerably or both. At night, using fast films, reduced light intensity obviates this particular prob-



Paris gendarmes photographed with zoom lens. Note that sharpest point is toward center of zoom area. This picture was cropped on right. Photographed at night with 50~100mm zoom f/3.5 at full aperture 1/15 sec., hand-held. Francisco Hidalgo.

lem. Ordinarily, your subject needs to be one that is stationary, at least for the moment. Obviously, you cannot use this technique for action photography. Some of the best results are obtained with color film where the interplay of color mass and tone is a more important element of composition compared with the relatively higher importance attached to image resolution in black-and-white photography.

Notes on Zoom Technique

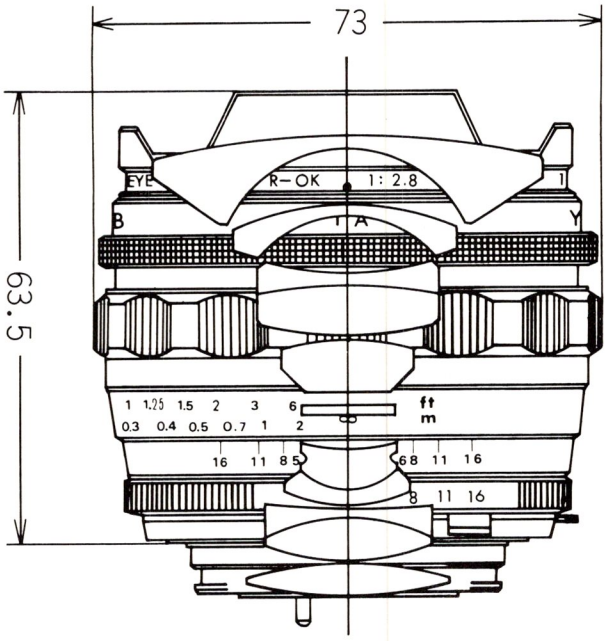
Focusing is usually best done with the lens extended to its maximum focal length in order to reduce or narrow the zone of sharpness. The lens can then be readjusted for the desired picture-taking range.

Regardless of lighting conditions, the longer zooms are best used on tripods. Remember that you have a heavier lens, which may cause some body fatigue and therefore affect camera movement, and you also have one additional variable to consider—the need for adjusting the image or magnification ratio of the lens in relation to the subject. A gunstock type of shoulder support might be helpful, but a tripod is advisable.

Since in many instances you are moving the lens around from left to right or vice versa as well as changing the variable focal length, you must be alert to changes in exposure conditions. A slight shift in direction could mean one or more stops in exposure control. Hence, you should check the exposure needle alignment within the viewfinder with the SR-T, or if you are using an independent exposure meter, you might want to take different readings beforehand, because you might not have an opportunity to do so later while trying to capture the action. Because of the greater likelihood of picking up light striking the lens surface as you change directions, you should minimize the problem of flare by using a lens hood.

Lens Directory





16mm f/2.8 MC FISHEYE ROKKOR

Lens construction: 11 elements, 8 groups
Apertures: 2.8～16
Focusing distance, one head, vertical: 0.3m (1 ft)—subject to perspective distortion
Focusing distance, two heads, horizontal: 0.3m (1 ft)—subject to perspective distortion
Focusing distance, one to three persons (6 ft) standing: 0.45m (1.5 ft)
Angles of view: Diagonal: 180°
Horizontal: 137°
Vertical: 86°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:3.3 (0.3X)
Filters: Built-in, turret-type 1A, Y48, O56, 80B
Lens hood: Built-in, fixed
Weight: 445g (15.7 oz)

DEPTH-OF-FIELD TABLES FOR 16mm f/2.8 MC FISHEYE ROKKOR

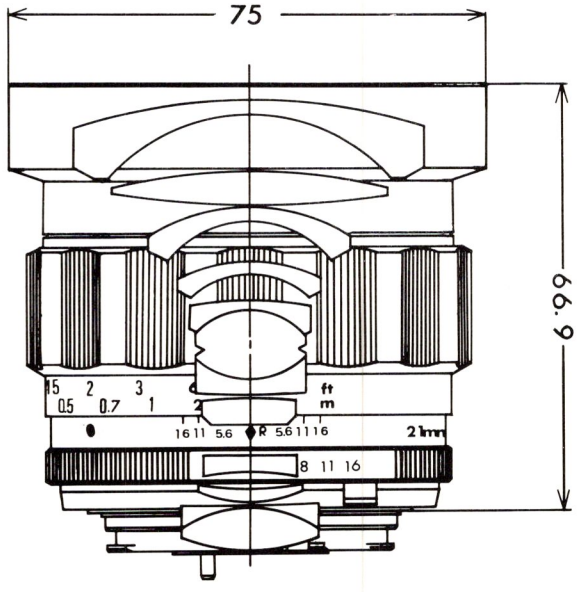
(in feet)

Dis (ft) \ F No.	2.8	4	5.6	8	11	16	22
∞	∞ 9'4⅛"	∞ 6'8¼"	∞ 4'9½"	∞ 3'5½"	∞ 2' 6¼"	∞ 1'10"	∞ 1'4⅝"
6	15'8" 3'9⅜"	50'8" 3'3½"	∞ 2'9½"	∞ 2'3⅛"	∞ 1'11	∞ 1' 6⅛"	∞ 1'2⅜"
3	4'1⅞" 2'4⅜"	5'0" 2'2¼"	7'3⅝" 2'0"	17'6" 1'8⅛"	∞ 1' 6"	∞ 1' 3¼"	∞ 1'3¼"
2	2'4¾" 1'8⅝"	2'7½" 1'7⅝"	3'5⅝" 1'6¼"	4'0" 1'4¾"	7' 2½" 1' 3"	∞ 1' 1⅛"	∞ 11⅜"
1.5	1'8¼" 1'4¼"	1'9⅜" 1'3⅝"	1'11⅜" 1'2⅞"	2'3" 1'1⅞"	2'11" 1'¾"	5'2" 11½"	∞ 10¼"
1.25	1'4⅜" 1'1⅞"	1'5" 1'1½"	1'6⅛" 1'⅞"	1'8" 1'¼"	2'0" 11⅜"	2' 8½" 10½"	6'4¾" 9½"
1	1'¾" 11⅜"	1'1" 11⅛"	1'1⅝" 10¾"	1'2½" 10⅜"	1' 4" 9⅞"	1' 7" 9¼"	2'2½" 8½"

(in meters)

Dis (m) \ F No.	2.8	4	5.6	8	11	16	22
∞	∞ 2.85	∞ 2.04	∞ 1.46	∞ 1.06	∞ 0.77	∞ 0.57	∞ 0.42
2	6.26 1.21	71.2 1.05	∞ 0.89	∞ 0.73	∞ 0.59	∞ 0.47	∞ 0.37
1	1.45 0.77	1.80 0.71	2.77 0.63	12.8 0.55	∞ 0.48	∞ 0.40	∞ 0.33
0.7	0.88 0.59	0.98 0.55	1.19 0.51	1.73 0.46	5.20 0.41	∞ 0.35	∞ 0.30
0.5	0.57 0.45	0.61 0.43	0.68 0.40	0.81 0.37	1.11 0.34	2.65 0.31	∞ 0.27
0.4	0.44 0.37	0.46 0.36	0.49 0.34	0.55 0.32	0.66 0.30	0.96 0.27	3.07 0.25
0.3	0.318 0.284	0.327 0.278	0.340 0.270	0.361 0.260	0.397 0.248	0.468 0.233	0.642 0.215





21mm f/2.8 MC ROKKOR

Lens construction: 12 elements, 9 groups
Apertures: 2.8~16, intermediate click-stops
Nearest focus: 0.25m (0.8 ft)
Ratio of object to image size at nearest focusing distance: 1:5.7 (0.175X)
Focusing distance, one head, vertical: 0.3m (1 ft)—subject to perspective distortion
Focusing distance, two heads, horizontal: 0.37m (1.2 ft)—subject to perspective distortion
Focusing distance, one to three persons (6 ft) standing: 1.2m (4 ft)
Angles of view: Diagonal: 92°
Horizontal: 81° 30′
Vertical: 60°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:2.5 (0.4X)
Screw-in filter mount diameter: 72mm
Lens hood: Exclusive angle (Minolta-type)
Weight: 510g (18 oz)

DEPTH-OF-FIELD TABLES FOR 21mm *f*/2.8 MC ROKKOR

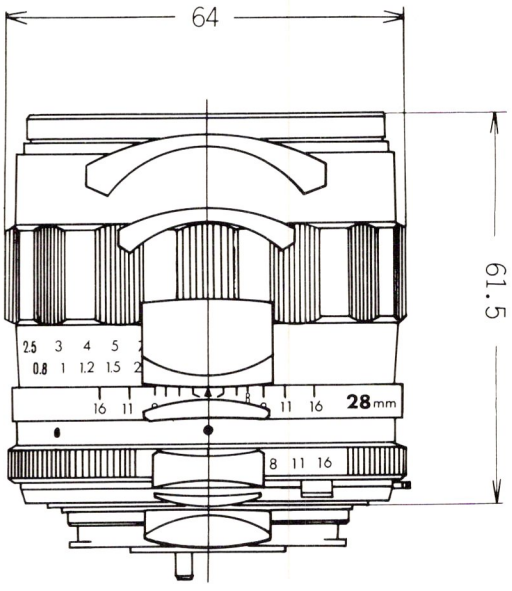
(in feet)

Dis (ft) \ F No.	2.8	4	5.6	8	11	16
∞	∞ 16′33″	∞ 11′ 9″	∞ 8′ 4⅞″	∞ 6′1⅛″	∞ 4′ 3⅞″	∞ 3′ 1⅜″
6	9′ 2″ 4′ 5¾″	11′ 7″ 4′ 1⅛″	19′ 2″ 3′ 7⅛″	363″ 3′ 1⅝″	∞ 2′ 7⅝″	∞ 2′2″
3	3′ 6⅝″ 2′ 7⅛″	3′10⅛″ 2′ 5⅝″	4′ 4⅜″ 2′ 3⅝″	5′ 5⅛″ 2′ 1⅜″	8′ 4⅜″ 1′10¾″	41′4″ 1′ 7⅞″
2	2′ 2½″ 1′ 9⅞″	2′ 3⅝″ 1′ 9¼″	2′ 5½″ 1′ 8¼″	2′ 8¾″ 1′ 7⅛″	3′ 3⅛″ 1′ 5¾″	4′ 6⅛″ 1′ 4⅛″
1.5	1′ 7⅛″ 1′ 4⅞″	1′ 7¾″ 1′ 4½″	1′ 8½″ 1′ 4″	1′ 9⅞″ 1′ 3⅜″	2′¼″ 1′2½″	2′ 4¾″ 1′ 1½″
1.25	1′ 3¾″ 1′ 2¼″	1′ 4⅛″ 1′ 2⅛″	1′ 4½″ 1′1 ⅝″	1′ 5⅜″ 1′1¼″	1′ 6⅝″ 1′⅝″	1′ 8⅞″ 11⅞″
1	1′ ⅜″ 11½″	1′ ½″ 11⅜″	1′¾″ 11¼″	1′1¼″ 11″	1′ 1⅞″ 10⅝″	1′ 2⅞″ 10⅛″

(in meters)

Dis (m) \ F No.	2.8	4	5.6	8	11	16
∞	∞ 4.98	∞ 3.60	∞ 2.57	∞ 1.83	∞ 1.82	∞ 0.95
5	∞ 2.53	∞ 2.13	∞ 1.73	∞ 1.37	∞ 1.07	∞ 0.82
2	3.23 1.46	4.27 1.32	8.28 1.16	∞ 1.00	∞ 0.83	∞ 0.68
1	1.21 0.85	1.32 0.81	1.53 0.75	1.99 0.68	3.49 0.61	∞ 0.51
0.7	0.79 0.63	0.83 0.61	0.90 0.58	1.03 0.54	1.30 0.49	2.10 0.44
0.5	0.54 0.47	0.56 0.46	0.58 0.44	0.63 0.42	0.71 0.39	0.87 0.36
0.4	0.42 0.38	0.43 0.37	0.45 0.36	0.47 0.35	0.51 0.34	0.58 0.32
0.25	0.26 0.25	0.26 0.24	0.26 0.24	0.27 0.24	0.28 0.23	0.29 0.22





28mm f/2.5 MC ROKKOR

Lens construction: 9 elements, 7 groups
Apertures: 2.5~16, intermediate stops from *f*/4
Nearest focus: 0.5m (1.75 ft)
Ratio of object to image size at nearest focusing distance: 1:12 (0.83X)
Focusing distance, one head, vertical: 0.5m (1.75 ft)—subject to perspective distortion
Focusing distance, two heads, horizontal: 0.5m (1.75 ft)—subject to perspective distortion
Focusing distance, one to three persons (6 ft) standing: 1.7m (5.5 ft)
Angles of view: Diagonal: 76°
Horizontal: 65°
Vertical: 46°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:2 (0.5X)
Screw-in filter mount diameter: 55mm
Lens hood: Exclusive angle (Minolta-type)
Replacement lens cap: 57mm
Weight: 364g (12.8 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.91~1.01×	149.99~149.74mm
100mm Macro ring (+50mm)	1.77~1.87×	161.19 ~ 159.21mm
Reverse adapter	2.3×	169.9mm (6.69")

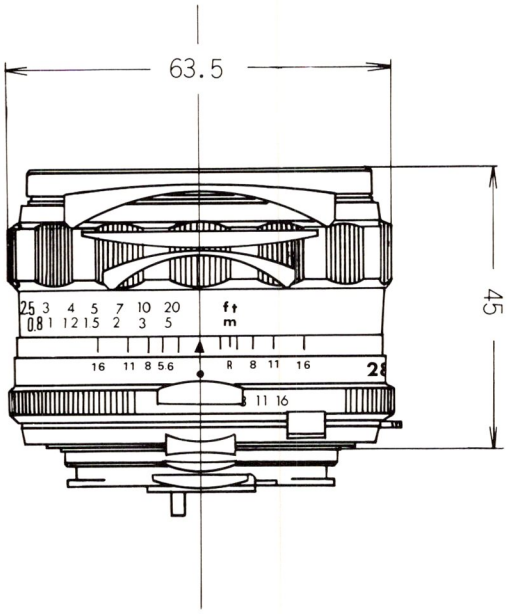
Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	8.70~0.00mm	749.00~0.00mm	10.36~0.00mm
Magnification (image ratio) range	1.38~2.38×	1.47~2.38×	1.27~2.38×
b. Distance to subject from lens edge set at infinity (reversed)	44.31~39.92mm	44.15~40.46mm	44.47~39.87mm
Magnification (image ratio) range	3.44~7.47×	3.53~6.66×	3.33~7.54

DEPTH-OF-FIELD TABLES FOR 28mm f/2.5 MC ROKKOR

Dis (ft) \ F No.	2.5	3.5	4	5.6	8	11	16
∞	∞ 31′	∞ 22′ 3″	∞ 19′11″	∞ 14′ 2″	∞ 10′ 1″	∞ 7′ 2″	∞ 5′ 2″
20	55′ 1″ 12′ 3″	188′ 10′ 8″	∞ 10′ 1″	∞ 8′ 4¾″	∞ 6′ 9¾″	∞ 5′ 4⅝″	∞ 4′ 2″
10	14′ 6″ 7′ 7⅛″	17′ 9″ 6′11⅛″	19′ 6″ 6′ 9¼″	32′ 5″ 6′ 0″	∞ 5′ 1¾″	∞ 4′ 3⅝″	∞ 3′ 6⅛″
7	8′11″ 5′ 9⅜″	10′ 0″ 5′ 4⅛″	10′ 6″ 5′ 3¼″	13′ 3¼″ 4′ 9½″	21′ 4″ 4′ 3″	171′ 3′ 8″	∞ 3′ 1″
5	5′10″ 4′ 4⅜″	6′ 3¾″ 4′ 1¾″	6′ 6″ 5′ 0″	7′ 5⅛″ 3′ 9½″	9′ 4¼″ 3′ 5⅝″	14′10″ 3′⅛″	101′ 2′ 7″
4	4′ 6⅛″ 3′ 7⅛″	4′ 9⅜″ 3′ 5⅜″	4′10½″ 3′ 4¾″	5′ 4⅜″ 3′ 2⅜″	6′ 3¼″ 3′ 0″	8′ 3⅛″ 2′ 8¼″	15′ 4″ 2′ 4½″
3	3′ 3¼″ 2′ 9¼″	3′ 4¾″ 2′ 8¼″	3′ 5¼″ 2′ 7⅛″	3′ 8″ 2′ 6½″	4′½″ 2′ 4¾″	4′ 9″ 2′ 2⅝″	6′ 4¼″ 2⅛″
2.5	2′ 8⅛″ 2′ 4⅛″	2′ 9¼″ 2′ 3½″	2′ 9⅜″ 2′ 3¼″	2′11⅛″ 2′ 2¼″	3′ 1⅞″ 2′ 1″	3′ 6½″ 1′11″	4′ 3⅞″ 1′ 9½″
2	2′ 1¼″ 1′11″	2′ 1″ 1′10⅜″	2′ 2″ 1′10¼″	2′ 3″ 1′ 9⅝″	2′ 4⅜″ 1′ 8¾″	2′ 6″ 1′ 7¾″	2′11⅛″ 1′ 6½″
1.5	1′ 6″ 1′ 5⅜″	1′ 6¾″ 1′ 5¼″	1′ 7″ 1′ 5⅛″	1′ 7⅜″ 1′ 4¾″	1′ 8⅛″ 1′ 4¼″	1′ 9⅛″ 1′ 3¾″	1′11″ 1′ 3″

Dis m \ F No.	2.5	3.5	4	5.6	8	11	16
∞	∞ 9.45	∞ 6.78	∞ 6.07	∞ 4.31	∞ 3.07	∞ 2.19	∞ 1.57
5	10.4 3.31	18.5 2.94	27 2.78	∞ 2.35	∞ 1.94	∞ 1.56	∞ 1.22
3	4.32 2.31	5.35 2.13	5.75 2.04	9.37 1.81	90.8 1.56	∞ 1.30	∞ 1.06
2	2.49 1.67	2.78 1.57	2.90 1.53	3.58 1.40	5.36 1.25	18.9 1.08	∞ 0.92
1.5	1.75 1.31	1.89 1.25	1.94 1.23	2.21 1.14	2.76 1.04	4.31 0.93	22.6 0.81
1.2	1.35 1.08	1.43 1.04	1.46 1.02	1.60 0.97	1.86 0.90	2.43 0.81	4.37 0.72
1.0	1.10 0.92	1.15 0.89	1.17 0.88	1.25 0.84	1.40 0.78	1.69 0.72	2.42 0.65
0.8	0.86 0.75	0.89 0.74	0.90 0.73	0.95 0.70	1.03 0.66	1.17 0.62	1.45 0.57
0.6	0.63 0.57	0.65 0.56	0.65 0.56	0.67 0.54	0.71 0.52	0.77 0.50	0.87 0.47
0.5	0.52 0.48	0.53 0.47	0.53 0.47	0.55 0.46	0.57 0.45	0.60 0.43	0.66 0.41





28mm f/3.5 MC ROKKOR

Lens construction: 7 elements, 7 groups
Apertures: 3.5~16
Nearest focus: 0.6m (2 ft)
Ratio of object to image size at nearest focusing distance: 1:19 (0.053X)
Focusing distance, one head, vertical: 0.6m (2 ft)—subject to perspective distortion
Focusing distance, two heads, horizontal: 0.6m (2 ft)—subject to perspective distortion
Focusing distance, one to three persons (6 ft) standing: 1.7m (5.5 ft)
Angles of view: Diagonal: 76°
Horizontal: 65°
Vertical: 46°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:2 (0.5X)
Screw-in filter mount diameter: 55mm
Lens hood: Exclusive angle (Minolta-type)
Replacement lens cap: 57mm
Weight: 245g (8.6 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.92~0.98×	133.63~133.45mm
100mm Macro ring (+50mm)	1.79~1.84×	144.17 ~ 143.20mm
Reverse adapter	2.1×	148.6mm (5.85")

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	9.00~0.00mm	7.79~0.00mm	10.76~0.00mm
Magnification (image ratio) range	1.39~2.53×	1.48~2.53×	1.29~2.53×
b. Distance to subject from lens edge set at infinity (reversed)	44.15~39.72mm	43.97~40.22mm	44.34~39.65mm
Magnification (image ratio) range	3.45~7.52×	3.54~6.70×	3.34~7.59×

DEPTH-OF-FIELD TABLES FOR 28mm *f*/3.5 MC ROKKOR

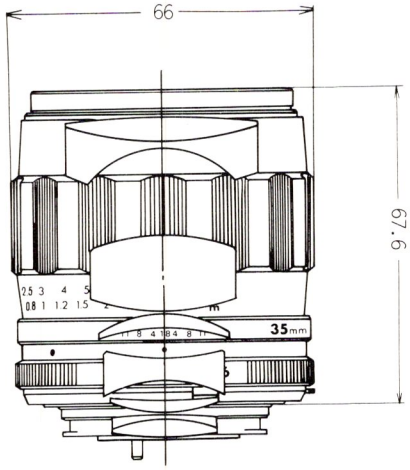
(In feet)

Dis (ft) \ F No	2.5	3.5	4	5.6	8	11	16
∞	∞ 31′	∞ 22′ 3″	∞ 19′11″	∞ 14′ 2″	∞ 10′ 1″	∞ 7′ 2″	∞ 5′ 2″
20	55′ 1″ 12′ 3″	188′ 10′ 8″	∞ 10′ 1″	∞ 8′ 4¾″	∞ 6′ 9¾″	∞ 5′ 4⅝″	∞ 4′ 2″
10	14′ 6″ 7′ 7⅛″	17′ 9″ 6′11⅞″	19′ 6″ 6′ 9¼″	32′ 5″ 6′ 0″	∞ 5′ 1¾″	∞ 4′ 3⅝″	∞ 3′ 6⅛″
7	8′11″ 5′ 9⅜″	10′ 0″ 5′ 4⅞″	10′ 6″ 5′ 3¼″	13′ 3¼″ 4′ 9½″	21′ 4″ 4′ 3″	171′ 3′ 8″	∞ 3′ 1″
5	5′10″ 4′ 4⅜″	6′ 3¾″ 4′ 1¾″	6′ 6″ 5′ 0″	7′ 5⅛″ 3′ 9½″	9′ 4¼″ 3′ 5⅝″	14′10″ 3′⅞″	101′ 2′ 7″
4	4′ 6⅛″ 3′ 7⅛″	4′ 9⅜″ 3′ 5⅜″	4′10½″ 3′ 4¾″	5′ 4⅜″ 3′ 2⅜″	6′ 3¼″ 3′ 0″	8′ 3⅛″ 2′ 8¼″	15′ 4″ 2′ 4½″
3	3′ 3¼″ 2′ 9¼″	3′ 4¾″ 2′ 8¼″	3′ 5¼″ 2′ 7⅞″	3′ 8″ 2′ 6½″	4′½″ 2′ 4¾″	4′ 9″ 2′ 2⅝″	6′ 4¼″ 2⅛″
2.5	2′ 8⅛″ 2′ 4⅛″	2′ 9¼″ 2′ 3½″	2′ 9⅜″ 2′ 3¼″	2′11⅛″ 2′ 2¼″	3′ 1⅞″ 2′ 1″	3′ 6½″ 1′11″	4′ 3⅞″ 1′ 9½″
2	2′ 1¼″ 1′11″	2′ 1″ 1′10⅜″	2′ 2″ 1′10¼″	2′ 3″ 1′ 9⅝″	2′ 4⅜″ 1′ 8¾″	2′ 6″ 1′ 7¾″	2′11⅛″ 1′ 6½″
1.5	1′ 6″ 1′ 5⅜″	1′ 6¾″ 1′ 5¼″	1′ 7″ 1′ 5⅛″	1′ 7⅜″ 1′ 4¾″	1′ 8⅛″ 1′ 4¼″	1′ 9⅛″ 1′ 3¾″	1′11″ 1′ 3″

(in meters)

Dis m \ F No.	2.5	3.5	4	5.6	8	11	16
∞	∞ 9.45	∞ 6.78	∞ 6.07	∞ 4.31	∞ 3.07	∞ 2.19	∞ 1.57
5	10.4 3.31	18.5 2.94	27 2.78	∞ 2.35	∞ 1.94	∞ 1.56	∞ 1.22
3	4.32 2.31	5.35 2.13	5.75 2.04	9.37 1.81	90.8 1.56	∞ 1.30	∞ 1.06
2	2.49 1.67	2.78 1.57	2.90 1.53	3.58 1.40	5.36 1.25	18.9 1.08	∞ 0.92
1.5	1.75 1.31	1.89 1.25	1.94 1.23	2.21 1.14	2.76 1.04	4.31 0.93	22.6 0.81
1.2	1.35 1.08	1.43 1.04	1.46 1.02	1.60 0.97	1.86 0.90	2.43 0.81	4.37 0.72
1.0	1.10 0.92	1.15 0.89	1.17 0.88	1.25 0.84	1.40 0.78	1.69 0.72	2.42 0.65
0.8	0.86 0.75	0.89 0.74	0.90 0.73	0.95 0.70	1.03 0.66	1.17 0.62	1.45 0.57
0.6	0.63 0.57	0.65 0.56	0.65 0.56	0.67 0.54	0.71 0.52	0.77 0.50	0.87 0.47
0.5	0.52 0.48	0.53 0.47	0.53 0.47	0.55 0.46	0.57 0.45	0.60 0.43	0.66 0.41





35mm f/1.8 MC ROKKOR

Lens construction: 8 elements, 6 groups
Apertures: 1.8~16, intermediate stops from 2.8
Nearest focus: 0.3m (1 ft)
Ratio of object to image size at nearest focusing distance: 1:5.4 (0.184X)
Focusing distance, one head, vertical: 0.5m (1.7 ft)—subject to perspective distortion
Focusing distance, two heads, horizontal: 0.6m (2.1 ft)—subject to perspective distortion
Focusing distance, one to three persons (6 ft) standing: 2.1m (7 ft)
Angles of view: Diagonal: 64°
Horizontal: 54°
Vertical: 38°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1.67 (0.6X)
Screw-in filter mount diameter: 55mm
Lens hood: Exclusive angle (Minolta-type)
Replacement lens cap: 57mm
Weight: 420g (14.8 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.74~0.92×	174.63~171.68mm
100mm Macro ring (+50mm)	1.43~1.61×	179.52 ~ 175.96mm
Reverse adapter	1.4×	176.0mm (6.93")

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	26.81~4.71mm	19.79~5.91mm	24.46~4.37mm
Magnification (image ratio) range	1.11~4.56×	1.19~3.90×	1.03~4.61×
b. Distance to subject from lens edge set at infinity (reversed)	49.3~42.04mm	48.93~43.01mm	49.59~42.09mm
Magnification (image ratio) range	2.72~5.97×	2.79~5.32×	2.63~6.03×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.072~0.245×	332×498~97×147mm	613~259mm
No. 2	0.133~0.301×	181×272~80×120mm	389~236mm
No. 1+2	0.199~0.356×	120×180~67×101mm	307~224mm

DEPTH-OF-FIELD TABLES FOR 35mm f/1.8 MC ROKKOR

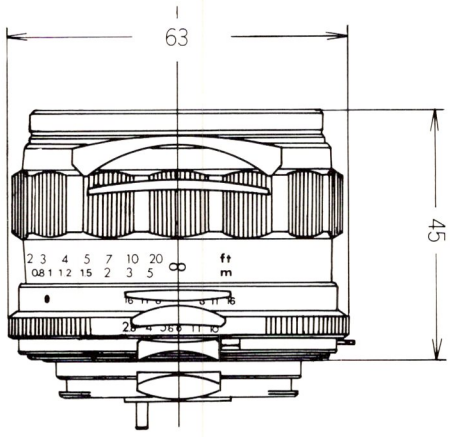
(in feet)

Dis ft \ F No.	1.8	2.8	4	5.6	8	11	16
∞	∞ 65′ 9″	∞ 42′10″	∞ 30′ 4″	∞ 21′ 6″	∞ 15′ 3″	∞ 10′11	∞ 7′ 9″
20	28′ 6″ 15′ 5″	36′11″ 13′ 9″	57′ 2″ 12′ 2″	256′ 10′ 6″	∞ 8′10″	∞ 7′ 2	∞ 5′ 8⅜″
10	11′ 8″ 8′ 8¾″	12′10″ 8′ 2¼″	14′ 7″ 7′ 7½″	18′ 1″ 6′11″	27′ 6″ 6′ 2⅛″	105′ 5′ 4¼″	∞ 4′ 6″
7	7′ 9¼″ 7′ 4⅜″	8′ 3⅛″ 6′ 1″	8′11″ 5′ 9¼″	10′ 1″ 5′ 4½″	12′ 4½″ 4′11″	18′ 4″ 4′ 4¾″	58′11″ 3′ 9¾″
5	5′ 4⅜″ 4′ 8⅛″	5′ 7″ 4′ 6¼″	5′10″ 4′ 4¼″	6′ 4⅛″ 4′ 1¾″	7′ 1¾″ 3′11″	8′ 8¾″ 3′ 6½″	12′ 9″ 3′ 2″
4	4′ 2″ 3′ 9½″	4′ 4¼″ 3′ 3⅜″	4′ 6¼″ 3′ 7″	4′ 9⅜″ 3′ 5¼″	5′ 2½″ 3′ 3⅛″	6′ 0″ 3′⅜″	7′ 7″ 2′ 9⅛″
3	3′ 1⅜″ 2′11″	3′ 2¼″ 2′10″	3′ 3¼″ 2′ 9¼″	3′ 4¾″ 2′ 8¼″	3′ 7⅛″ 2′ 7″	3′11″ 2′ 5¼″	4′ 6¼″ 2′ 3¼″
2.5	2′ 6″ 2′ 5⅛″	2′ 7½″ 2′ 4″	2′ 8⅛″ 2′ 4⅛″	2′ 9⅛″ 2′ 3⅜″	2′11″ 2′ 2½″	4′ 0″ 2′ 1⅜″	3′ 5″ 1′11″
2	2′½″ 1′11″	2′ 0″ 1′11″	2′ 1¼″ 1′11″	2′ 1¾″ 1′10″	2′ 2″ 1′ 9″	2′ 3″ 1′ 9⅛″	2′ 6″ 1′ 8⅛″
1.5	1′ 6¼″ 1′ 5″	1′ 6⅜″ 1′ 5½″	1′ 6½″ 1′ 5⅜″	1′ 6¾″ 1′ 5⅛″	1′ 7¼″ 1′ 4¾″	1′ 7⅜″ 1′ 4½″	1′ 8¾″ 1′ 4″
1.25	1′ 3⅛″ 1′ 2⅞″	1′ 3¼″ 1′ 2¾″	1′ 3⅜″ 1′ 2⅝″	1′ 3½″ 1′ 2½″	1′ 3¾″ 1′ 2¼″	1′ 4⅛″ 1′ 2″	1′ 4½″ 1′ 1¾″
1.0	1′ 11⅞″	1′⅛″ 11⅞″	1′⅛″ 11¾″	1′¼″ 11¾″	1′⅜″ 11⅝″	1′½″ 11½″	1′¾″ 11¼″

(in meters)

Dis (m) \ F No.	1.8	2.8	4	5.6	8	11	16
∞	∞ 20	∞ 13.1	∞ 9.25	∞ 6.56	∞ 4.66	∞ 3.32	∞ 2.36
5	6.60 4.03	7.98 3.65	10.6 3.28	20.1 2.88	∞ 2.45	∞ 2.03	∞ 1.64
3	3.50 2.63	3.84 2.47	4.35 2.30	5.36 2.10	8.01 1.87	27.2 1.62	∞ 1.36
2	2.20 1.83	2.33 1.75	2.50 1.67	2.80 1.56	3.36 1.43	4.71 1.29	11.2 1.13
1.5	1.61 1.41	1.67 1.36	1.76 1.31	1.89 1.25	2.13 1.17	2.58 1.07	3.73 0.96
1.2	1.27 1.14	1.30 1.11	1.35 1.08	1.43 1.04	1.56 0.98	1.78 0.91	2.24 0.83
1	1.04 0.96	1.07 0.94	1.10 0.92	1.15 0.89	1.23 0.85	1.36 0.80	1.60 0.74
0.8	0.83 0.78	0.84 0.76	0.86 0.75	0.89 0.73	0.93 0.70	1.00 0.67	1.12 0.63
0.6	0.61 0.59	0.62 0.58	0.63 0.57	0.64 0.56	0.66 0.55	0.70 0.53	0.75 0.51
0.5	0.51 0.49	0.51 0.49	0.52 0.48	0.53 0.47	0.54 0.47	0.56 0.45	0.59 0.44
0.4	0.41 0.40	0.41 0.39	0.41 0.39	0.42 0.39	0.42 0.38	0.43 0.37	0.45 0.36
0.3	0.30 0.30	0.30 0.30	0.31 0.29	0.31 0.29	0.31 0.29	0.31 0.29	0.32 0.28





35mm f/2.8 MC ROKKOR

Lens construction: 7 elements, 6 groups
Apertures: 2.8~16
Nearest focus: 0.4m (1.4 ft)
Ratio of object to image size at nearest focusing distance: 1:8 (0.125X)
Focusing distance, one head, vertical: 0.5m (1.7 ft)—subject to perspective distortion
Focusing distance, two heads, horizontal: 0.6m (2.1 ft)—subject to perspective distortion
Focusing distance, one to three persons (6 ft) standing: 2.1m (7 ft)
Angles of view: Diagonal: 64°
Horizontal: 54°
Vertical: 38°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1.67 (0.6X)
Screw-in filter mount diameter: 55mm
Lens hood: Clip-on type
Replacement lens cap: 57mm
Weight: 215g (7.6 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.74~0.86×	158.01~155.61mm
100mm Macro ring (+50mm)	1.43~1.61×	179.52 ~ 175.96mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	27.39~7.96mm	25.57~9.53mm	30.04~7.96mm
Magnification (image ratio) range	1.11~4.49×	1.19~3.84×	1.03~4.55×
b. Distance to subject from lens edge set at infinity (reversed)	49.78~41.89mm	49.37~42.9mm	50.13~41.93mm
Magnification (image ratio) range	2.56~5.81×	2.63~5.16×	2.47~5.87×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.07~0.185×	343×514~130×194mm	607~287mm
No. 2	0.132~0.245×	182×272~ 98×147mm	369~243mm
No. 1+2	0.199~0.306×	120×181~ 78×118mm	286~221mm

DEPTH-OF-FIELD TABLES FOR 35mm f/2.8 MC ROKKOR

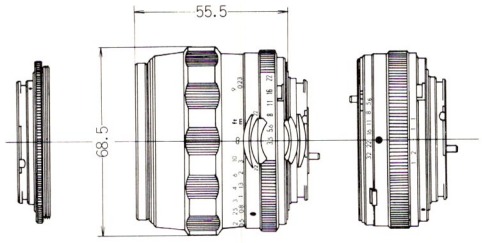
(in feet)

F No. / Dis ft	1.8	2.8	4	5.6	8	11	16
∞	∞ 65′ 9″	∞ 42′10″	∞ 30′ 4″	∞ 21′ 6″	∞ 15′ 3″	∞ 10′11	∞ 7′ 9″
20	28′ 6″ 15′ 5″	36′11″ 13′ 9″	57′ 2″ 12′ 2″	256′ 10′ 6″	∞ 8′10″	∞ 7′ 2	∞ 5′ 8⅜″
10	11′ 8″ 8′ 8¾″	12′10″ 8′ 2¼″	14′ 7″ 7′ 7½″	18′ 1″ 6′11″	27′ 6″ 6′ 2⅛″	105′ 5′ 4¼″	∞ 4′ 6″
7	7′ 9¼″ 7′ 4⅜″	8′ 3⅛″ 6′ 1″	8′11″ 5′ 9¼″	10′ 1″ 5′ 4½″	12′ 4½″ 4′11″	18′ 4″ 4′ 4¾″	58′11″ 3′ 9¾″
5	5′ 4⅜″ 4′ 8⅛″	5′ 7″ 4′ 6¼″	5′10″ 4′ 4¼″	6′ 4⅛″ 4′ 1¾″	7′ 1¾″ 3′11″	8′ 8¾″ 3′ 6½″	12′ 9″ 3′ 2″
4	4′ 2″ 3′ 9½″	4′ 4¼″ 3′ 3⅜″	4′ 6¼″ 3′ 7″	4′ 9⅜″ 3′ 5¼″	5′ 2½″ 3′ 3⅛″	6′ 0″ 3′⅜″	7′ 7″ 2′ 9⅛″
3	3′ 1⅜″ 2′11″	3′ 2¼″ 2′10″	3′ 3¼″ 2′ 9¼″	3′ 4¾″ 2′ 8¼″	3′ 7⅛″ 2′ 7″	3′11″ 2′ 5¼″	4′ 6¼″ 2′ 3¼″
2.5	2′ 6″ 2′ 5⅛″	2′ 7½″ 2′ 4″	2′ 8⅛″ 2′ 4⅛″	2′ 9⅛″ 2′ 3⅜″	2′11″ 2′ 2½″	4′ 0″ 2′ 1⅜″	3′ 5″ 1′11″
2	2′½″ 1′11″	2′ 0″ 1′11″	2′ 1¼″ 1′11″	2′ 1¾″ 1′10″	2′ 2″ 1′ 9″	2′ 3″ 1′ 9⅛″	2′ 6″ 1′ 8⅛″
1.5	1′ 6¼″ 1′ 5″	1′ 6⅜″ 1′ 5½″	1′ 6½″ 1′ 5⅜″	1′ 6¾″ 1′ 5⅛″	1′ 7¼″ 1′ 4¾″	1′ 7⅜″ 1′ 4½″	1′ 8¾″ 1′ 4″
1.25	1′ 3⅛″ 1′ 2⅞″	1′ 3¼″ 1′ 2¾″	1′ 3⅜″ 1′ 2⅝″	1′ 3½″ 1′ 2½″	1′ 3¾″ 1′ 2¼″	1′ 4⅛″ 1′ 2″	1′ 4½″ 1′ 1¾″
1.0	1′ 11⅞″	1′⅛″ 11⅞″	1′⅛″ 11¾″	1′¼″ 11¾″	1′⅜″ 11⅝″	1′½″ 11½″	1′¾″ 11¼″

(in meters)

F No. / Dis (m)	1.8	2.8	4	5.6	8	11	16
∞	∞ 20	∞ 13.1	∞ 9.25	∞ 6.56	∞ 4.66	∞ 3.32	∞ 2.36
5	6.60 4.03	7.98 3.65	10.6 3.28	20.1 2.88	∞ 2.45	∞ 2.03	∞ 1.64
3	3.50 2.63	3.84 2.47	4.35 2.30	5.36 2.10	8.01 1.87	27.2 1.62	∞ 1.36
2	2.20 1.83	2.33 1.75	2.50 1.67	2.80 1.56	3.36 1.43	4.71 1.29	11.2 1.13
1.5	1.61 1.41	1.67 1.36	1.76 1.31	1.89 1.25	2.13 1.17	2.58 1.07	3.73 0.96
1.2	1.27 1.14	1.30 1.11	1.35 1.08	1.43 1.04	1.56 0.98	1.78 0.91	2.24 0.83
1	1.04 0.96	1.07 0.94	1.10 0.92	1.15 0.89	1.23 0.85	1.36 0.80	1.60 0.74
0.8	0.83 0.78	0.84 0.76	0.86 0.75	0.89 0.73	0.93 0.70	1.00 0.67	1.12 0.63
0.6	0.61 0.59	0.62 0.58	0.63 0.57	0.64 0.56	0.66 0.55	0.70 0.53	0.75 0.51
0.5	0.51 0.49	0.51 0.49	0.52 0.48	0.53 0.47	0.54 0.47	0.56 0.45	0.59 0.44
0.4	0.41 0.40	0.41 0.39	0.41 0.39	0.42 0.39	0.42 0.38	0.43 0.37	0.45 0.36
0.3	0.30 0.30	0.30 0.30	0.31 0.29	0.31 0.29	0.31 0.29	0.31 0.29	0.32 0.28





50mm f/3.5 MC MACRO ROKKOR

Lens construction: 6 elements, 4 groups
Apertures: 3.5~22 (5.6~32 with intermediate tube)
Nearest focus: 0.23m (0.75 ft)
Ratio of object to image size at nearest focusing distance: 1:2 (0.5X); 1:1 with tube
Focusing distance, one head, vertical: 0.7m (2.25 ft)—subject to slight perspective distortion
Focusing distance, two heads, horizontal: 0.9m (3 ft)—subject to slight perspective distortion
Focusing distance, one to three persons (6 ft) standing: 3m (10 ft)
Angles of view: Diagonal: 45°
Horizontal: 38°
Vertical: 26°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1.1 (0.9X)
Screw-in filter mount diameter: 55mm
Lens hood: Integral; lens deeply recessed within mount
Replacement lens cap: 57mm
Weight: 330g (11.6 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.50~1.00×	445.76 ~ 395.76mm
Reverse adapter	0.9×	203.8mm (8.02")

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	68.9~42.1mm	64.79~44.1mm	74.62~41.52mm
Magnification (image ratio) range	0.76~3.48×	0.81~3.03×	0.70~3.51×
b. Distance to subject from lens edge set at infinity (reversed)	67.86~49.75mm	67.01~51.79mm	68.76~49.67mm
Magnification (image ratio) range	1.64~3.85×	1.69~3.41×	1.58~3.89×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.103~0.588×	233×349~41×61mm	616~218mm
No. 2	0.195~0.675×	123×184~36×53mm	377~208mm
No. 1+2	0.294~0.764×	82×123~31×47mm	295~204mm

Close-Up Lenses (With Adapter Ring)	Magnification	Area Range	Distance Range
No. 1	0.589~1.074×	41×61~22×34mm	218~203mm
No. 2	0.677~1.157×	35×53~21×31mm	208~201mm
No. 1+2	0.754~1.213×	32×48~20×30mm	205~202mm

DEPTH-OF-FIELD TABLES FOR 50mm *f*/3.5 MC MACRO ROKKOR

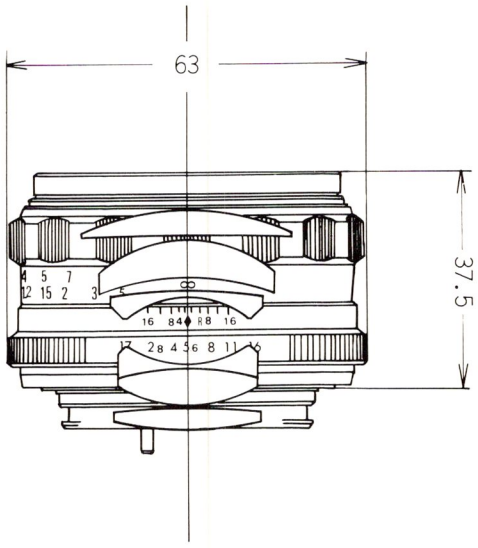
(in feet)

F No. / Dis ft	3.5	4	5.6	8	11	16	22
∞	∞ 74′12″	∞ 65′ 7″	∞ 46′ 5″	∞ 32′11″	∞ 23′ 4″	∞ 16′ 6″	∞ 11′ 9″
10	11′ 6″ 8′10½″	11′ 8″ 8′ 8⅞″	12′ 7″ 8′ 3⅝″	14′ 2″ 7′ 9⅛″	17′ 1″ 7′ 1¼″	24′ 3″ 6′ 4¼″	60′ 0″ 5′ 6¼″
6	6′ 5¾″ 5′ 7⅛″	6′ 6⅝″ 5′ 6½″	6′ 9¾″ 5′ 4⅜″	7′ 2⅝″ 5′ 1¾″	7′10⅝″ 4′10¼″	9′ 1¼″ 4′ 5″	11′ 7″ 4′ 0″
4	4′ 2⅜″ 3′ 9⅞″	4′ 2¾″ 3′ 9⅝″	4′ 3⅞″ 3′ 8⅝″	4′ 5¾″ 3′ 7⅜″	4′ 8⅝″ 3′ 5¾″	5′ 1¼″ 3′ 3⅝″	5′ 9¼″ 3′ 1″
3	3′ 1¼″ 2′10⅞″	3′ 1¼″ 2′10¾″	3′ 2″ 2′10¼″	3′ 3″ 2′ 9½″	3′ 4⅜″ 2′ 8½″	3′ 6⅝″ 2′ 7¼″	3′10¼″ 2′ 5⅝″
2.5	2′ 6¾″ 2′ 5¼″	2′ 6⅞″ 2′ 5¼″	2′ 7⅜″ 2′ 4¾″	2′ 8″ 2′ 4¼″	2′ 8⅞″ 2′ 3⅝″	2′10¼″ 2′ 2¾″	3′ ⅜″ 2′ 1⅝″
2	2′½″ 1′11½″	2′⅝″ 1′11⅜″	2′⅞″ 1′11¼″	2′ 1¼″ 1′10⅞″	2′ 1⅞″ 1′10⅜″	2′ 2¾″ 1′ 9⅞″	2′ 4¼″ 1′ 9″
1.75	1′ 9⅜″ 1′ 8⅝″	1′ 9⅜″ 1′ 8⅝″	1′ 9⅝″ 1′ 8⅜″	1′ 9⅞″ 1′ 8¼″	1′10⅜″ 1′ 7⅞″	1′11″ 1′ 7⅜″	1′11⅞″ 1′ 6¾″
1.5	1′ 6¼″ 1′ 5¾″	1′ 6¼″ 1′ 5¾″	1′ 6⅜″ 1′ 5⅝″	1′ 6⅝″ 1′ 5⅜″	1′ 6⅞″ 1′ 5¼″	1′ 7⅜″ 1′ 4⅞″	1′ 8″ 1′ 4⅜″
1.25	1′ 3⅛″ 1′ 2⅞″	1′ 3⅛″ 1′ 2⅞″	1′ 3¼″ 1′ 2¾″	1′ 3⅜″ 1′ 2⅝″	1′ 3⅝″ 1′ 2½″	1′ 3⅞″ 1′ 2¼″	1′ 4¼″ 1′ 2″
1	1′ 11⅞″	1′ 11⅞″	1′⅛″ 11⅞″	1′¼″ 11¾″	1′¼″ 11¾″	1′½″ 11⅝″	1′⅝″ 11⅜″
10(in.)	10″ 10″	10″ 10″	10⅛″ 9⅞″	10¼″ 9⅞″	10⅛″ 9⅞″	10¼″ 9¾″	10⅜″ 9⅜″
9(in.)	9″ 9″	9″ 9″	9″ 9″	9⅛″ 8⅞″	9⅛″ 8⅞″	9⅛″ 8⅞″	9¼″ 8¾″

(in meters)

F No. / Dis (m)	3.5	4	5.6	8	11	16	22
∞	∞ 30	∞ 20	∞ 14	∞ 10	∞ 7	∞ 5	∞ 3.6
3	3.4 2.7	3.5 2.6	3.8 2.5	4.2 2.3	5.1 2.1	7.1 1.9	16.6 1.7
2	2.2 1.9	2.2 1.8	2.3 1.8	2.5 1.7	2.7 1.6	3.2 1.5	4.3 1.3
1.3	1.4 1.2	1.4 1.2	1.4 1.2	1.5 1.2	1.7 1.1	1.7 1.1	1.9 1.0
1	1.0 0.96	1.0 0.96	1.1 0.94	1.1 0.92	1.1 0.89	1.2 0.86	1.3 0.81
0.8	0.82 0.78	0.83 0.78	0.84 0.77	0.86 0.75	0.88 0.73	0.92 0.71	0.98 0.68
0.6	0.61 0.59	0.62 0.59	0.62 0.58	0.63 0.57	0.65 0.56	0.68 0.55	0.70 0.53
0.5	0.51 0.49	0.51 0.49	0.51 0.49	0.52 0.49	0.53 0.48	0.54 0.46	0.56 0.45
0.4	0.41 0.40	0.41 0.39	0.41 0.39	0.41 0.39	0.42 0.38	0.43 0.38	0.44 0.37
0.35	0.354 0.346	0.354 0.346	0.356 0.344	0.359 0.342	0.363 0.338	0.368 0.334	0.376 0.328
0.3	0.303 0.298	0.303 0.297	0.304 0.296	0.306 0.294	0.308 0.292	0.312 0.289	0.317 0.285
0.25	0.251 0.249	0.252 0.248	0.252 0.248	0.253 0.247	0.255 0.245	0.257 0.244	0.260 0.241
0.23	0.231 0.229	0.231 0.229	0.232 0.228	0.233 0.228	0.234 0.227	0.235 0.225	0.237 0.223





55mm f/1.7 MC ROKKOR

Lens construction: 6 elements, 5 groups
Apertures: 1.7~16
Nearest focus: 0.5m (1.75 ft)
Ratio of object to image size at nearest focusing distance: 1:7.5 (0.133X)
Focusing distance, one head, vertical: 0.7m (2.5 ft)—subject to slight perspective distortion
Focusing distance, two heads, horizontal: 1m (3.3 ft)—subject to slight perspective distortion
Focusing distance, one to three persons (6 ft) standing: 3.1m (11 ft)
Angles of view: Diagonal: 43°
Horizontal: 36° 10′
Vertical: 24° 40′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1 (1.0X)
Screw-in filter mount diameter: 52mm
Lens hood: Screw-in type
Replacement lens cap: 54mm
Weight: 225g (7.9 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.47~0.60×	243.73 ~ 225.46mm
100mm Macro ring (+50mm)	0.91~1.04×	211.24 ~ 210.83mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	97.28~45.46mm	92.84~48.96mm	104.15~45.41mm
Magnification (image ratio) range	0.71~2.90×	0.75~2.49×	0.65~2.94×
b. Distance to subject from lens edge set at infinity (reversed)	82.28~52.93mm	80.51~55.73mm	84.39~52.93mm
Magnification (image ratio) range	1.20~3.26×	1.24~2.85×	1.14~3.30×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.12~0.25×	197×227~96×144mm	600~330mm
No. 2	0.22~0.35×	109×163~69×103mm	360~260mm
No. 1+2	0.32~0.46×	74×112~52× 78mm	180~130mm

DEPTH-OF-FIELD TABLES FOR 55mm f/1.7 MC ROKKOR

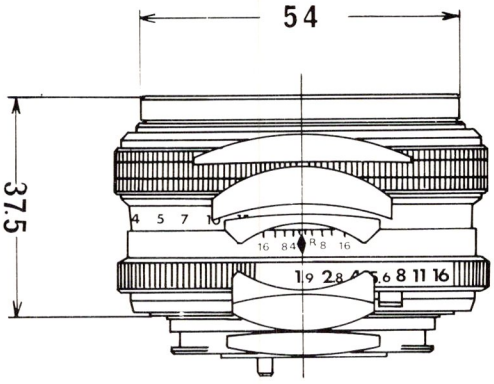
(in feet)

F No. / Dis. ft.	1.7	2.8	4	5.6	8	11	16
∞	∞ 175′	∞ 107′	∞ 75′	∞ 53′	∞ 38′	∞ 27′	∞ 19′
30	36′1″ 25′ 8″	41′ 6″ 23′ 6″	49′ 5″ 21′ 7″	67′ 7″ 19′ 4″	141′ 16′10″	∞ 14′ 3″	∞ 11′ 9″
15	16′ 4″ 13′10″	17′ 4″ 13′ 2″	18′ 7″ 12′ 7″	20′ 8″ 11′10″	24′ 6″ 10′10″	33′ 2″ 9′ 9″	67′ 4″ 8′ 6″
10	10′ 7″ 9′ 5⅞″	10′12″ 9′ 2¼″	11′ 5″ 8′10⅝″	12′ 2″ 8′ 5⅞″	13′ 5″ 7′11⅞″	15′ 7″ 7′ 4⅜″	20′ 5″ 6′ 8″
7	7′ 3¼″ 6′ 8″	7′ 5½″ 6′ 7¼″	7′ 7⅞″ 6′ 5⅜″	7′11¾″ 6′ 2⅞″	8′ 5⅝″ 5′11¾″	9′ 3⅜″ 5′ 7⅝″	10′ 9″ 5′ 2⅝″
5	5′ 1½″ 4′10½″	5′ 2⅝″ 4′ 9⅝″	5′ 3¾″ 4′ 8⅜″	5′ 5½″ 4′ 7⅜″	5′ 8⅛″ 4′ 5⅝″	6′¼″ 4′ 3⅜″	6′ 7″ 4′½″
4	4′ 1″ 3′11⅛″	4′ 1⅝″ 3′10½″	4′ 2⅜″ 3′ 9⅞″	4′ 3⅜″ 3′ 9⅛″	4′ 4⅛″ 3′ 8″	4′ 7¼″ 3′ 6½″	4′11″ 3′ 4½″
3.5	3′ 6¾″ 3′ 5⅛″	3′ 7¼″ 3′ 4⅞″	3′ 7¾″ 3′ 4⅜″	3′ 8½″ 3′ 3¾″	3′ 9⅝″ 3′ 3″	3′11¼″ 3′ 1¾″	4′ 2″ 3′¼″
3	3′½″ 2′11½″	3′⅞″ 2′11⅛″	3′ 1¼″ 2′10⅞″	3′ 1¾″ 2′10⅜″	3′ 2½″ 2′ 9¾″	3′ 3¾″ 2′ 9″	3′ 5½″ 2′ 7¾″
2.5	2′ 6⅜″ 2′ 5¾″	2′ 6¼″ 2′ 5½″	2′ 6¾″ 2′ 5¼″	2′ 7⅛″ 2′ 4″	2′ 7¾″ 2′ 4½″	2′ 8⅜″ 2′ 4″	2′ 9⅝″ 2′ 3¼″
2.25	2′ 3¼″ 2′ 2¾″	2′ 3⅜″ 2′ 2⅝″	2′ 3⅝″ 2′ 2⅜″	2′ 3⅞″ 2′ 2¼″	2′ 4¼″ 2′ 1¾″	2′ 4⅞″ 2′ 1⅜″	2′ 5¾″ 2′ 1¼″
2	2′⅛″ 1′11⅞″	2′¼″ 1′11¾″	2′½″ 1′11⅝″	2′¾″ 1′11⅜″	2′ 1″ 1′11⅛″	2′ 1½″ 1′10¾″	2′ 2″ 1′10¼″
1.75	1′ 9⅛″ 1′ 8⅞″	1′ 9¼″ 1′ 8¾″	1′ 9¼″ 1′ 8⅝″	1′ 9½″ 1′ 8½″	1′ 9″ 1′ 8¼″	1′10″ 1′ 8⅛″	1′10½″ 1′ 7⅞″

(in meters)

F No. / Dis. m.	1.7	2.8	4	5.6	8	11	16
∞	∞ 55	∞ 33	∞ 23	∞ 16	∞ 11.5	∞ 8.2	∞ 5.8
10	12.3 8.4	14.4 7.7	17.6 7.0	25.6 6.2	72.6 5.4	∞ 4.5	∞ 3.7
5	5.5 4.6	5.9 4.4	6.3 4.1	7.1 3.9	8.7 3.5	12.5 3.1	33.9 2.7
3	3.17 2.85	3.29 2.76	3.43 2.67	3.64 2.55	4.0 2.41	4.64 2.22	6.01 2.01
2	2.07 1.93	2.12 1.89	2.18 1.85	2.26 1.80	2.39 1.72	2.59 1.63	2.96 1.52
1.5	1.54 1.46	1.57 1.44	1.59 1.42	1.64 1.39	1.70 1.34	1.80 1.29	1.97 1.22
1.2	1.22 1.18	1.24 1.16	1.26 1.15	1.28 1.13	1.32 1.10	1.38 1.06	1.47 1.02
1	1.02 1.98	1.03 0.98	1.04 0.96	1.06 0.95	1.08 0.93	1.12 0.91	1.18 0.87
0.9	0.91 0.89	0.92 0.88	0.93 0.87	0.94 0.86	0.96 0.85	0.99 0.82	1.04 0.80
0.8	0.81 0.79	0.82 0.78	0.82 0.78	0.83 0.77	0.85 0.76	0.87 0.74	0.90 0.72
0.7	0.71 0.69	0.71 0.69	0.72 0.68	0.73 0.68	0.74 0.67	0.75 0.66	0.77 0.64
0.6	0.61 0.60	0.61 0.59	0.61 0.59	0.62 0.58	0.63 0.58	0.64 0.57	0.65 0.56
0.55	0.55 0.55	0.56 0.54	0.56 0.54	0.56 0.54	0.57 0.53	0.58 0.53	0.59 0.52





55mm f/1.9 MC ROKKOR

Lens construction: 6 elements, 5 groups
Apertures: 1.9~16
Nearest focus: 0.5m (1.75 ft)
Ratio of object to image size at nearest focusing distance: 1:7.5 (0.133X)
Focusing distance, one head, vertical: 0.7m (2.5 ft)—subject to slight perspective distortion
Focusing distance, two heads, horizontal: 1m (3.3 ft)—subject to slight perspective distortion
Focusing distance, one to three persons (6 ft) standing: 3.1m (11 ft)
Angles of view: Diagonal: 43°
Horizontal: 36° 10′
Vertical: 24° 40′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1 (1.0X)
Screw-in filter mount diameter: 52mm
Lens hood: Screw-in type
Replacement lens cap: 54mm
Weight: 225g (7.9 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.47~0.60×	243.73 ~ 225.46mm
100mm Macro ring (+50mm)	0.91~1.04×	211.24 ~ 210.83mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	97.28~45.46mm	92.84~48.96mm	104.15~45.41mm
Magnification (image ratio) range	0.71~2.90×	0.75~2.49×	0.65~2.94×
b. Distance to subject from lens edge set at infinity (reversed)	82.28~52.93mm	80.51~55.73mm	84.39~52.93mm
Magnification (image ratio) range	1.20~3.26×	1.24~2.85×	1.14~3.30×

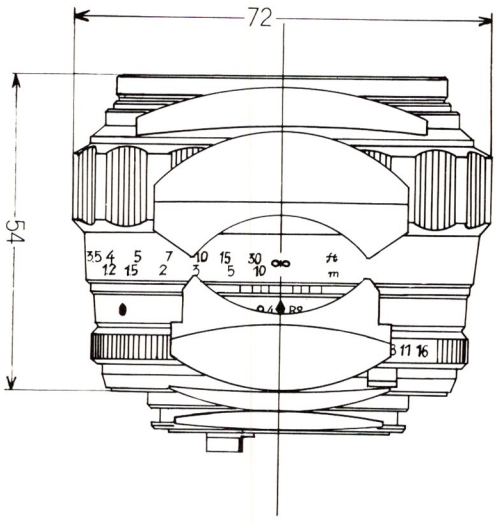
Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.12~0.25×	197×227~96×144mm	600~330mm
No. 2	0.22~0.35×	109×163~69×103mm	360~260mm
No. 1+2	0.32~0.46×	74×112~52× 78mm	180~130mm

DEPTH-OF-FIELD TABLE FOR 55mm f/1.9 MC ROKKOR

(in feet)

F No Dis (ft)	1.9	2.8	4	5.6	8	11	16
∞	∞ 156′	∞ 107′	∞ 75′ 5″	∞ 53′ 5″	∞ 37′ 9″	∞ 26′ 9″	∞ 19′
30	37′ 25′ 3″	41′ 6″ 23′ 6″	49′ 5″ 21′ 7″	67′ 7″ 19′ 4″	141′ 16′10″	∞ 14′ 3″	∞ 11′ 9″
15	16′ 6″ 13′ 9″	17′ 4″ 13′ 2″	18′ 7″ 12′ 7″	20′ 8″ 11′10″	24′ 5″ 10′10″	33′ 2″ 9′ 9″	67′ 4″ 8′ 6″
10	10′ 8″ 9′ 5⅛″	10′12″ 9′ 2¼″	11′ 5″ 8′10⅝″	12′ 2″ 8′ 5⅞″	13′ 5″ 7′11⅞″	15′ 7″ 7′ 4⅝″	20′ 5″ 6′ 8″
7	7′ 3⅝″ 6′ 8⅝″	7′ 5½″ 6′ 7¼″	7′ 7⅞″ 6′ 5⅜″	7′11¾″ 6′ 2⅞″	8′ 5⅝″ 5′11¾″	9′ 3⅜″ 5′ 7⅝″	10′ 9″ 5′ 2⅝″
5	5′ 1¾″ 4′10⅜″	5′ 2⅝″ 4′ 9⅝″	5′ 3¾″ 4′ 8⅝″	5′ 5½″ 4′ 7⅜″	5′ 8⅛″ 4′ 5⅝″	6′¼″ 4′ 3⅜″	6′ 7″ 4′½″
4	4′ 1⅛″ 3′10″	4′ 1⅝″ 3′10½″	4′ 2⅜″ 3′ 9⅞″	4′ 3⅜″ 3′ 9⅛″	4′ 4⅞″ 3′ 8″	4′ 7¼″ 3′ 6½″	4′11″ 3′ 4½″
3.5	3′ 6¾″ 3′ 5¼″	3′ 7¼″ 3′ 4⅞″	3′ 7¾″ 3′ 4⅜″	3′ 8½″ 3′ 3¾″	3′ 9⅝″ 3′ 3″	3′11¼″ 3′ 1¾″	4′ 2″ 3′¼″
3	3′½″ 2′11½″	3′⅞″ 2′11⅛″	3′ 1¼″ 2′10⅞″	3′ 1¾″ 2′10⅜″	3′ 2½″ 2′ 9¾″	3′ 3¾″ 2′ 9″	3′ 5½″ 2′ 7¾″
2.5	2′ 6½″ 2′ 5⅝″	2′ 6½″ 2′ 5½″	2′ 6¾″ 2′ 5¼″	2′ 7⅛″ 2′ 5″	2′ 7¾″ 2′ 4½″	2′ 8⅜″ 2′ 4″	2′ 9⅝″ 2′ 3¼″
2.25	2′ 3¼″ 2′ 2¾″	2′ 3⅜″ 2′ 2⅝″	2′ 3⅝″ 2′ 2⅜″	2′ 3⅞″ 2′ 2¼″	2′ 4¼″ 2′ 1¾″	2′ 4⅞″ 2′ 1⅜″	2′ 5¾″ 2′ 1¼″
2	2′¼″ 1′11¾″	2′¼″ 1′11¾″	2′½″ 1′11⅝″	2′¾″ 1′11⅜″	2′ 1″ 1′11⅛″	2′ 1½″ 1′10¾″	2′ 2″ 1′10¼″
1.75	1′ 9⅛″ 1′ 8¾″	1′ 9¼″ 1′ 8¾″	1′ 9⅜″ 1′ 8⅝″	1′ 9½″ 1′ 8½″	1′ 9⅝″ 1′ 8¼″	1′10″ 1′ 8⅛″	1′10½″ 1′ 7¾″





58mm f/1.2 MC ROKKOR

Lens construction: 7 elements, 5 groups
Apertures: 1.2~6
Nearest focus: 0.6m (2 ft)
Ratio of object to image size at nearest focusing distance: 1:8 (0.125X)
Focusing distance, one head, vertical: 0.85m (2.8 ft)—subject to slight perspective distortion
Focusing distance, two heads, horizontal: 1.1m (3.5 ft)—subject to slight perspective distortion
Focusing distance, one to three persons (6 ft) standing: 3.5m (11.5 ft)
Angles of view: Diagonal: 41°
Horizontal: 34° 30′
Vertical: 23° 20′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1 (1.0X)
Screw-in filter mount diameter: 55mm
Lens hood: Exclusive angle (Minolta-type)
Replacement lens cap: 57mm
Weight: 455g (16.0 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.44~0.56×	256.89~235.17mm
100mm Macro ring (+50mm)	0.84~0.97×	216.51~214.76mm
Reverse adapter	0.8×	217.5mm (8.56″)

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	88.57~28.08mm	83.31~31.66mm	95.76~27.61mm
Magnification (image ratio) range	0.66~2.71×	0.70~2.32×	0.61~2.74×
b. Distance to subject from lens edge set at infinity (reversed)	76.98~54.15mm	76.5~56.3mm	78.46~53.77mm
Magnification (image ratio) range	1.46~3.39×	1.51~3.00×	1.41~3.42×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.12~0.25×	199×299~96×144mm	600~360mm
No. 2	0.23~0.36×	104×157~67×100mm	360~280mm
No. 1+2	0.34~0.47×	67×106~51× 76mm	180~130mm

DEPTH-OF-FIELD TABLES FOR 58mm f/1.2 MC ROKKOR

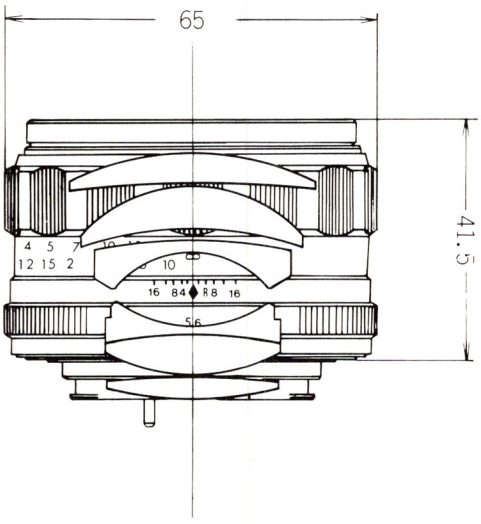
(in feet)

Dis (ft) \ F No.	1.2	1.4	2	2.8	4	5.6	8	11	16
∞	∞ 282′	∞ 244′	∞ 171′	∞ 121′	∞ 85′	∞ 61′	∞ 43′	∞ 30′	∞ 22′
30	33′ 6″ 27′ 2″	34′ 2″ 26′ 9″	36′ 3″ 25′ 7″	39′ 9″ 24′ 1″	45′11″ 22′ 4″	59′ 0″ 20′ 2″	98′ 0″ 17′ 9″	∞ 15′ 2″	∞ 12′ 8″
15	15′10″ 14′ 3″	15′11″ 14′ 2″	16′ 5″ 13′10″	17′ 1″ 13′ 5″	18′ 1″ 12′10″	19′ 9″ 12′11″	22′ 9″ 11′ 3″	29′ 0″ 10′ 2″	47′ 7″ 9′ 0″
10	10′ 4″ 9′ 8⅛″	10′ 5″ 9′ 8″	10′ 7″ 9′ 6″	10′10″ 9′ 3″	11′ 3″ 9′ 0″	11′10″ 8′ 8″	12′11″ 8′ 2″	14′ 8″ 7′ 7″	18′ 2″ 6′11″
7	7′ 2″ 6′⅛″	7′ 2¼″ 6′10″	7′ 3″ 6′ 9″	7′ 5″ 6′ 8″	7′ 7″ 6′ 6″	7′10″ 6′ 4″	8′ 3″ 6′ 1″	8′11″ 5′ 9″	10′ 1″ 5′ 5″
5	5′⅞″ 4′11″	5′ 1″ 4′11″	5′ 2″ 4′10″	5′ 2″ 4′10″	5′ 3″ 4′ 9″	5′ 5″ 4′ 8″	5′ 7″ 4′ 6″	5′10″ 4′ 4″	6′ 4″ 4′ 2″
4	4′½″ 3′11⅜″	4′ 1″ 3′11″	4′ 1″ 3′11″	4′ 1″ 3′11″	4′ 2″ 3′10″	4′ 3″ 3′ 9″	4′ 4″ 3′ 8″	4′ 6″ 3′ 7″	4′ 9″ 3′ 5″
3.5	3′ 6″ 3′ 5½″	3′ 6½″ 3′ 5½″	3′ 6¾″ 3′ 5¼″	3′ 7″ 3′ 4¾″	3′ 7½″ 3′ 4½″	3′ 8¼″ 3′ 4″	3′ 9¼″ 3′ 3¼″	3′10¾″ 3′ 2¼″	4′¾″ 3′¾″
3	3′¼″ 2′11⅝″	3′⅛″ 2′11¾″	3′⅛″ 2′11½″	3′⅜″ 2′11¼″	3′ 1″ 2′10¾″	3′ 1½″ 2′10½″	3′ 2¼″ 2′10″	3′ 3¼″ 2′ 9¼″	3′ 4¾″ 2′ 8¼″
2.5	2′ 6⅛″ 2′ 5¾″	2′ 6¼″ 2′ 5¾″	2′ 6½″ 2′ 5¼″	2′ 5½″ 2′ 5½″	2′ 6¾″ 2′ 5¼″	2′ 7″ 2′ 5″	2′ 7½″ 2′ 4¾″	2′ 8¼″ 2′ 4¼″	2′ 9″ 2′ 3½″
2.25	2′ 3⅛″ 2′ 2⅞″	2′ 3¼″ 2′ 2¾″	2′ 3¼″ 2′ 2¾″	2′ 3½″ 2′ 2¾″	2′ 3½″ 2′ 2½″	2′ 3¾″ 2′ 2¼″	2′ 4¼″ 2′ 2″	2′ 4¾″ 2′ 1½″	2′ 5½″ 2′ 1″
2	2′⅛″ 1′11⅞″	2′¼″ 1′11¾″	2′¼″ 1′11¾″	2′¼″ 1′11¾″	2′½″ 1′11¾″	2′¾″ 1′11½″	2′¾″ 1′11¼″	2′ 1¼″ 1′10¾″	2′ 1¾″ 1′10½″

(in meters)

Dis m \ F No.	1.2	1.4	2	2.8	4	5.6	8	11	16
∞	∞ 86.0	∞ 74.2	∞ 53.8	∞ 38.0	∞ 26.9	∞ 19.1	∞ 13.5	∞ 9.6	∞ 6.8
10	11.3 9.0	11.5 8.8	12.2 8.5	13.5 8.0	15.8 7.3	20.8 6.6	37.7 5.8	∞ 4.9	∞ 4.1
5	5.3 4.7	5.4 4.7	5.5 4.6	5.7 4.4	6.1 4.2	6.7 4.0	7.8 3.7	10.2 3.3	18.1 2.9
3	3.10 2.90	3.12 2.89	3.17 2.85	3.24 2.79	3.36 2.71	3.53 2.61	3.81 2.48	4.29 2.31	5.22 2.11
2	2.04 1.96	2.05 1.95	2.07 1.93	2.10 1.91	2.15 1.87	2.22 1.82	2.32 1.76	2.48 1.68	2.76 1.57
1.5	1.52 1.48	1.53 1.47	1.54 1.46	1.56 1.45	1.58 1.43	1.61 1.40	1.67 1.37	1.75 1.32	1.88 1.25
1.2	1.22 1.19	1.22 1.18	1.22 1.18	1.23 1.17	1.25 1.16	1.27 1.14	1.30 1.11	1.35 1.08	1.42 1.04
1	1.01 0.99	1.01 0.99	1.02 0.99	1.02 0.98	1.03 0.97	1.05 0.96	1.07 0.94	1.10 0.92	1.14 0.89
0.9	0.91 0.89	0.91 0.89	0.91 0.89	0.92 0.88	0.93 0.88	0.94 0.87	0.95 0.85	0.98 0.84	1.01 0.81
0.8	0.81 0.79	0.81 0.79	0.81 0.79	0.81 0.79	0.82 0.78	0.83 0.77	0.84 0.76	0.86 0.75	0.89 0.73
0.7	0.71 0.70	0.71 0.70	0.71 0.71	0.71 0.69	0.71 0.69	0.72 0.68	0.73 0.67	0.74 0.66	0.76 0.65
0.6	0.60 0.60	0.60 0.60	0.61 0.60	0.61 0.59	0.61 0.59	0.61 0.59	0.62 0.58	0.63 0.57	0.64 0.56





58mm f/1.4 MC ROKKOR

Lens construction: 6 elements, 5 groups
Apertures: 1.4~16
Nearest focus: 0.6m (2 ft)
Ratio of object to image size at nearest focusing distance: 1:8 (0.125X)
Focusing distance, one head, vertical: 0.85m (2.8 ft)—subject to slight perspective distortion
Focusing distance, two heads, horizontal: 1.1m (3.5 ft)—subject to slight perspective distortion
Focusing distance, one to three persons (6 ft) standing: 3.5m (11.5 ft)
Angles of view: Diagonal: 41°
Horizontal: 34° 30′
Vertical: 23° 20′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1:1 (1.0X)
Screw-in filter mount diameter: 55mm
Lens hood: Screw-in type
Replacement lens cap: 57mm
Weight: 275g (7.60 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.44~0.56×	269.98~248.30mm
100mm Macro ring (+50mm)	0.85~0.97×	229.45~227.94mm
Reverse adapter	0.4×	292.0mm (11.5″)

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	114.23~53.61mm	108.98~57.24mm	121.61~53.65mm
Magnification (image ratio) range	0.66~2.71×	0.70~2.32×	0.61~2.75×
b. Distance to subject from lens edge set at infinity (reversed)	93.94~56.53mm	91.66~59.53mm	96.91~56.1mm
Magnification (image ratio) range	1.03~2.96×	1.07~2.57×	0.98~2.99×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 1	0.12~0.25×	199×299~96×144mm	600~360mm
No. 2	0.23~0.36×	104×157~67×100mm	360~280mm
No. 1+2	0.34~0.47×	67×106~51× 76mm	180~130mm

DEPTH-OF-FIELD TABLES FOR 58mm f/1.4 MC ROKKOR

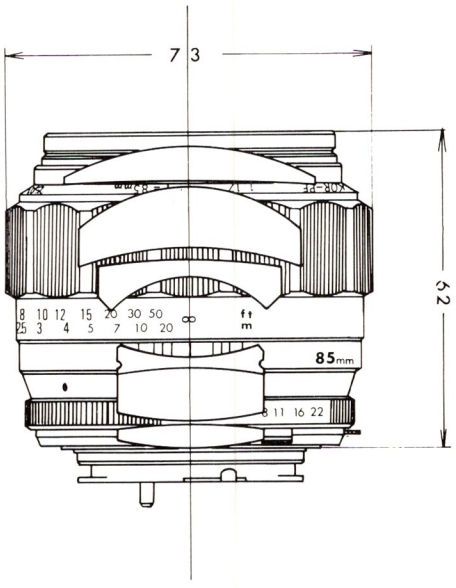
(in feet)

Dis.(ft) \ F No.	1.2	1.4	2	2.8	4	5.6	8	11	16
∞	∞ 282′	∞ 244′	∞ 171′	∞ 121′	∞ 85′	∞ 61′	∞ 43′	∞ 30′	∞ 22′
30	33′ 6″ 27′ 2″	34′ 2″ 26′ 9″	36′ 3″ 25′ 7″	39′ 9″ 24′ 1″	45′11″ 22′ 4″	59′ 0″ 20′ 2″	98′ 0″ 17′ 9″	∞ 15′ 2″	∞ 12′ 8″
15	15′10″ 14′ 3″	15′11″ 14′ 2″	16′ 5″ 13′10″	17′ 1″ 13′ 5″	18′ 1″ 12′10″	19′ 9″ 12′11″	22′ 9″ 11′ 3″	29′ 0″ 10′ 2″	47′ 7″ 9′ 0″
10	10′ 4″ 9′ 8⅛″	10′ 5″ 9′ 8″	10′ 7″ 9′ 6″	10′10″ 9′ 3″	11′ 3″ 9′ 0″	11′10″ 8′ 8″	12′11″ 8′ 2″	14′ 8″ 7′ 7″	18′ 2″ 6′11″
7	7′ 2″ 6′⅛″	7′ 2¼″ 6′10″	7′ 3″ 6′ 9″	7′ 5″ 6′ 8″	7′ 7″ 6′ 6″	7′10″ 6′ 4″	8′ 3″ 6′ 1″	8′11″ 5′ 9″	10′ 1″ 5′ 5″
5	5′⅞″ 4′11″	5′ 1″ 4′11″	5′ 2″ 4′10″	5′ 2″ 4′10″	5′ 3″ 4′ 9″	5′ 5″ 4′ 8″	5′ 7″ 4′ 6″	5′10″ 4′ 4″	6′ 4″ 4′ 2″
4	4′½″ 3′11⅜″	4′ 1″ 3′11″	4′ 1″ 3′11″	4′ 1″ 3′11″	4′ 2″ 3′10″	4′ 3″ 3′ 9″	4′ 4″ 3′ 8″	4′ 6″ 3′ 7″	4′ 9″ 3′ 5″
3.5	3′ 6″ 3′ 5½″	3′ 6½″ 3′ 5½″	3′ 6¾″ 3′ 5¼″	3′ 7″ 3′ 4¾″	3′ 7½″ 3′ 4½″	3′ 8¼″ 3′ 4″	3′ 9¼″ 3′ 3¼″	3′10¾″ 3′ 2¼″	4′¾″ 3′¾″
3	3′¼″ 2′11⅝″	3′½″ 2′11¾″	3′½″ 2′11½″	3′¾″ 2′11¼″	3′ 1″ 2′10¼″	3′ 1½″ 2′10½″	3′ 2¼″ 2′10″	3′ 3¼″ 2′ 9¼″	3′ 4¾″ 2′ 8¼″
2.5	2′ 6⅛″ 2′ 5¾″	2′ 6¼″ 2′ 5¾″	2′ 6½″ 2′ 5¼″	2′ 5½″ 2′ 5½″	2′ 6¼″ 2′ 5¼″	2′ 7″ 2′ 5″	2′ 7½″ 2′ 4¾″	2′ 8¼″ 2′ 4¼″	2′ 9″ 2′ 3½″
2.25	2′ 3⅛″ 2′ 2⅞″	2′ 3¼″ 2′ 2¼″	2′ 3¼″ 2′ 2¼″	2′ 3½″ 2′ 2¾″	2′ 3½″ 2′ 2½″	2′ 3¾″ 2′ 2¼″	2′ 4¼″ 2′ 2″	2′ 4¾″ 2′ 1½″	2′ 5½″ 2′ 1″
2	2′⅛″ 1′11⅞″	2′¼″ 1′11¾″	2′¼″ 1′11¾″	2′¼″ 1′11¾″	2′½″ 1′11¾″	2′¾″ 1′11½″	2′¾″ 1′11¼″	2′ 1¼″ 1′10¾″	2′ 1¾″ 1′10½″

(in meters)

Dis.m \ F No.	1.2	1.4	2	2.8	4	5.6	8	11	16
∞	∞ 86.0	∞ 74.2	∞ 53.8	∞ 38.0	∞ 26.9	∞ 19.1	∞ 13.5	∞ 9.6	∞ 6.8
10	11.3 9.0	11.5 8.8	12.2 8.5	13.5 8.0	15.8 7.3	20.8 6.6	37.7 5.8	∞ 4.9	∞ 4.1
5	5.3 4.7	5.4 4.7	5.5 4.6	5.7 4.4	6.1 4.2	6.7 4.0	7.8 3.7	10.2 3.3	18.1 2.9
3	3.10 2.90	3.12 2.89	3.17 2.85	3.24 2.79	3.36 2.71	3.53 2.61	3.81 2.48	4.29 2.31	5.22 2.11
2	2.04 1.96	2.05 1.95	2.07 1.93	2.10 1.91	2.15 1.87	2.22 1.82	2.32 1.76	2.48 1.68	2.76 1.57
1.5	1.52 1.48	1.53 1.47	1.54 1.46	1.56 1.45	1.58 1.43	1.61 1.40	1.67 1.37	1.75 1.32	1.88 1.25
1.2	1.22 1.19	1.22 1.18	1.22 1.18	1.23 1.17	1.25 1.16	1.27 1.14	1.30 1.11	1.35 1.08	1.42 1.04
1	1.01 0.99	1.01 0.99	1.02 0.99	1.02 0.98	1.03 0.97	1.05 0.96	1.07 0.94	1.10 0.92	1.14 0.89
0.9	0.91 0.89	0.91 0.89	0.91 0.89	0.92 0.88	0.93 0.88	0.94 0.87	0.95 0.85	0.98 0.84	1.01 0.81
0.8	0.81 0.79	0.81 0.79	0.81 0.79	0.81 0.79	0.82 0.78	0.83 0.77	0.84 0.76	0.86 0.75	0.89 0.73
0.7	0.71 0.70	0.71 0.70	0.71 0.71	0.71 0.69	0.71 0.69	0.72 0.68	0.73 0.67	0.74 0.66	0.76 0.65
0.6	0.60 0.60	0.60 0.60	0.61 0.60	0.61 0.59	0.61 0.59	0.61 0.59	0.62 0.58	0.63 0.57	0.64 0.56





85mm f/1.7 MC TELE ROKKOR

Lens construction: 6 elements, 5 groups
Apertures: 1.7~16, intermediate stops
Nearest focus: 1m (3.3 ft)
Ratio of object to image size at nearest focusing distance: 1:10 (0.10X)
Focusing distance, one head, vertical: 1.2m (4 ft)
Focusing distance, two heads, horizontal: 1.5m (5 ft)
Focusing distance, one to three persons (6 ft) standing: 5.2m (17 ft)
Angles of view: Diagonal: 28° 30′
Horizontal: 25° 50′
Vertical: 16°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1.5:1 (1.5X)
Screw-in filter mount diameter: 55mm
Lens hood: Exclusive angle (Minolta-type)
Replacement lens cap: 57mm
Weight: 460g (16.2 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.31~0.41×	448.35~390.66mm
100mm Macro ring (+50mm)	0.60~0.70×	341.75~330.15mm
Reverse adapter	0.0065×	14168.5mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	228.09~97.88mm	216.93~105.36mm	241.31~97.72mm
Magnification (image ratio) range	0.46~1.92×	0.49~1.65×	0.43~1.95×
b. Distance to subject from lens edge set at infinity (reversed)	215.55~82.97mm	204.85~96.23mm	228.22~82.15mm
Magnification (image ratio) range	0.47~1.83×	0.50~1.56×	0.44~1.85×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 0	0.079~0.182×	302×454~132×198mm	1184~610mm
No. 1	0.168~0.274×	143×214~ 88×131mm	624~490mm
No. 2	0.318~0.431×	75×113~ 56× 84mm	385~332mm
No. 0+1	0.246~0.354×	98×146~ 68×102mm	470~382mm
No. 0+2	0.394~0.478×	61× 92~ 50× 75mm	339~313mm
No. 1+2	0.479~0.596×	50× 75~ 40× 60mm	303~282mm
No. 0+1+2	0.551~0.669×	44× 65~ 36× 54mm	284~270mm

DEPTH-OF-FIELD TABLES FOR 85mm *f*/1.7 MC TELE ROKKOR

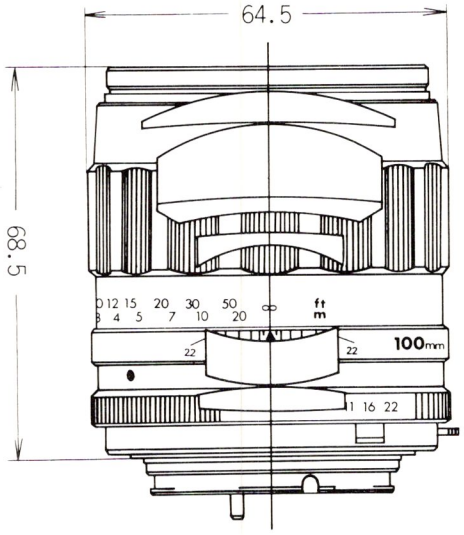
(in feet)

F. No. / Dis. ft	1.7	2.8	4	5.6	8	11	16	22
∞	∞ 409′	∞ 246′	∞ 174′	∞ 123′	∞ 87′ 1″	∞ 61′ 8″	∞ 43′ 8″	∞ 30′11″
30	32′ 4″ 28′	34′ 1″ 26′10″	36′ 1″ 25′ 8″	39′ 5″ 24′ 3″	45′ 4″ 22′ 5″	57′ 6″ 20′ 4″	93′ 18′	750′ 15′ 5″
20	21′ 19′ 1″	21′ 8″ 18′ 7″	22′ 6″ 18′	23′ 9″ 17′ 4″	25′ 9″ 16′ 5″	29′ 2″ 15′ 3″	36′ 1″ 13′10″	54′ 4″ 12′ 4″
15	15′ 7″ 14′ 6″	15′11″ 14′ 2″	16′ 4″ 13′10″	17′ 13′ 5″	18′ 12′11″	19′ 7″ 12′ 2″	22′ 5″ 11′ 4″	28′ 2″ 10′ 3″
12	12′ 4″ 11′ 8″	12′ 7″ 11′ 6″	12′10″ 11′ 3″	13′ 3″ 11′	13′10″ 10′ 7″	14′ 9″ 10′ 2″	16′ 3″ 9′ 6 7/16″	19′ 8′ 9 1/2″
10	10′ 3″ 9′ 9 5/16″	10′ 5″ 9′ 7 5/8″	10′ 7″ 9′ 5 7/8″	10′10″ 9′ 3 9/16″	11′ 2″ 9′ 7/16″	11′ 9″ 8′ 8 1/4″	12′ 9″ 8′ 2 15/16″	14′ 4″ 7′ 8 5/16″
8	8′ 1 11/16″ 7′10 5/16″	8′ 2 7/8″ 7′ 9 3/16″	8′ 4 3/16″ 7′ 8 1/8″	8′ 6″ 7′ 6 5/8″	8′ 8 3/4″ 7′ 4 9/16″	9′ 1 5/16″ 7′ 1 13/16″	9′ 7 3/8″ 6′10 1/4″	10′ 6″ 6′ 5 11/16″
7	7′ 1 1/4″ 6′10 11/16″	7′ 2 3/16″ 6′ 9 7/8″	7′ 3 1/8″ 6′ 9 1/16″	7′ 4 1/2″ 6′ 7 7/8″	7′ 6 1/2″ 6′ 6 5/16″	7′ 9 3/16″ 6′ 4 7/16″	8′ 2 1/4″ 6′ 1 7/16″	8′ 9 3/4″ 5′ 9 13/16″
6	6′ 15/16″ 5′11 1/16″	6′ 1 1/16″ 5′10 7/16″	6′ 2 1/4″ 5′ 9 7/8″	6′ 3 3/16″ 5′ 9″	6′ 4 5/8″ 5′ 7 7/8″	6′ 6 3/4″ 5′ 6 5/16″	6′10″ 5′ 4 3/16″	7′ 3″ 5′ 1 1/2″
5	5′ 5/8″ 4′11 3/8″	5′ 1″ 4′10 5/16″	5′ 1 1/2″ 4′10 1/2″	5′ 2 1/8″ 4′ 9 1/16″	5′ 3 1/16″ 4′ 9 3/16″	5′ 4 1/2″ 4′ 8 1/16″	5′ 6 9/16″ 4′ 6 5/8″	5′ 9 3/4″ 4′ 4 11/16″
4.5	4′ 6 1/2″ 4′ 5 1/2″	4′ 6 13/16″ 4′ 5 1/8″	4′ 7 3/16″ 4′ 4 13/16″	4′ 7 11/16″ 4′ 4 3/8″	4′ 8 7/16″ 4′ 3 3/4″	4′ 9 1/2″ 4′ 2 7/8″	4′11 1/8″ 4′ 1 11/16″	5′ 1 9/16″ 4′ 1/8″
4	4′ 3/8″ 3′11 9/16″	4′ 5/8″ 3′11 5/16″	4′ 7/8″ 3′11 1/16″	4′ 1 5/16″ 3′10 3/4″	4′ 1 7/8″ 3′10 1/4″	4′ 2 11/16″ 3′ 9 5/16″	4′ 3 7/8″ 3′ 8 5/8″	4′ 5 3/4″ 3′ 7 3/8″
3.5	3′ 6 1/4″ 3′ 5 11/16″	3′ 6 7/16″ 3′ 5 1/2″	3′ 6 5/8″ 3′ 5 5/16″	3′ 6 15/16″ 3′ 5 1/16″	3′ 7 3/8″ 3′ 4 11/16″	3′ 7 15/16″ 3′ 4 3/16″	3′ 8 13/16″ 3′ 3 11/16″	3′10 3/16″ 3′ 2 1/2″

(in meters)

F. No. / Dis. m	1.7	2.8	4	5.6	8	11	16	22
∞	∞ 125	∞ 75.0	∞ 53.0	∞ 37.5	∞ 26.6	∞ 18.8	∞ 13.3	∞ 9.43
20	23.8 17.3	27.2 15.8	31.9 14.6	42.5 13.1	79.6 11.5	∞ 9.74	∞ 8.04	∞ 6.46
10	10.9 9.27	11.5 8.85	12.3 8.44	13.5 7.93	15.9 7.31	21.0 6.58	38.8 5.76	∞ 4.91
5	5.20 4.82	5.34 4.70	5.50 4.59	5.73 4.43	6.10 4.24	6.72 3.99	7.85 3.68	10.3 3.32
3	3.07 2.93	3.12 2.89	3.17 2.85	3.24 2.79	3.35 2.72	3.53 2.61	3.80 2.48	4.28 2.32
2.5	2.55 2.46	2.58 2.43	2.61 2.40	2.66 2.36	2.74 2.30	2.85 2.23	3.02 2.13	3.31 2.01
2	2.03 1.97	2.05 1.95	2.07 1.94	2.10 1.91	2.14 1.87	2.21 1.83	2.31 1.76	2.47 1.68
1.7	1.72 1.68	1.73 1.67	1.75 1.65	1.77 1.64	1.80 1.61	1.85 1.58	1.91 1.53	2.02 1.47
1.5	1.52 1.48	1.53 1.47	1.54 1.46	1.55 1.45	1.58 1.43	1.61 1.40	1.66 1.37	1.74 1.32
1.3	1.31 1.29	1.32 1.28	1.33 1.27	1.34 1.26	1.36 1.25	1.38 1.23	1.42 1.20	1.47 1.17
1.2	1.21 1.19	1.22 1.18	1.22 1.18	1.23 1.17	1.25 1.16	1.27 1.14	1.30 1.12	1.34 1.09
1.1	1.11 1.09	1.11 1.09	1.12 1.08	1.13 1.07	1.14 1.06	1.15 1.05	1.18 1.03	1.21 1.01
1	1.01 0.99	1.01 0.99	1.01 0.99	1.02 0.98	1.03 0.97	1.04 0.96	1.06 0.95	1.09 0.92





100mm f/2.5 MC TELE ROKKOR

Lens construction: 6 elements, 5 groups
Apertures: 2.5~22
Nearest focus: 1.2m (4 ft)
Ratio of object to image size at nearest focusing distance: 1:9.5 (0.105X)
Focusing distance, one head, vertical: 1.5m (4.8 ft)
Focusing distance, two heads, horizontal: 1.8m (6 ft)
Focusing distance, one to three persons (6 ft) standing: 6.1m (20 ft)
Angles of view: Diagonal: 24°
Horizontal: 20° 40′
Vertical: 13° 40′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1.8:1 (1.8X)
Screw-in filter mount diameter: 55mm
Lens hood: Exclusive angle (Minolta-type)
Replacement lens cap: 57mm
Weight: 410g (14.4 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.26~0.36×	600.73~503.90mm
100mm Macro ring (+50mm)	0.50~0.60×	440.12~416.78mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	334.53~149.47mm	316.71~159.55mm	355.90~143.42mm
Magnification (image ratio) range	0.39~1.63×	0.42~1.40×	0.36~1.65×
b. Distance to subject from lens edge set at infinity (reversed)	1465.19~119.26mm	1037.12~138.66mm	2536.62~117.92mm
Magnification (image ratio) range	0.07~1.21×	0.10~0.98×	0.04~1.23×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 0	0.1~0.2×	240×360~120×180mm	1080~530mm

DEPTH-OF-FIELD TABLES FOR 100mm f/2.5 MC TELE ROKKOR

(in feet)

F No. / Dis ft	2.5	2.8	3.5	4	5.6	8	11	16	22
∞	∞ 394′	∞ 349′	∞ 280′	∞ 247′	∞ 174′	∞ 123′	∞ 87′ 5″	∞ 61′10″	∞ 43′10″
50	57′ 1″ 44′ 6″	58′ 2″ 43′10″	60′ 8″ 42′ 7″	62′ 6″ 41′ 8″	69′ 8″ 39′ 0″	83′ 3″ 35′ 9″	115′ 32′ 0″	251′ 23′11″	∞ 23′ 7″
30	32′ 5″ 27′11″	32′ 9″ 27′ 8″	33′ 6″ 27′ 2″	34′ 0″ 26′10″	36′ 0″ 25′ 9″	39′ 4″ 24′ 3″	45′ 1″ 22′ 6″	57′ 1″ 20′ 5″	91′ 7″ 18′ 0″
20	21′ 0″ 19′ 1″	21′ 2″ 18′11″	21′ 6″ 18′ 9″	21′ 8″ 18′ 7″	22′ 6″ 18′ 0″	23′ 8″ 17′ 4″	25′ 8″ 16′ 5″	29′ 0″ 15′ 3″	35′ 9″ 13′11″
15	15′ 7″ 14′ 6″	15′ 8″ 14′ 5″	15′10″ 14′ 3″	15′11″ 14′ 2″	16′ 4″ 13′11″	16′11″ 13′ 6″	17′11″ 12′11″	19′ 6″ 12′ 3″	22′ 3″ 11′ 4″
12	12′ 4″ 11′ 8″	12′ 5″ 11′ 8″	12′ 6″ 11′ 7″	12′ 7″ 11′ 6″	12′10″ 11′ 3″	13′ 2″ 11′ 0″	13′ 9″ 10′ 8″	14′ 8″ 10′ 2″	16′ 2″ 9′ 6⅞″
10	10′ 3″ 9′ 9¼″	10′ 3″ 9′ 8⅞″	10′ 4″ 9′ 8¼″	10′ 5″ 9′ 7⅝″	10′ 7″ 9′ 6″	10′10″ 9′ 3¾″	11′ 2″ 9′⅝″	11′ 8″ 8′ 8⅝″	12′ 8″ 8′ 3⅜″
8	8′ 1¾″ 7′10¼″	8′ 1⅞″ 7′10⅛″	8′ 2½″ 7′ 9⅝″	8′ 2¾″ 7′ 9¼″	8′ 4⅛″ 7′ 8¼″	8′ 5¾″ 7′ 6¾″	8′ 8½″ 7′ 4¾″	9′½″ 7′ 2⅛″	9′ 6¾″ 6′10⅝″
7	7′ 1¼″ 6′10⅝″	7′ 1⅜″ 6′10½″	7′ 1⅞″ 6′10¼″	7′ 2⅛″ 6′ 9⅞″	7′ 3″ 6′ 9⅛″	7′ 4¼″ 6′ 8″	7′ 6¼″ 6′ 6½″	7′ 9⅛″ 6′ 4⅜″	8′ 1⅝″ 6′ 1¾″
6	6′⅞″ 5′11⅛″	6′ 1⅛″ 5′10⅞″	6′ 1¼″ 5′10¾″	6′ 1½″ 5′10½″	6′ 2⅛″ 5′ 9⅞″	6′ 3⅛″ 5′ 9⅛″	6′ 4⅜″ 5′ 8″	6′ 6⅜″ 5′ 6½″	6′ 9½″ 5′ 4½″
5	5′⅝″ 4′11⅜″	5′⅝″ 4′11¼″	5′⅞ 4′11¼″	5′ 1″ 4′11″	5′ 1⅜″ 4′10⅝″	5′ 2″ 4′10⅛″	5′ 2⅞″ 4′ 9¼″	5′ 4¼″ 4′ 8¼″	5′ 6⅛″ 4′ 6⅞″
4.5	4′ 6⅜″ 4′ 5½″	4′ 6½″ 4′ 5⅜″	4′ 6⅝″ 4′ 5⅜″	4′ 6¾″ 4′ 5¼″	4′ 7⅛″ 4′ 4⅞″	4′ 7½″ 4′ 4½″	4′ 8¼″ 4′ 3½″	4′ 9¼″ 4′ 3″	4′10¾″ 4′ 1⅞″
4	4′⅜″ 3′11⅝″	4′⅜″ 3′11¼″	4′½″ 3′11½″	4′½″ 3′11⅜″	4′¾″ 3′11⅛″	4′ 1⅛″ 3′10½″	4′ 1¾″ 3′10⅜″	4′ 2½″ 3′ 9¾″	4′ 3⅝″ 3′ 8¾″

(in meters)

F No. / Dis m	2.5	2.8	3.5	4	5.6	8	11	16	22
∞	∞ 120	∞ 106	∞ 85	∞ 75	∞ 53	∞ 38	∞ 27	∞ 19	∞ 13
20	24 17	25 17	26 16	27 16	32 15	42 13	79 12	∞ 9.8	∞ 8
10	10.9 9.3	11.0 9.2	11.3 9.0	11.5 8.9	12.2 8.5	13.5 8.0	15.8 7.3	20.8 6.6	38.1 5.8
7	7.4 6.6	7.5 6.6	7.6 6.5	7.7 6.4	8.0 6.2	8.5 6.0	9.4 5.6	10.9 5.2	14.3 4.7
5	5.2 4.81	5.2 4.78	5.3 4.73	5.3 4.70	5.5 4.49	5.7 4.44	6.1 4.25	6.7 4.00	7.8 3.69
4	4.13 3.88	4.15 3.86	4.18 3.83	4.21 3.81	4.30 3.74	4.44 3.64	4.65 3.51	4.99 3.34	5.57 3.13
3	3.07 2.93	3.08 2.93	3.10 2.91	3.11 2.90	3.16 2.85	3.23 2.80	3.34 2.72	3.51 2.62	3.78 2.49
2.5	2.55 2.45	2.55 2.45	2.57 2.44	2.58 2.43	2.61 2.40	2.66 2.36	2.73 2.31	2.84 2.24	3.01 2.14
2	2.03 1.97	2.03 1.97	2.04 1.96	2.05 1.96	2.07 1.94	2.10 1.91	2.14 1.88	2.20 1.83	2.30 1.77
1.7	1.72 1.68	1.72 1.68	1.73 1.67	1.73 1.67	1.75 1.66	1.77 1.64	1.80 1.61	1.84 1.58	1.90 1.54
1.5	1.52 1.48	1.52 1.48	1.52 1.48	1.52 1.48	1.54 1.47	1.55 1.45	1.57 1.43	1.60 1.41	1.65 1.37
1.3	1.31 1.29	1.31 1.29	1.32 1.28	1.32 1.28	1.33 1.28	1.34 1.27	1.35 1.25	1.37 1.23	1.41 1.21
1.2	1.21 1.19	1.21 1.19	1.21 1.19	1.21 1.19	1.22 1.18	1.23 1.17	1.24 1.16	1.26 1.15	1.29 1.12



100mm f/3.5 MC MACRO ROKKOR

Lens construction: 5 elements, 4 groups
Apertures: 3.5~22
Nearest focus: 0.45m (1.5 ft); 0.4m (1.33 ft) with intermediate ring
Ratio of object to image size at nearest focusing distance: 1:2; 1:1 with intermediate ring
Focusing distance, one head, vertical: 1.5m (4.8 ft)
Focusing distance, two heads, horizontal: 1.8m (6 ft)
Focusing distance, one to three persons (6 ft) standing: 6.1 (20 ft)
Angles of view: Diagonal: 24°
Horizontal: 20° 40′
Vertical: 13° 40′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1.8:1 (1.8X)
Screw-in filter mount diameter: 55mm
Lens hood: Built-in
Replacement lens cap: 57mm
Weight: 550g (19.4 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
100mm Macro ring (+50mm)	0.50~1.00×	445.76~395.76mm

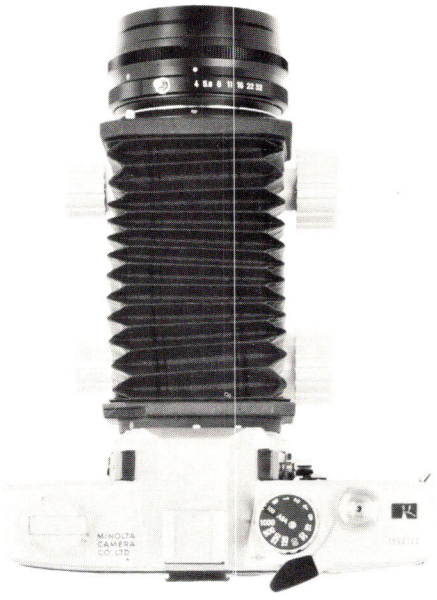
Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	357.74~173.58mm	333.99~183.58mm	379.04~172.84mm
Magnification (image ratio) range	0.39~1.64×	0.42~1.41×	0.36~1.66×
b. Distance to subject from lens edge set at infinity (reversed)	∞~139.29mm	∞~171.3mm	∞~137.21mm
Magnification (image ratio) range	1/∞~0.97×	1/∞~0.74mm	1/∞~0.99×

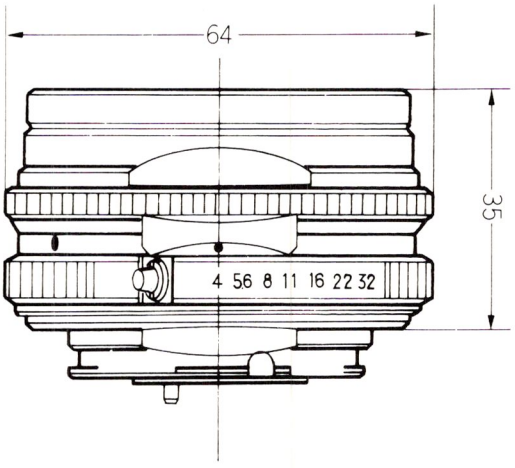
Close-Up Lenses (Without Adapter Ring)	Magnification	Area Range	Distance Range
No. 0	0.094~0.6×	254×381~40×60mm	1209~404mm
No. 1	0.2~0.731×	120×180~33×49mm	649~367mm
No. 2	0.379~0.959×	63× 95~25×38mm	411~326mm
No. 1+2	0.570~1.188×	42× 63~20×30mm	328~306mm
No. 0+1	0.293~0.842×	82×123~28×43mm	496~348mm
No. 0+2	0.469~1.066×	52× 77~23×34mm	365~316mm
No. 0+1+2	0.656~1.287×	37× 55~19×28mm	310~301mm

Close-Up Lenses (With Adapter Ring)	Magnification	Area Range	Distance Range
No. 0	0.617~1.122×	39×58~21×32mm	401~380mm
No. 1	0.749~1.28×	32×48~19×28mm	366~363mm
No. 2	0.979~1.559×	25×37~15×23mm	326~343mm
No. 1+2	1.209~1.827×	20×30~13×20mm	306~332mm
No. 0+1	0.861~1.41×	28×42~17×26mm	347~356mm
No. 0+2	1.087~1.684×	22×33~14×21mm	316~338mm
No. 0+1+2	1.309~1.940×	18×28~12×19mm	301~331mm

DEPTH-OF-FIELD TABLE FOR 100mm f/3.5 MC MACRO ROKKOR

F No / Dis (m)	3.5	4	5.6	8	11	16	22	32
∞	∞	∞	∞	∞	∞	∞	∞	∞
	85.8	15.1	53.1	37.6	26.6	18.8	13.4	9.47
50	119	14.8	819	∞	∞	∞	∞	∞
	31.7	30.1	25.8	215	17.4	13.7	10.6	8
30	45.9	49.7	68.4	146	∞	∞	∞	∞
	22.3	21.5	19.2	16.8	14.2	11.6	9.3	7.25
20	26	27.1	31.9	42.3	98.6	∞	∞	∞
	16.3	15.8	14.6	13.1	11.5	9.78	8.08	6.49
15	18.1	18.7	20.8	24.7	33.8	70.9	∞	∞
	12.8	12.5	11.7	10.8	9.66	8.43	7.14	5.88
10	11.3	11.5	12.2	13.5	15.8	20.8	38.1	∞
	8.98	8.86	8.46	7.95	7.33	6.60	5.79	4.94
7	7.6	7.69	8.02	8.53	9.38	10.9	14.3	21.2
	6.49	6.43	6.22	5.94	3.59	5.16	4.66	4.1
5	5.29	5.34	5.49	5.72	6.08	6.69	7.78	10.1
	4.74	4.71	4.59	4.44	4.25	4	3.7	3.34
4	4.12	4.21	4.30	4.44	4.65	4.99	5.57	6.66
	3.83	3.81	3.74	3.64	3.51	3.34	3.13	2.87
3	3.1	3.11	3.16	3.23	3.34	3.51	3.73	4.24
	2.91	2.9	2.85	2.8	2.42	2.62	2.49	2.33
2.5	2.57	2.58	2.61	2.66	2.73	2.84	3	3.28
	2.44	2.43	2.4	2.36	2.31	2.24	2.15	2.03
2	2.04	2.05	2.07	2.1	2.14	2.2	2.3	2.35
	1.96	1.96	1.94	1.91	1.88	1.83	1.77	1.67
1.7	1.73	1.73	1.75	1.77	1.8	1.84	1.9	2
	1.67	1.67	1.66	1.64	1.61	1.58	1.51	1.48
1.5	1.52	1.52	1.53	1.55	1.57	1.6	1.65	1.83
	1.48	1.48	1.47	1.45	1.43	1.41	1.38	1.35
1.3	1.32	1.32	1.33	1.34	1.35	1.37	1.41	1.46
	1.28	1.28	1.28	1.27	1.25	1.23	1.21	1.13
1.2	1.21	1.21	1.22	1.23	1.24	1.26	1.29	1.33
	1.19	1.19	1.18	1.14	1.16	1.14	1.12	1.10
1.1	1.11	1.11	1.12	1.12	1.13	1.15	1.17	1.20
	1.09	1.09	1.08	1.08	1.07	1.05	1.04	1.01
1.0	1.01	1.01	1.01	1.02	1.03	1.04	1.06	1.08
	0.991	0.991	0.987	0.982	0.974	0.964	0.950	0.951
0.9	0.906	0.907	0.91	0.915	0.921	0.930	0.943	0.863
	0.894	0.893	0.89	0.886	0.88	0.872	0.861	0.846
0.8	0.805	0.805	0.808	0.811	0.816	0.822	0.832	0.846
	0.795	0.795	0.792	0.789	0.785	0.779	0.771	0.76
0.7	0.703	0.704	0.705	0.708	0.711	0.715	0.722	0.732
	0.697	0.696	0.695	0.693	0.698	0.685	0.679	0.671
0.6	0.602	0.602	0.603	0.605	0.607	0.61	0.614	0.62
	0.598	0.598	0.597	0.595	0.593	0.591	0.587	0.582





100mm f/4 MC AUTO-BELLOWS ROKKOR

Lens construction: 3 elements, 3 groups
Apertures: 4~32
Nearest focus: Subject to bellows and other extensions
Focusing distance, one head, vertical: 1.5m (4.8 ft)
Focusing distance, two heads, horizontal: 1.8m (6 ft)
Focusing distance, one to three persons (6 ft) standing: 6.1m (20 ft)
Angles of view: Diagonal: 24°
Horizontal: 20° 40′
Vertical: 13° 40′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 1.8:1 (1.8X)
Screw-in filter mount diameter: 55mm
Replacement lens cap: 57mm
Weight: 165g (5.8 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
100mm Macro ring (+50mm)	0.08×	1457.99mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	334.96~143.79mm	321.93~155.34mm	356.35~142.95
Magnification (image ratio) range	0.39~1.53×	0.41~1.30×	0.36~1.55×
b. Distance to subject from lens edge set at infinity (reversed)	1467.13~119.35mm	1038.42~138.74mm	2540.16~118.01mm
Magnification (image ratio) range	0.07~1.21×	0.10~0.98×	0.04~1.23×

DEPTH-OF-FIELD TABLES FOR 100mm f/4 MC AUTO-BELLOWS ROKKOR

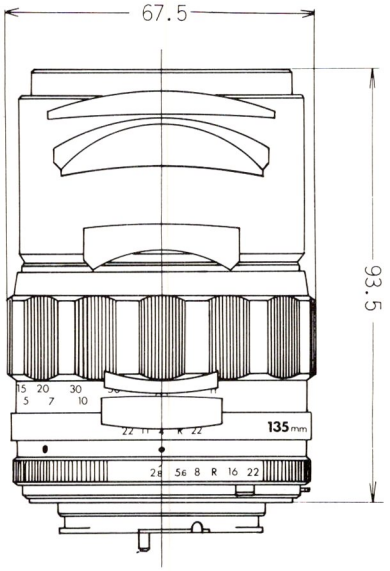
(in (feet)

Dis ft \ F No.	4	5.6	8	11	16	22
∞	∞ 247′	∞ 174′	∞ 123′	∞ 87′ 5″	∞ 61′10″	∞ 43′10″
50	62′ 6″ 41′ 8″	69′ 8″ 39′ 0″	83′ 3″ 35′ 9″	115′ 32′ 0″	251′ 23′11″	∞ 23′ 7″
30	34′ 0″ 26′10″	36′ 0″ 25′ 9″	39′ 4″ 24′ 3″	45′ 1″ 22′ 6″	57′ 1″ 20′ 5″	91′ 7″ 18′ 0″
20	21′ 8″ 18′ 7″	22′ 6″ 18′ 0″	23′ 8″ 17′ 4″	25′ 8″ 16′ 5″	29′ 0″ 15′ 3″	35′ 9″ 13′11″
15	15′11″ 14′ 2″	16′ 4″ 13′11″	16′11″ 13′ 6″	17′11″ 12′11″	19′ 6″ 12′ 3″	22′ 3″ 11′ 4″
12	12′ 7″ 11′ 6″	12′10″ 11′ 3″	13′ 2″ 11′ 0″	13′ 9″ 10′ 8″	14′ 8″ 10′ 2″	16′ 2″ 9′ 6⅞″
10	10′ 5″ 9′ 7⅝″	10′ 7″ 9′ 6″	10′10″ 9′ 3¾″	11′ 2″ 9′5⅝″	11′ 8″ 8′ 8⅝″	12′ 8″ 8′ 3⅜″
8	8′ 2¾″ 7′ 9¼″	8′ 4⅛″ 7′ 8¼″	8′ 5¾″ 7′ 6¾″	8′ 8½″ 7′ 4¾″	9′½″ 7′ 2⅛″	9′ 6¾″ 6′10⅝″
7	7′ 2⅛″ 6′ 9⅞″	7′ 3″ 6′ 9⅛″	7′ 4¼″ 6′ 8″	7′ 6¼″ 6′ 6½″	7′ 9⅛″ 6′ 4⅜″	8′ 1⅝″ 6′ 1¾″
6	6′ 1½″ 5′10½″	6′ 2⅛″ 5′ 9⅞″	6′ 3⅛″ 5′ 9⅛″	6′ 4⅜″ 5′ 8″	6′ 6⅜″ 5′ 6½″	6′ 9½″ 5′ 4½″
5	5′ 1″ 4′11″	5′ 1⅜″ 4′10⅝″	5′ 2″ 4′10⅛″	5′ 2⅞″ 4′ 9¼″	5′ 4¼″ 4′ 8¼″	5′ 6⅛″ 4′ 6⅞″
4.5	4′ 6¾″ 4′ 5¼″	4′ 7⅛″ 4′ 4⅞″	4′ 7½″ 4′ 4½″	4′ 8¼″ 4′ 3½″	4′ 9¼″ 4′ 3″	4′10¾″ 4′ 1⅞″
4	4′½″ 3′11⅜″	4′¾″ 3′11⅛″	4′ 1⅛″ 3′10½″	4′ 1¾″ 3′10⅜″	4′ 2½″ 3′ 9¾″	4′ 3⅝″ 3′ 8¾″

(in meters)

Dis m \ F No.	4	5.6	8	11	16	22
∞	∞ 75	∞ 53	∞ 38	∞ 27	∞ 19	∞ 13
20	27 16	32 15	42 13	79 12	∞ 9.8	∞ 8
10	11.5 8.9	12.2 8.5	13.5 8.0	15.8 7.3	20.8 6.6	38.1 5.8
7	7.7 6.4	8.0 6.2	8.5 6.0	9.4 5.6	10.9 5.2	14.3 4.7
5	5.3 4.70	5.5 4.49	5.7 4.44	6.1 4.25	6.7 4.00	7.8 3.69
4	4.21 3.81	4.30 3.74	4.44 3.64	4.65 3.51	4.99 3.34	5.57 3.13
3	3.11 2.90	3.16 2.85	3.23 2.80	3.34 2.72	3.51 2.62	3.78 2.49
2.5	2.58 2.43	2.61 2.40	2.66 2.36	2.73 2.31	2.84 2.24	3.01 2.14
2	2.05 1.96	2.07 1.94	2.10 1.91	2.14 1.88	2.20 1.83	2.30 1.77
1.7	1.73 1.67	1.75 1.66	1.77 1.64	1.80 1.61	1.84 1.58	1.90 1.54
1.5	1.52 1.48	1.54 1.47	1.55 1.45	1.57 1.43	1.60 1.41	1.65 1.37
1.3	1.32 1.28	1.33 1.28	1.34 1.27	1.35 1.25	1.37 1.23	1.41 1.21
1.2	1.21 1.19	1.22 1.18	1.23 1.17	1.24 1.16	1.26 1.15	1.29 1.12





135mm f/2.8 MC TELE ROKKOR

Lens construction: 6 elements, 5 groups
Apertures: 2.8～22
Nearest focus: 1.5m (5 ft)
Ratio of object to image size at nearest focusing distance: 1:9 (0.111X)
Focusing distance, one head, vertical: 2m (6.5 ft)
Focusing distance, two heads, horizontal: 2.4m (8 ft)
Focusing distance, one to three persons (6 ft) standing: 8.2m (27 ft)
Angles of view: Diagonal: 18°
Horizontal: 15°
Vertical: 10°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 2.5:1 (2.5X)
Screw-in filter mount diameter: 55mm
Lens hood: Built-in
Replacement lens cap: 57mm
Weight: 425g (15 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.19～0.30×	992.90～747.23×
100mm Macro ring (+50mm)	0.37～0.48×	671.55～602.79×

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	585.4～243.49mm	555.56～260.54mm	620.18～241.98mm
Magnification (image ratio) range	0.29～1.25×	0.31～1.08×	0.27～1.26×
b. Distance to subject from lens edge set at infinity (reversed)	∞～265.7mm	∞～358.36mm	∞～258.9mm
Magnification (image ratio) range	1/∞～0.59×	1/∞～0.42×	1/∞～0.61×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 0	0.13~0.25×	163×227~96×144mm	1070~600mm

DEPTH-OF-FIELD TABLES FOR 135mm f/2.8 MC TELE ROKKOR

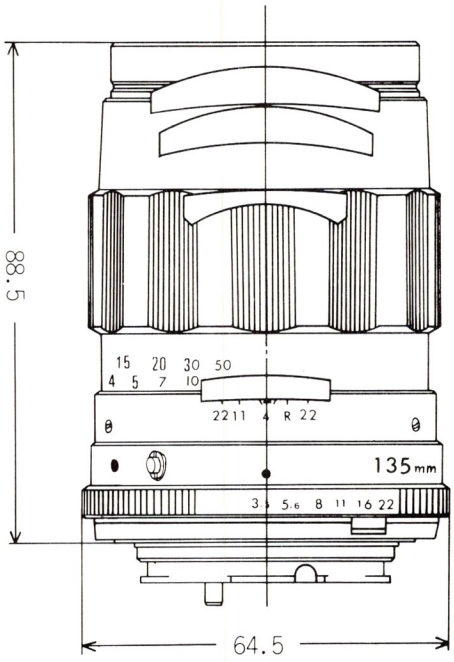
(in feet)

Dis. ft \ F No.	2.8	3.5	4	5.6	8	11	16	22
∞	∞ 246′	∞ 518′	∞ 449′	∞ 318′	∞ 225′	∞ 159′	∞ 113′	∞ 80′
50	54′ 1″ 46′ 6″	55′ 2″ 45′ 9″	56′ 1″ 45′ 1″	59′ 1″ 43′ 4″	63′11″ 41′ 1″	72′ 3″ 38′ 3″	88′ 8″ 34′11″	131′ 31′
30	31′ 5″ 28′ 9″	31′ 9″ 28′ 5″	32′ 1″ 28′ 2″	33′ 0″ 27′ 6″	34′ 5″ 26′ 7″	36′ 8″ 25′ 5″	40′ 5″ 23′11″	47′ 2″ 22′ 1″
20	20′ 7″ 19′ 5″	20′ 9″ 19′ 4″	20′11″ 19′ 2″	21′ 3″ 18′11″	21′10″ 18′ 6″	22′ 8″ 17′11″	24′ 0″ 17′ 2″	26′ 3″ 16′ 2″
15	15′ 4″ 14′ 8″	15′ 5″ 14′ 7″	15′ 6″ 14′ 7″	15′ 8″ 14′ 5″	16′ 0″ 14′ 2″	16′ 5″ 13′10″	17′ 1″ 13′ 4″	18′ 2″ 12′10″
12	12′ 2″ 11′10″	12′ 3″ 11′ 9″	12′ 4″ 11′ 9″	12′ 5″ 11′ 7″	12′ 7″ 11′ 5″	12′11″ 11′ 3″	13′ 3″ 10′11″	13′11″ 10′ 7″
10	10′ 2″ 9′10″	10′ 2″ 9′10″	10′ 2″ 9′ 9″	10′ 3″ 9′ 8″	10′ 5″ 9′ 7″	10′ 7″ 9′ 5″	10′10″ 9′ 3″	11′ 3″ 9′¼″
8	8′ 1″ 7′11″	8′ 1¼″ 7′10¾″	8′ 1⅜″ 7′10⅝″	8′ 2″ 7′10″	8′ 3″ 7′ 9¼″	8′ 4¼″ 7′ 8⅛″	8′ 6⅛″ 7′ 6⅝″	8′ 9″ 7′ 4½″
7	7′¾″ 6′11¼″	7′ 1″ 6′11″	7′ 1″ 6′11″	7′ 1⅝″ 6′10½″	7′ 2⅛″ 6′ 9⅞″	7′ 3⅛″ 6′ 9⅛″	7′ 4½″ 6′ 8″	7′ 6⅝″ 6′ 6⅜″
6	6′½″ 5′11½″	6′¾″ 5′11¼″	6′¾″ 5′11¼″	6′ 1¼″ 5′11″	6′ 1½″ 5′10½″	6′ 2¼″ 5′10″	6′ 3¼″ 5′ 9⅛″	6′ 4⅝″ 5′ 8″
5	5′⅜″ 4′11⅝″	5′½″ 4′11½″	5′½″ 4′11½″	5′⅝″ 4′11⅜″	5′ 1″ 4′11″	5′ 1⅜″ 4′10⅝″	5′ 2⅛″ 4′10⅛″	5′ 3″ 4′ 9⅜″

(in meters)

Dis. (m) \ (F No.	2.8	3.5	4	5.6	8	11	16	22
∞	∞ 196	∞ 158	∞ 137	∞ 97	∞ 69	∞ 49	∞ 34	∞ 24
20	22.2 18.2	22.8 17.8	23.4 17.5	25.1 16.6	28.1 15.5	33.7 14.2	47.1 12.7	∞ 11.1
10	10.5 9.5	10.6 9.4	10.8 9.3	11.1 9.1	11.6 8.8	12.5 8.3	13.9 7.8	16.7 7.2
7	7.3 6.8	7.3 6.7	7.4 6.7	7.5 6.6	7.8 6.4	8.1 6.2	8.7 5.9	9.7 5.5
5	5.1 4.9	5.1 4.9	5.2 4.8	5.3 4.8	5.4 4.7	5.5 4.6	5.8 4.4	6.2 4.2
4	4.08 3.93	4.09 3.91	4.11 3.90	4.16 3.86	4.22 3.80	4.32 3.72	4.48 3.62	4.71 3.48
3	3.04 2.96	3.05 2.95	3.06 2.94	3.08 2.92	3.12 2.89	3.17 2.85	3.25 2.79	3.37 2.71
2.5	2.53 2.47	2.53 2.47	2.54 2.46	2.56 2.45	2.58 2.43	2.61 2.40	2.67 2.35	2.74 2.30
2	2.02 1.98	2.02 1.98	2.02 1.98	2.03 1.97	2.05 1.95	2.07 1.94	2.10 1.91	2.14 1.88
1.7	1.71 1.69	1.71 1.69	1.72 1.68	1.72 1.68	1.73 1.67	1.75 1.66	1.77 1.64	1.80 1.61
1.5	1.51 1.49	1.51 1.49	1.51 1.49	1.52 1.48	1.52 1.48	1.54 1.47	1.55 1.45	1.57 1.43





135mm f/3.5 MC TELE ROKKOR

Lens construction: 4 elements, 4 groups
Apertures: 3.5~22
Nearest focus: 1.5m (5 ft)
Ratio of object to image size at nearest focusing distance: 1:9 (0.111X)
Focusing distance, one head, vertical: 2m (6.5 ft)
Focusing distance, two heads, horizontal: 2.4m (8 ft)
Focusing distance, one to three persons (6 ft) standing: 8.2m (27 ft)
Angles of view: Diagonal: 18°
Horizontal: 15°
Vertical: 10°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 2.5:1 (2.5X)
Screw-in filter mount diameter: 52mm
Lens hood: Exclusive (Minolta-type)
Weight: 400g (14 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.19~0.30×	1005.32~759.64mm
100mm Macro ring (+50mm)	0.37~0.48×	683.95~615.19mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	602.81~260.89mm	572.97~277.94mm	637.59~259.38mm
Magnification (image ratio) range	0.29~1.25×	0.31~1.08×	0.27~1.26×
b. Distance to subject from lens edge set at infinity (reversed)	∞~330.22mm	∞~358.36mm	∞~258.9mm
Magnification (image ratio) range	1/∞~0.46×	1/∞~0.29×	1/∞~0.48×

Close-Up Lenses	Magnification	Area Range	Distance Range
No. 0	0.13~0.25×	163×227~96×144mm	1070~600mm

DEPTH-OF-FIELD TABLES FOR 135mm *f*/3.5 MC TELE ROKKOR

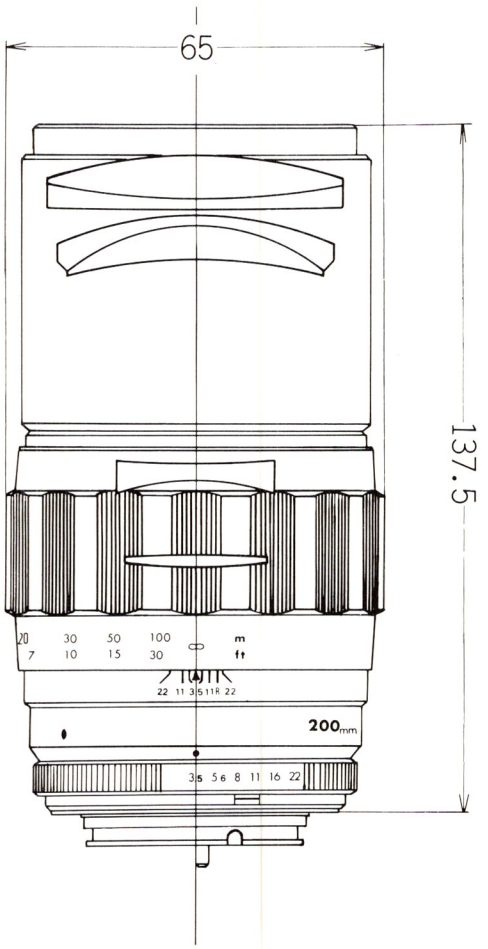
(in feet)

Dis.(ft.) \ F No.	2.8	3.5	4	5.6	8	11	16	22
∞	∞ 246′	∞ 518′	∞ 449′	∞ 318′	∞ 225′	∞ 159′	∞ 113′	∞ 80′
50	54′ 1″ 46′ 6″	55′ 2″ 45′ 9″	56′ 1″ 45′ 1″	59′ 1″ 43′ 4″	63′11″ 41′ 1″	72′ 3″ 38′ 3″	88′ 8″ 34′11″	131′ 31′
30	31′ 5″ 28′ 9″	31′ 9″ 28′ 5″	32′ 1″ 28′ 2″	33′ 0″ 27′ 6″	34′ 5″ 26′ 7″	36′ 8″ 25′ 5″	40′ 5″ 23′11″	47′ 2″ 22′ 1″
20	20′ 7″ 19′ 5″	20′ 9″ 19′ 4″	20′11″ 19′ 2″	21′ 3″ 18′11″	21′10″ 18′ 6″	22′ 8″ 17′11″	24′ 0″ 17′ 2″	26′ 3″ 16′ 2″
15	15′ 4″ 14′ 8″	15′ 5″ 14′ 7″	15′ 6″ 14′ 7″	15′ 8″ 14′ 5″	16′ 0″ 14′ 2″	16′ 5″ 13′10″	17′ 1″ 13′ 4″	18′ 2″ 12′10″
12	12′ 2″ 11′10″	12′ 3″ 11′ 9″	12′ 4″ 11′ 9″	12′ 5″ 11′ 7″	12′ 7″ 11′ 5″	12′11″ 11′ 3″	13′ 3″ 10′11″	13′11″ 10′ 7″
10	10′ 2″ 9′10″	10′ 2″ 9′10″	10′ 2″ 9′ 9″	10′ 3″ 9′ 8″	10′ 5″ 9′ 7″	10′ 7″ 9′ 5″	10′10″ 9′ 3″	11′ 3″ 9′1¼″
8	8′ 1″ 7′11″	8′ 1¼″ 7′10¾″	8′ 1⅜″ 7′10⅝″	8′ 2″ 7′10″	8′ 3″ 7′ 9¼″	8′ 4¼″ 7′ 8⅛″	8′ 6⅛″ 7′ 6⅝″	8′ 9″ 7′ 4½″
7	7′¾″ 6′11¼″	7′ 1″ 6′11″	7′ 1″ 6′11″	7′ 1⅝″ 6′10½″	7′ 2⅛″ 6′ 9⅞″	7′ 3⅛″ 6′ 9⅛″	7′ 4½″ 6′ 8″	7′ 6⅝″ 6′ 6⅜″
6	6′½″ 5′11½″	6′¾″ 5′11¼″	6′¾″ 5′11¼″	6′ 1¼″ 5′11″	6′ 1½″ 5′10½″	6′ 2¼″ 5′10″	6′ 3¼″ 5′ 9⅞″	6′ 4⅝″ 5′ 8″
5	5′⅜″ 4′11⅝″	5′½″ 4′11½″	5′½″ 4′11½″	5′⅝″ 4′11⅜″	5′ 1″ 4′11″	5′ 1⅜″ 4′10⅝″	5′ 2⅛″ 4′10⅛″	5′ 3″ 4′ 9⅜″

(in meters)

Dis.(m) \ F No.	2.8	3.5	4	5.6	8	11	16	22
∞	∞ 196	∞ 158	∞ 137	∞ 97	∞ 69	∞ 49	∞ 34	∞ 24
20	22.2 18.2	22.8 17.8	23.4 17.5	25.1 16.6	28.1 15.5	33.7 14.2	47.1 12.7	∞ 11.1
10	10.5 9.5	10.6 9.4	10.8 9.3	11.1 9.1	11.6 8.8	12.5 8.3	13.9 7.8	16.7 7.2
7	7.3 6.8	7.3 6.7	7.4 6.7	7.5 6.6	7.8 6.4	8.1 6.2	8.7 5.9	9.7 5.5
5	5.1 4.9	5.1 4.9	5.2 4.8	5.3 4.8	5.4 4.7	5.5 4.6	5.8 4.4	6.2 4.2
4	4.08 3.93	4.09 3.91	4.11 3.90	4.16 3.86	4.22 3.80	4.32 3.72	4.48 3.62	4.71 3.48
3	3.04 2.96	3.05 2.95	3.06 2.94	3.08 2.92	3.12 2.89	3.17 2.85	3.25 2.79	3.37 2.71
2.5	2.53 2.47	2.53 2.47	2.54 2.46	2.56 2.45	2.58 2.43	2.61 2.40	2.67 2.35	2.74 2.30
2	2.02 1.98	2.02 1.98	2.02 1.98	2.03 1.97	2.05 1.95	2.07 1.94	2.10 1.91	2.14 1.88
1.7	1.71 1.69	1.71 1.69	1.72 1.68	1.72 1.68	1.73 1.67	1.75 1.66	1.77 1.64	1.80 1.61
1.5	1.51 1.49	1.51 1.49	1.51 1.49	1.52 1.48	1.52 1.48	1.54 1.47	1.55 1.45	1.57 1.43





200mm f/3.5 MC TELE ROKKOR

Lens construction: 6 elements, 4 groups
Apertures: 3.5～22
Nearest focus: 2.5m (8 ft)
Ratio of object to image size at nearest focusing distance: 1:9.6 (0.141X)
Focusing distance, one head, vertical: 2.9m (9.5 ft)
Focusing distance, two heads, horizontal: 3.7m (12 ft)
Focusing distance, one to three persons (6 ft) standing: 12.2m (40 ft)
Angles of view: Diagonal: 12°
Horizontal: 10°
Vertical: 7°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 3.6:1 (3.6X)
Screw-in filter mount diameter: 62mm
Lens hood: Built-in
Replacement lens cap: 65mm
Weight: 720g (25.4 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.13～0.23×	1979.85～1331.86mm
100mm Macro ring (+50mm)	0.25～0.35×	1266.39～1058.11mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	1236.12~486.9mm	1188.07~522.66mm	1346.09~484.29mm
Magnification (image ratio) range	0.20~0.87×	0.21~0.75×	0.18~0.88×

DEPTH-OF-FIELD TABLES FOR 200mm f/3.5 MC TELE ROKKOR

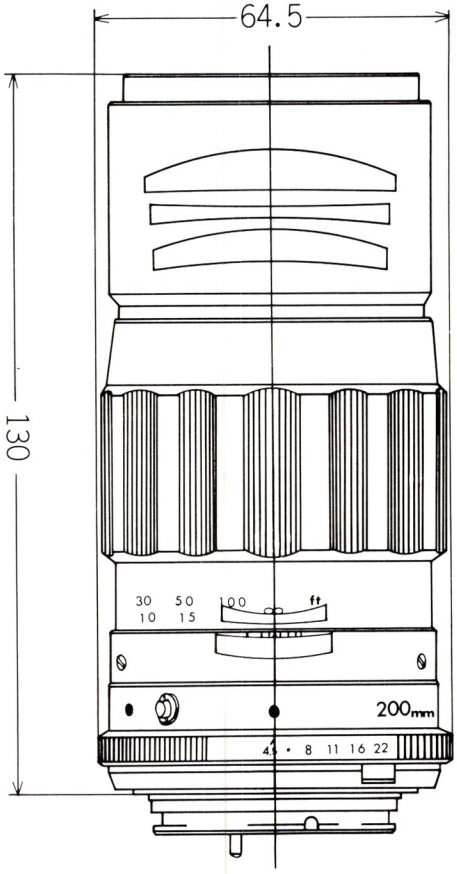
(in feet)

Dis. ft \ F No.	3.5	4	4.5	5.6	8	11	16	22
∞	∞ 1122′	∞ 982′	∞ 884′	∞ 695′	∞ 491′	∞ 348′	∞ 246′	∞ 174′
100	110′ 92′	111′ 91′	112′ 90′	116′ 88′	125′ 83′	139′ 78′	167′ 72′	231′ 64′
50	52′ 3″ 47′11″	52′ 7″ 47′ 8″	52′10″ 47′ 5″	53′ 8″ 46′ 9″	55′ 5″ 45′ 7″	58′ 0″ 43′11″	62′ 2″ 41′10″	69′ 2″ 39′ 3″
30	30′ 9″ 29′ 3″	30′11″ 29′ 2″	30′11″ 29′ 1″	31′ 3″ 28′10″	31′10″ 28′ 5″	32′ 8″ 27′ 9″	33′10″ 26′11″	35′ 9″ 25′10″
20	20′ 4″ 19′ 8″	20′ 4″ 19′ 8″	20′ 4″ 19′ 7″	20′ 6″ 19′ 6″	20′ 9″ 19′ 4″	21′ 1″ 19′ 0″	21′ 7″ 18′ 8″	22′ 4″ 18′ 2″
15	15′ 2″ 14′10″	15′ 2″ 14′10″	15′ 2″ 14′ 9″	15′ 3″ 14′ 9″	15′ 5″ 14′ 7″	15′ 7″ 14′ 6″	15′10″ 14′ 3″	16′ 3″ 14′ 0″
14	12′ 1″ 11′11″	12′ 1″ 11′11″	12′ 1″ 11′10″	12′ 2″ 11′10″	12′ 3″ 11′ 9″	12′ 4″ 11′ 8″	12′ 6″ 11′ 6″	12′ 9″ 11′ 4″
10	10′ 1″ 9′11¼″	10′ 1″ 9′11″	10′ 1″ 9′10⅞″	10′ 1″ 9′10⅝″	10′ 2″ 9′10¼″	10′ 3″ 9′ 9⅜″	10′ 4″ 9′ 8¼″	10′ 6″ 9′ 6¾″
8	8′½ 7′11½″	8′½″ 7′11⅜″	8′⅝″ 7′11⅜″	8′¾″ 7′11¼″	8′ 1⅛″ 7′10⅞″	8′ 1½″ 7′10⅛″	8′ 2⅜″ 7′ 9¾″	8′ 3¼″ 7′ 8⅞″

(in meters)

Dis (m) \ F No.	3.5	4	4.5	5.6	8	11	16	22
∞	∞ 342	∞ 299	∞ 268	∞ 212	∞ 150	∞ 106	∞ 75	∞ 53
30	33 28	33 27	34 27	35 26	37 25	42 24	50 22	68 19
15	15.7 14.4	15.8 14.3	15.8 14.2	16.1 14.0	16.6 13.7	17.4 13.2	18.6 12.6	20.6 11.8
10	10.3 9.7	10.3 9.7	10.4 9.7	10.5 9.6	10.7 9.4	11.0 9.2	11.4 8.9	12.2 8.5
7	7.1 6.9	7.2 6.9	7.2 6.8	7.2 6.8	7.3 6.7	7.5 6.6	7.7 6.5	8.0 6.3
5	5.1 4.9	5.1 4.9	5.1 4.9	5.1 4.9	5.2 4.8	5.2 4.8	5.3 4.7	5.5 4.6
4	4.0 3.96	4.1 3.96	4.1 3.95	4.1 3.94	4.1 3.91	4.1 3.88	4.2 3.83	4.2 3.76
3	3.02 2.98	3.02 2.98	3.03 2.97	3.03 2.97	3.05 2.95	3.07 2.93	3.10 2.91	3.14 2.87
2.5	2.51 2.49	2.52 2.48	2.52 2.48	2.52 2.48	2.53 2.47	2.54 2.46	2.56 2.44	2.59 2.42





200mm f/4.5 MC TELE ROKKOR

Lens construction: 5 elements, 5 groups
Apertures: 4.5~22
Nearest focus: 2.5m (8 ft)
Ratio of object to image size at nearest focusing distance: 1:9.6 (0.141X)
Focusing distance, one head, vertical: 2.9m (9.5 ft)
Focusing distance, two heads, horizontal: 3.7m (12 ft)
Focusing distance, one to three persons (6 ft) standing: 12.2m (40 ft)
Angles of view: Diagonal: 12°
Horizontal: 10°
Vertical: 7°
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 3.6:1 (3.6X)
Screw-in filter mount diameter: 52mm
Lens hood: Built-in (Note: will not be extensible when 52/55mm step-up ring is used, in which case independent hood must be used)
Replacement lens cap: 54mm
Weight: 500g (17.6 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.13~0.23×	2038.33~1389.44mm
100mm Macro ring (+50mm)	0.25~0.35×	1323.87~1115.30mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	1301.37~551.26mm	1253.25~587.04mm	1411.48~548.64mm
Magnification (image ratio) range	0.20~0.87×	0.21~0.75×	0.18~0.88×

DEPTH-OF-FIELD TABLES FOR 200mm f/4.5 MC TELE ROKKOR

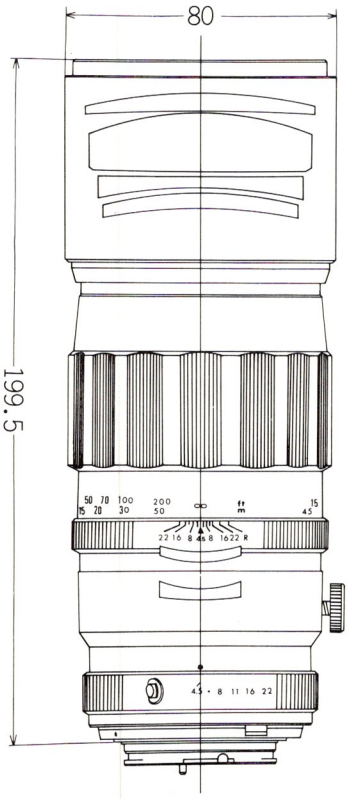
(in feet)

Dis. ft \ F No.	3.5	4	4.5	5.6	8	11	16	22
∞	∞ 1122′	∞ 982′	∞ 884′	∞ 695′	∞ 491′	∞ 348′	∞ 246′	∞ 174′
100	110′ 92′	111′ 91′	112′ 90′	116′ 88′	125′ 83′	139′ 78′	167′ 72′	231′ 64′
50	52′ 3″ 47′11″	52′ 7″ 47′ 8″	52′10″ 47′ 5″	53′ 8″ 46′ 9″	55′ 5″ 45′ 7″	58′ 0″ 43′11″	62′ 2″ 41′10″	69′ 2″ 39′ 3″
30	30′ 9″ 29′ 3″	30′11″ 29′ 2″	30′11″ 29′ 1″	31′ 3″ 28′10″	31′10″ 28′ 5″	32′ 8″ 27′ 9″	33′10″ 26′11″	35′ 9″ 25′10″
20	20′ 4″ 19′ 8″	20′ 4″ 19′ 8″	20′ 4″ 19′ 7″	20′ 6″ 19′ 6″	20′ 9″ 19′ 4″	21′ 1″ 19′ 0″	21′ 7″ 18′ 8″	22′ 4″ 18′ 2″
15	15′ 2″ 14′10″	15′ 2″ 14′10″	15′ 2″ 14′ 9″	15′ 3″ 14′ 9″	15′ 5″ 14′ 7″	15′ 7″ 14′ 6″	15′10″ 14′ 3″	16′ 3″ 14′ 0″
14	12′ 1″ 11′11″	12′ 1″ 11′11″	12′ 1″ 11′10″	12′ 2″ 11′10″	12′ 3″ 11′ 9″	12′ 4″ 11′ 8″	12′ 6″ 11′ 6″	12′ 9″ 11′ 4″
10	10′ 1″ 9′11¼″	10′ 1″ 9′11″	10′ 1″ 9′10⅞″	10′ 1″ 9′10⅝″	10′ 2″ 9′10¼″	10′ 3″ 9′ 9″⅜	10′ 4″ 9′ 8¼″	10′ 6″ 9′ 6¾″
8	8′½ 7′11½″	8′½″ 7′11⅜″	8′⅝″ 7′11⅜″	8′¾″ 7′11¼″	8′ 1⅛″ 7′10⅞″	8′ 1½″ 7′10⅛″	8′ 2⅜″ 7′ 9¾″	8′ 3¼″ 7′ 8⅞″

(in meters)

Dis. (m) \ F No.	3.5	4	4.5	5.6	8	11	16	22
∞	∞ 342	∞ 299	∞ 268	∞ 212	∞ 150	∞ 106	∞ 75	∞ 53
30	33 28	33 27	34 27	35 26	37 25	42 24	50 22	68 19
15	15.7 14.4	15.8 14.3	15.8 14.2	16.1 14.0	16.6 13.7	17.4 13.2	18.6 12.6	20.6 11.8
10	10.3 9.7	10.3 9.7	10.4 9.7	10.5 9.6	10.7 9.4	11.0 9.2	11.4 8.9	12.2 8.5
7	7.1 6.9	7.2 6.9	7.2 6.8	7.2 6.8	7.3 6.7	7.5 6.6	7.7 6.5	8.0 6.3
5	5.1 4.9	5.1 4.9	5.1 4.9	5.1 4.9	5.2 4.8	5.2 4.8	5.3 4.7	5.5 4.6
4	4.0 3.96	4.1 3.96	4.1 3.95	4.1 3.94	4.1 3.91	4.1 3.88	4.2 3.83	4.2 3.76
3	3.02 2.98	3.02 2.98	3.03 2.97	3.03 2.97	3.05 2.95	3.07 2.93	3.10 2.91	3.14 2.87
2.5	2.51 2.49	2.52 2.48	2.52 2.48	2.52 2.48	2.53 2.47	2.54 2.46	2.56 2.44	2.59 2.42





300mm f/4.5 MC TELE ROKKOR

Lens construction: 6 elements, 6 groups
Aperture: 4.5~22
Nearest focus: 4.5m (15 ft)
Ratio of object to image size at nearest focusing distance: 1:12 (0.083X)
Focusing distance, one head, vertical: 4.4m (14.5 ft)
Focusing distance, two heads, horizontal: 5.5m (18 ft)
Focusing distance, one to three persons (6 ft) standing: 18.3m (60 ft)
Angles of view: Diagonal: 8° 10′
Horizontal: 6° 50′
Vertical: 4° 30′
Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 5.5:1 (5.5X)
Screw-in filter mount diameter: 72mm
Lens hood: Built-in
Replacement lens cap: 75mm
Weight: 1150g (40.5 oz)

Close-Up Data

Extension Rings	Magnification	Distance Range—Subject to Film
50mm Macro ring (+25mm)	0.09~0.17×	4139.13~2594.35mm
100mm Macro ring (+50mm)	0.17~0.25×	2594.35~2053.59mm

Bellows Data	Auto Bellows I	Auto Bellows II	Bellows III
a. Distance to subject from lens edge (normal position)	2843.39~1068.0mm	2679.04~1138.46mm	3035.71~1060.53mm
Magnification (image ratio) range	0.13~0.59×	0.14~0.52×	0.12~0.60×

DEPTH-OF-FIELD TABLES FOR 300mm f/4.5 MC TELE ROKKOR

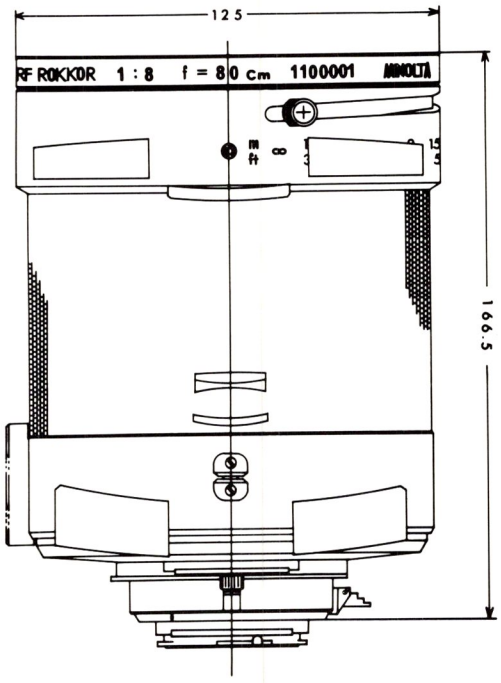
(in feet)

Dis (ft) \ F No.	4.5	5.6	8	11	16	22
∞	∞ 1990′	∞ 1584′	∞ 1120′	∞ 793′	∞ 561′	∞ 397′
200	222′ 182′	228′ 178′	243′ 170′	266′ 160′	308′ 148′	398′ 134′
100	105′ 95′4″	106′ 94′3″	109′ 92′1″	114′ 89′3″	121′ 85′5″	132′ 80′7″
70	72′5″ 67′9″	73′1″ 67′2″	74′5″ 66′1″	76′5″ 64′7″	79′6″ 62′7″	84′3″ 59′11″
50	51′2″ 48′10″	51′6″ 48′7″	52′2″ 48′0″	53′1″ 47′3″	54′6″ 46′3″	56′7″ 44′10″
40	40′9″ 39′3″	40′11″ 39′3″	41′4″ 38′9″	41′11″ 38′3″	42′9″ 37′7″	44′1″ 36′8″
30	30′5″ 29′7″	30′6″ 29′6″	30′9″ 29′4″	31′0″ 29′1″	31′6″ 28′8″	32′1″ 28′2″
25	25′3″ 24′9″	25′4″ 24′8″	25′6″ 24′6″	25′8″ 24′4″	26′0″ 24′1″	26′5″ 23′9″
20	20′2″ 19′10″	20′2″ 19′10″	20′3″ 19′9″	20′5″ 19′7″	20′7″ 19′5″	20′10″ 19′3″
17	17′1″ 16′11″	17′2″ 16′10″	17′2″ 16′10″	17′3″ 16′9″	17′5″ 16′7″	17′7″ 16′5″
15	15′1″ 14′11″	15′1″ 14′11″	15′2″ 14′10″	15′3″ 14′10″	15′4″ 14′9″	15′5″ 14′7″

(in meters)

Dis (m) \ F No.	4.5	5.6	8	11	16	22
∞	∞ 607	∞ 483	∞ 341	∞ 242	∞ 171	∞ 121
50	54.4 46.3	55.6 45.4	58.4 43.8	62.7 41.6	70.1 38.9	84.2 35.6
30	31.5 28.6	31.9 28.3	32.8 27.7	34.1 26.8	36.1 25.7	39.4 24.2
20	20.6 19.4	20.8 19.3	21.2 19.0	21.7 18.6	22.5 18.0	23.7 17.3
15	15.3 14.7	15.4 14.6	15.6 14.4	15.9 14.2	16.3 13.9	16.9 13.5
10	10.1 9.86	10.2 9.82	10.3 9.75	10.4 9.65	10.5 9.51	10.8 9.32
8	8.09 7.91	8.12 7.89	8.16 7.84	8.23 7.78	8.33 7.69	8.48 7.57
7	7.07 6.93	7.08 6.92	7.12 6.88	7.17 6.84	7.25 6.77	7.35 6.68
6	6.05 5.95	6.06 5.94	6.09 5.92	6.12 5.88	6.17 5.84	6.25 5.77
5	5.03 4.97	5.04 4.96	5.06 4.95	5.08 4.92	5.11 4.89	5.16 4.85
4.5	4.52 4.48	4.53 4.47	4.54 4.46	4.56 4.44	4.59 4.41	4.63 4.38





800mm f/8 RF ROKKOR

Lens construction: Catadioptric; second mirror rotated by lever to focus

Apertures: f/8 fixed; smaller apertures to f/22 simulated by neutral density filters 2X, 4X, and 8X

Nearest focus: 8m (26 ft)

Focusing distance, one head, vertical: 11.6m (38 ft)

Focusing distance, two heads, horizontal: 14.6m (48 ft)

Focusing distance, one to three persons (6 ft) standing: 48.8m (160 ft)

Angles of view: Diagonal: 3° 2′
Horizontal: 2° 30′
Vertical: 1° 40′

Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 14.5:1 (14.5X)

Filters: Built-in behind-the-lens turret for Y4, O54, and R60

Weight: 1500g (53 oz)

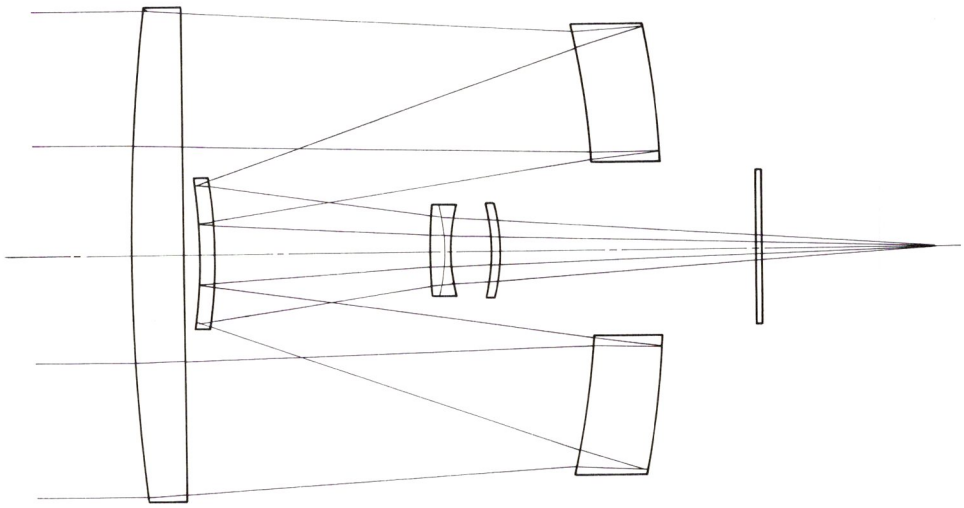
DEPTH-OF-FIELD TABLES FOR 800mm f/8.0 RF ROKKOR

(in meters)

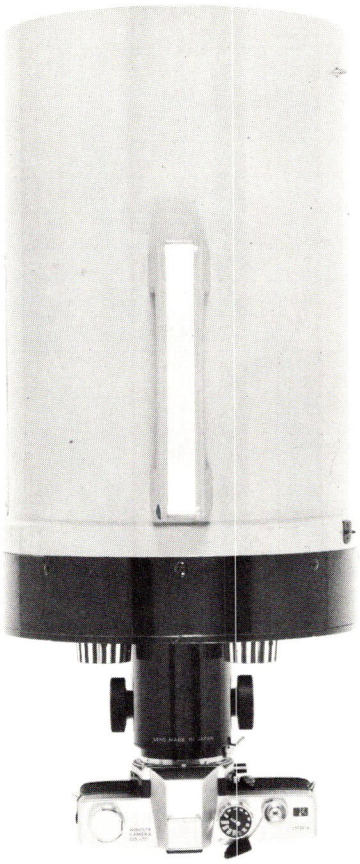
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100	104.2 ~ 96.13
50	51.03 ~ 49.02
30	30.36 ~ 29.65
20	20.16 ~ 19.84
15	15.09 ~ 14.91
12	12.06 ~ 11.94
10	10.04 ~ 9.962
8	8.025 ~ 7.976

(in feet)

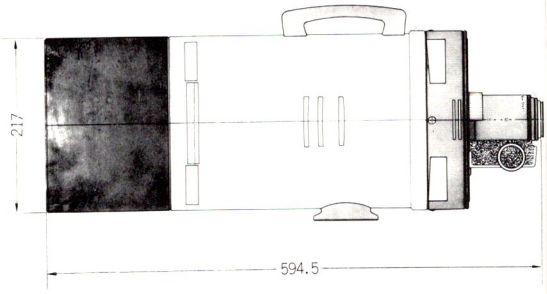
F No Dis (ft)	8.0
∞	∞ ~ 1940'3"
300	311'6" ~ 289'4"
150	152'10" ~ 147'4"
100	101'3" ~ 98'10"
70	70'7" ~ 69'5"
50	50'4" ~ 49'8"
40	40'2" ~ 39'10"
35	35'2" ~ 34'10"
30	30'1" ~ 29'11"



Optical path of 800mm *f*/8 RF Rokkor. Light enters from left and is reflected and refracted internally as shown.







1000mm f/6.3 RF ROKKOR

Lens construction: Catadioptric

Apertures: f/6.3 fixed; smaller apertures to f/22 simulated by neutral density filters in turret

Nearest focus: 30.43 (100 ft)

Ratio of object to image size at nearest focusing distance: 1:28

Focusing distance, one head, vertical: 11.6m (48 ft)

Focusing distance, two heads, horizontal: 18.3m (60 ft)

Focusing distance, one to three persons (6 ft) standing: 61m (200 ft)

Angles of view: Diagonal: 2° 30′
Horizontal: 2°
Vertical: 1° 20′

Ratio of image size at infinity to image of standard lens (55 or 58mm = 1): 18.2:1 (18.2X)

Filters: Built-in rear turret for 49mm filters Y48, O, R60, UV, and others

Weight: 10.6Kg (23.2 lb)

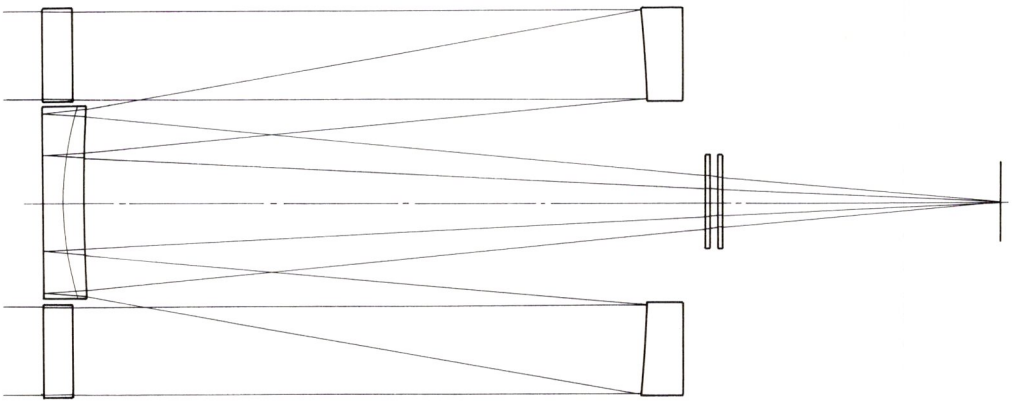
DEPTH-OF-FIELD TABLES FOR 1000mm f/6.3 RF ROKKOR

(in meters)

F No Dis (m)	6.3 ~ 22
∞	5396 ~ ∞
200	193 ~ 207
100	98.3 ~ 100.2
70	69.2 ~ 70.8
50	49.6 ~ 50.4
40	39.7 ~ 40.3
30	29.9 ~ 30.1

(in feet)

F No Dis (ft)	6.3 ~ 22
∞	7734'3" ~ ∞
600	580'7" ~ 620'9"
300	295'2" ~ 305'
200	197'10" ~ 202'2"
150	148'10" ~ 151'3"
120	119'3" ~ 120'9"
100	99'5" ~ 100'6"



Optical path of 1000mm *f*/6.3 RF Rokkor. Light enters from left and is reflected and refracted internally as shown.

A hazy bright light helps model subject because the light is directional while preserving detail in both the highlights and shadows. 58mm lens, Agfa Isopan-IF. Joseph D. Cooper.



CHAPTER V

Principles and Techniques of Exposure

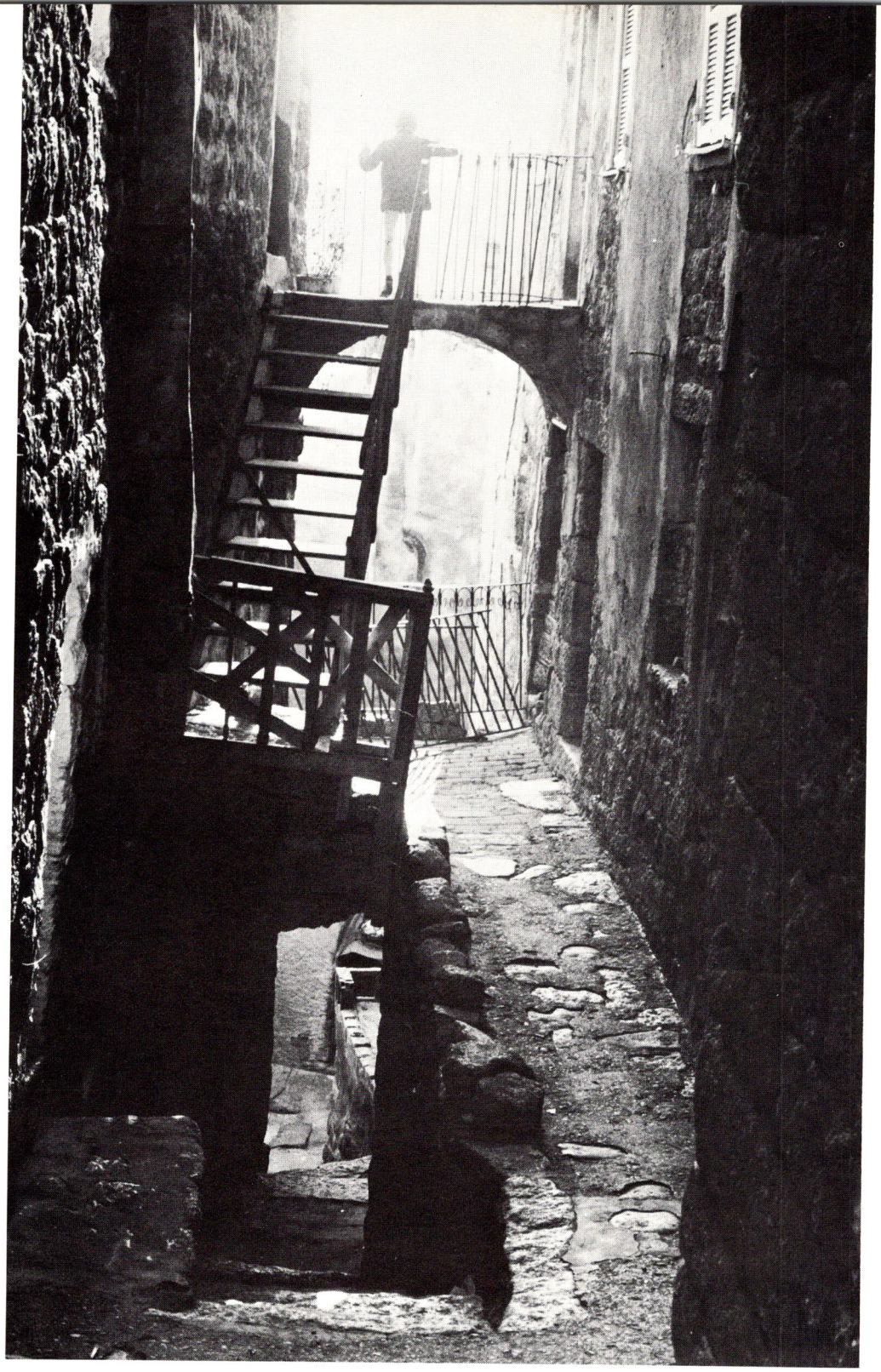
The object of exposure technique is to choose the combination of lens aperture and shutter speed that assures that the right amount of light reaches the film to produce a satisfactory negative or color transparency. In general photography, you need to know very few principles and techniques of exposure, so long as you follow the few brief instructions for the use of the built-in CLC exposure-measuring system, as described in a preceding chapter. Even then, however, you must still do your own thinking about problems of light and shade and the use of filters, among other things, if you want to get the best possible results. If you are using a non-meter-coupled model of one of the Minolta SR cameras, you will need to do a bit more independent thinking.

In this chapter we cover:

1. The general strategy of exposure
2. Light, film, and filters—their selection and usage
3. Light, shade, and pictorial effect
4. Existing light technique—taking pictures under difficult lighting conditions
5. The measurement of light, including the use of Minolta exposure meters and independently manufactured exposure meters

THE GENERAL STRATEGY OF EXPOSURE

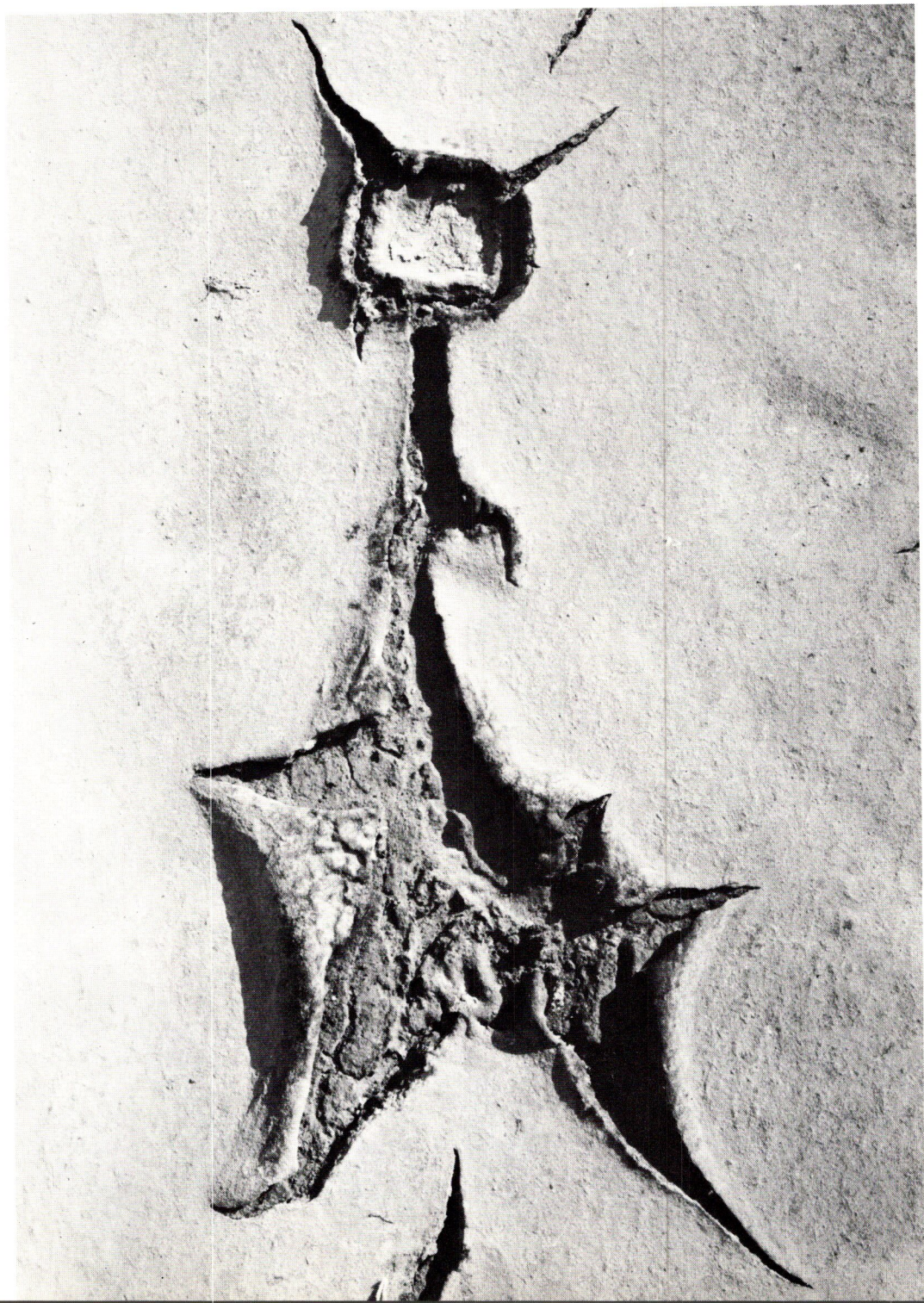
Theoretically, there should be one ideal combination of lens aperture and shutter-speed setting for any single picture. Practically, this is either wishful thinking or a statistical abstraction having no place in reality. A good exposure is one that produces the result you want to achieve. True, there are extremes, such as badly overexposed or underexposed films, neither of which will yield satisfactory results unless, again, you are in hot pursuit of some way-out effect. For the majority of pictures there are certain standards of image density, tonal range, and contrast that are expected to produce satisfactory negatives or transparencies. Nevertheless, the photographer might want to depart from the



A most difficult scene to photograph as it includes extreme contrasts from bright to dark. This series of stone landings was photographed in Sartene, Corsica, with the macro 50mm lens. With these extremes Lucien Clergue could compromise only by shooting for the middle tone, but this overall effect is a striking one. At f/16, 1/250 sec., Plus-X.

average with a characteristic snap or brilliance in his pictures, perhaps an extreme contrast—even to the point of having what appears to be a line drawing. On the other hand, he might want to have a picture that is best characterized as quiet or flat in that it does not have too much of a difference in brightness range from highlights to shadows. In short, what constitutes good exposure is

The sand crack in the parched earth made this animal-like pattern which is given depth by the oblique sidelighting from the bright sun. 50mm Macro, *f*/16, 1/250 sec., Plus-X. Lucien Clergue.



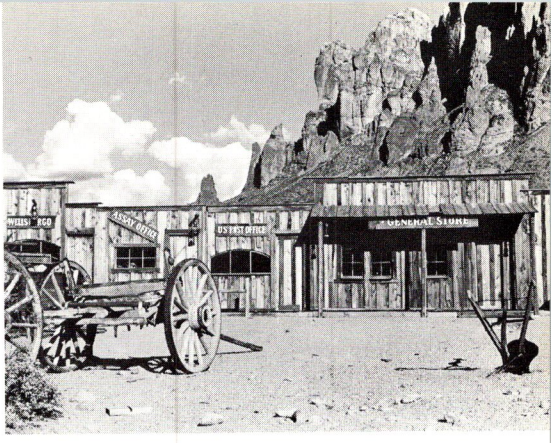
influenced by the stylistic or artistic preference of the photographer. While this general concept will be reflected in the ensuing discussion, most of what follows will be based upon orthodox principles of what constitutes generally good exposure, since the best way to learn how to deviate creatively is to learn first how to cope with the general run of situations.

What Is Good Exposure?

Whether the exposure is to be made on black-and-white film, color negative material, or color reversal (transparency or slide film), one general principle is that the film should have discernible detail in both the highlight and shadow areas. This means that in a color transparency the brightest areas should have textural detail. The bright or highlight areas should not have the washed-out appearance characterized by a loss of good color saturation. The shadow detail, on the other hand, should not be blocked out or lost because of insufficient exposure. In the extremely overexposed color transparency there will be a loss of color saturation throughout, a complete absence of highlight detail, and even a loss of shadow detail. In the moderately overexposed transparency, bright or highlight areas will show a lack of detail and absence of good color saturation, but the darker areas and the shadow details will come through very well; the overall effect will not be pleasing, however, since there will not be a good balance between light and dark, highlight and shadow.

The moderately underexposed transparency reveals itself through the excellent rendition of detail and fairly deep color saturation in the brighter areas, but the areas of shadow and darkness are lacking in detail and brilliance of color; the overall effect is rather depressing in tone and mood. Badly underexposed transparencies veer toward almost total blackness with only the highlight areas and bright points of reflection coming through. Obviously, such transparencies are beyond salvage. With negatives, whether black-and-white or color, the same general attributes are to be found, except in reverse. Overexposure is observed through the general darkening of the negative and the blocking up of highlight areas, accompanied by the suppression of detail and texture in those areas. Underexposure is characterized by thin or translucent areas, which under conditions of extreme underexposure show no visible detail. The classical rule-of-thumb test for a good black-and-white negative is that it should show details in the thinnest parts while in the more dense areas it should be possible, when holding the negative against a background of newsprint, to read the print through the darkest portions of the negative. Another rule of thumb for black-and-white negatives is that their overall density, while preserving detail at both extremes, should be at that minimum which still makes it possible to make good prints on what is considered normal contrast (grade 2) enlarging papers. Contrast grade 3 is preferred when the density range of the black-and-white negative tends to be somewhat short or lacking in contrast. A sample of an ideal color negative, which takes into account both tonal range or density scale and overall density, is included with the *Kodak Color Dataguide,* Kodak Publication R-19, $4.95. This publication, which includes a color print to match the sample negative, is intended for both professionals and advanced amateurs and includes data needed to expose, process, and print color pictures.

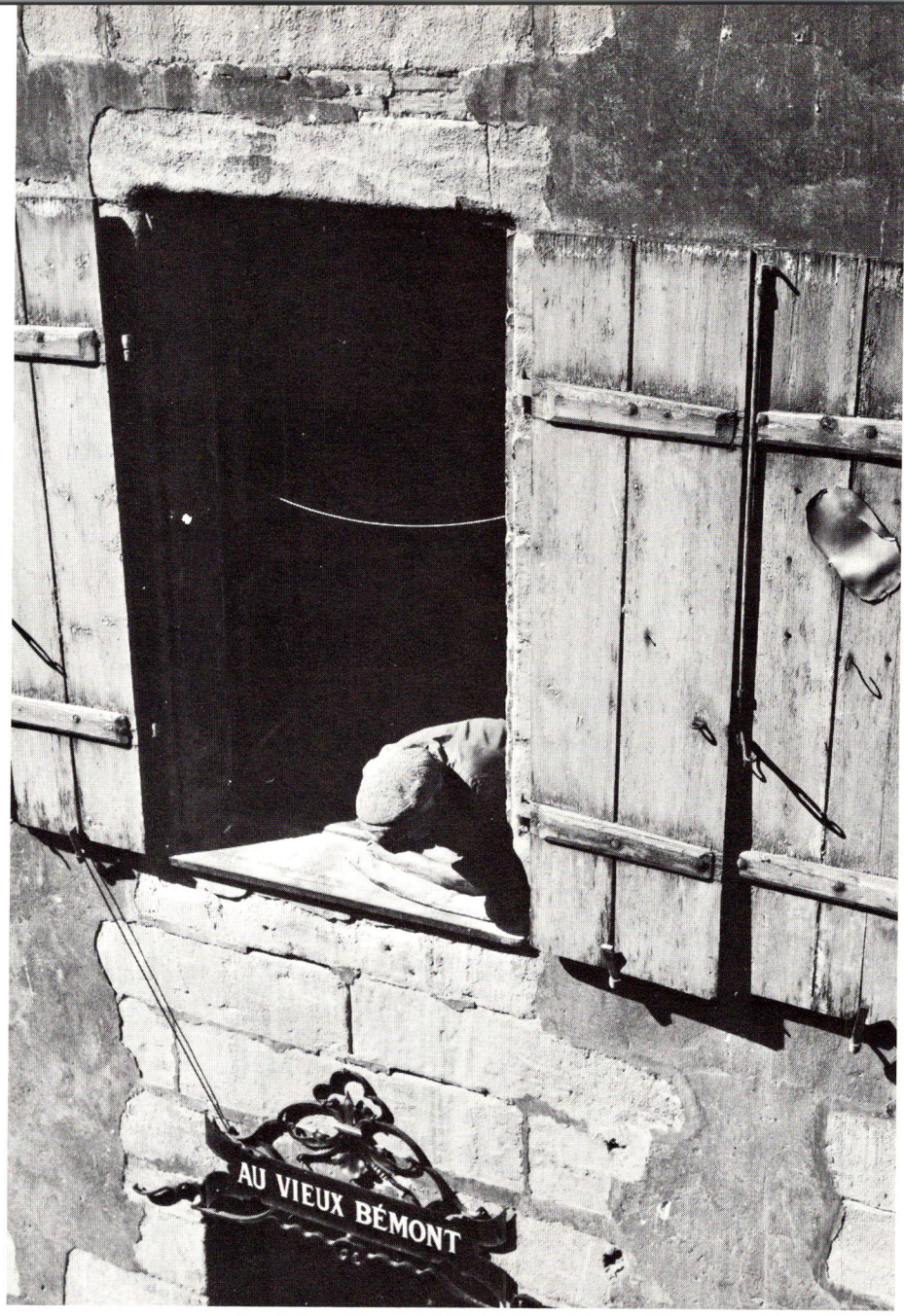
The earlier literature on photographic exposure and development techniques put considerable emphasis on manipulation of the individual photograph, suggesting selective techniques of overexposure and underdevelopment and



In the scene of the old western town, the stone mountains, above, seem to be growing out of the top of the general store because there is no shading to give depth. The picture is improved somewhat by moving to the side to get some shading at one end of the building, below, but the shadows are still quite jet black. The ordinary scene of the statue is made somewhat more interesting by the lower angle, the yellow filter for darkening the sky, and the birds on top of the horse and its rider. Tri-X, 1/500 sec., *f*/11.







Sidelighting brings out texture of wall surfaces. Tri-X, 1/500 sec., *f*/16.

sometimes the reverse. However, when you are using film magazines that contain 20- or 36-exposure lengths of film and when all of the exposed image frames are subjected to the identical darkroom or developing treatment, you cannot think of individual manipulation except after the fact. Rather, you must have a general strategy for exposure that, at the every least, covers all of the exposures made on the same length of film. Another consideration in exposure strategy is that the exposure action, for whatever duration, be uniform across the entire film area. Variations result only from the amount of

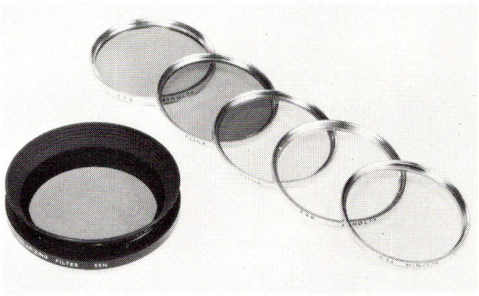
light reflected from objects within the field of view, gathered by the lens and projected onto the film frame. Obviously, there is no such thing as selective exposure that deliberately or automatically builds up shadow areas while holding back highlight areas. This can be accomplished in photography with all types of film through the judicious placement of objects, the proper use of reflectors, and the placement of direct or supplemental lighting. In black-and-white photography, as will be discussed below, contrast range or density scale can be manipulated somewhat through techniques of exposure and development. For the most part, however, your treatment of exposure needs to be correct in the first instance. This means that for a camera with a built-in exposure meter, you need to know how to make selective adjustments in exposure settings to cope with unusual conditions that lie beyond the ordinary capacity of the CLC exposure-measuring system. When using external exposure meters you need to know how to measure light sources or light reflectance from subjects and how to interpret these readings in order to achieve your objectives.

Good exposure includes much more than the intelligent use of exposure-metering systems. For you to achieve the most pleasing or satisfactory results you should be aware of: (1) the attributes, exposure latitude, and development latitude of films; (2) the uses of filters in color and black-and-white photography; (3) the qualities of light sources; (4) the manner in which light is reflected from object surfaces and environment; and (5) the significance of the contrast ratio.

All of these factors interrelate. Starting with film, whether it is color or black-and-white, our choice is usually governed by the lighting conditions under which we expect to operate. If we need fast shutter speeds and small apertures in daylight, we are inclined to pick fast or highly sensitive films; but if small apertures are not important or if the ultimate in tight, fine-grain, razor-sharp images is desired, we might select from among the so-called slower films. On the whole, the slower films are of higher contrast and therefore more suited for relatively flat lighting whereas the fastest films tend to be less contrasty and therefore are more suited for combinations of brilliant lighting and subject matter of high contrast. Films of in-

This scene is in the shade, because the sun is in back of the building fronts, rather high, casting its shadow forward. The contrast is so great that the buildings are silhouetted against the background. Standard 55mm lens. Joseph D. Cooper.





Minolta filters are optically flat and are available for black-and-white films in most common sizes and dimensions, particularly 52mm and 55mm screw-thread diameters.

dividual manufacturers continue to undergo modification, so we cannot be too specific about individual film characteristics. Nevertheless, from these generalities we can see how film selection is related to the other elements of exposure strategy mentioned above.

Filters are used to alter the color properties or amount of light reaching the film. Hence, they have important implications for all other elements of exposure strategy. In color photography, filters are used to convert the type of light illuminating the subject so that it matches the particular spectral sensitivity of the film. With black-and-white films, filters are used to alter tonal properties and contrast characteristics of scenes. In both black-and-white and color photography, filters are used to achieve special effects, some of which will be described subsequently. The main thing to remember is that the use of filters is closely interrelated with the characteristics of both light and film.

The subject of light quality covers a fairly wide range. There are many different kinds of daylight and artificial light sources, each of which have different characteristics that affect pictorial quality. The direction from which the light strikes the subject not only governs how much light is reflected back into the camera, thereby influencing the exposure determination, but also creates the shadow patterns, which contribute to the illusion of depth and also lend contrast to the scene.

The term *contrast* is used variously to refer to the ratio between the brightest and darkest areas of the subject, the image on film, and the photographic print. We know also that the subject or scene contrast is in part governed by the quality of light by which it is illuminated and that optical performance also has a bearing on image contrast. Films and printing papers also have their contrast characteristics. All of these influences on contrast—the ratio between brightness and darkness—can have either a cumulative effect or a mutually balancing or offsetting effect. The contrast ratio of an average subject is in the order of about 130:1, or a contrast range of eight *f*/stops. The contrast range of a typical flat or dull scene, where subject reflectance or luminance provides the contrast characteristics, is in the order of about 30:1, or about six *f*/stops. Sidelit scenes under brilliant lighting may have much wider contrast ratios because of the deep shadow areas created by such lighting.

As a practical matter, films and printing papers cannot accommodate all of the brightness range to be found in average and brighter scenes. Black-and-white film can accommodate a wider range of contrast than black-and-white paper, which typically has a contrast ratio of about 32:1. Exposure latitude, to which further reference will be made, is also related to both the contrast characteristics of the photosensitive materials and those of the subject itself. Where high contrast ratios exist, you have much less exposure latitude than where you have lower contrast ratios. Color films can accommodate much less contrast than black-and-white films. A 4:1 ratio in color would be considered rather harsh; a 3:1 contrast ratio would generally be considered satisfactory. Some-



The low sun near day's end suggests mood appropriate for picture of the two old men. 200mm lens at distance brings out effect of compression. High-Speed Ektachrome rated ASA 400. Joseph D. Cooper.

Sidelighting gives depth to building front while absence of light flattens it. Direction of sun can be seen in rooftop shadows. High-Speed Ektachrome rated at ASA 400, 100mm f/2.5, 1/500 sec. at f/11. Joseph D. Cooper.



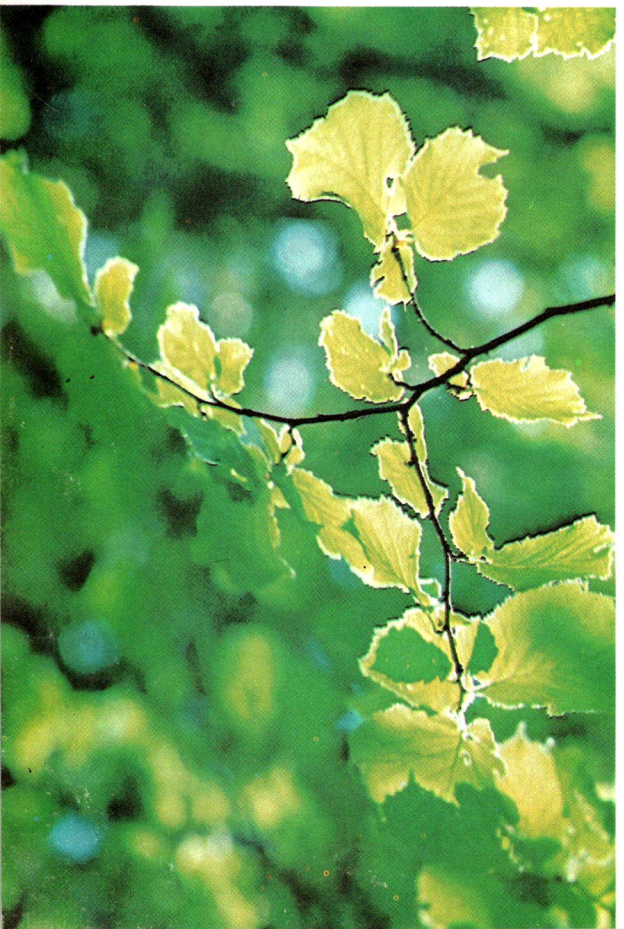




58mm *f*/1.4

58mm *f*/1.4





100mm *f*/2

The Håkansson family—in these pictures Lars and Tore—have a liking for pictures against the sun. These suggest drama and depth. Exposure must be for the front of the subject obscuring the sun. Note deep blue shadows on snow reflecting blue sky. Kodachrome II.



This is a color picture made by Gene Vos on Kodachrome II with a 58mm lens. "A heavy late March snow-fall sent me out stalking with camera and umbrella," he said. The most creative photographers are challenged by working at the edge of light—early morning, late day, fog, snow, and so on.



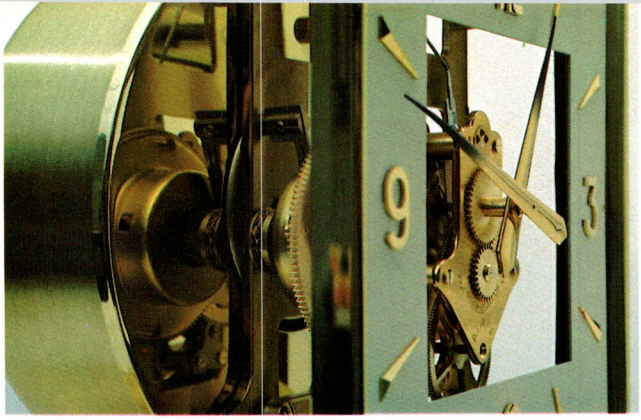
Fjordscape, Norway. When shooting sunsets you have to help the meter think. For a deep sunset effect, you need ordinarily to expose for the sky and cut the indicated exposure. Here, Graham Finlayson brightened the scene strikingly by exposing for the water reflection. 100mm, Kodachrome II, *Daily Telegraph Magazine.*

During the last two weeks of June the sun goes down in the 42nd Street chasm in New York. Gene Vos waited patiently for a smog-free, cloud-free night to take this picture on Kodachrome II with a 200mm lens on a tripod. A sunset lasts about four minutes and is at its best about 30 seconds.

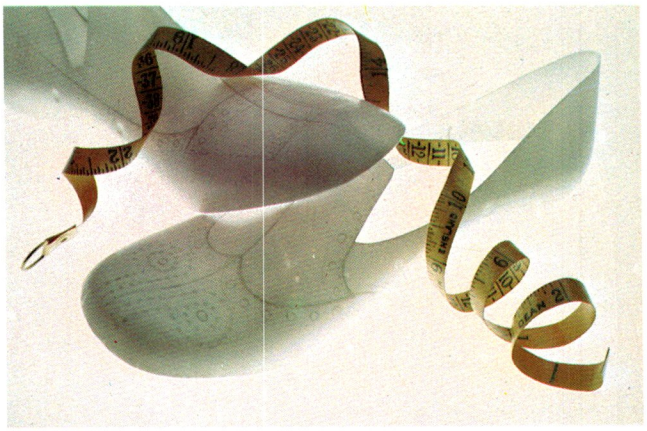




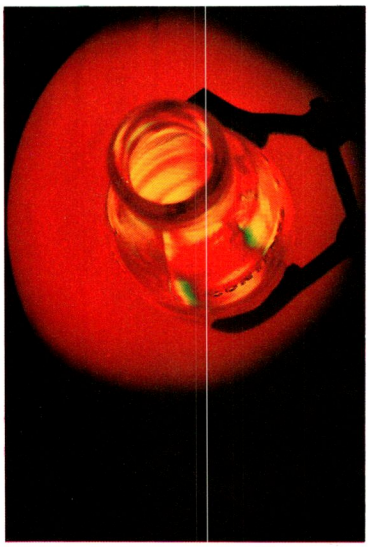
Gene Vos took this picture of water reflections against the sun. The prominence of the reeds, which are only knee high, was achieved by getting down to ground level. The sunset effect was achieved in mid-afternoon by using an 81C filter and underexposing.



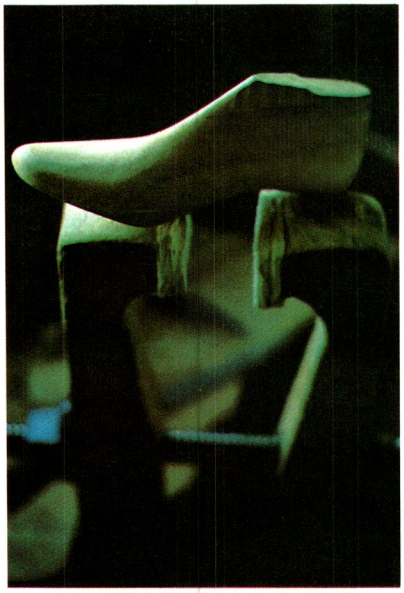
To illuminate exposed works of Atmos atmospheric pressure clock, Graham Finlayson used three flash units bounced off reflectors facing the clock, which rested on a white sheet. Macro Rokkor 55mm, Kodachrome II, *Daily Telegraph Magazine.*



These designers' models of thin plastic for Clark's Shoes, England, placed on a sheet of opal glass, were illuminated from below with electronic flash. Graham Finlayson, *Management Today*, 35mm, Kodachrome II.



Birth of a milk bottle illuminated by its own cherry-red heat. 58mm, *f*/1.4 at 1/15 sec., Kodachrome II, Graham Finlayson. Story about Rockware Glass Company for *Management Today.*



Shoe last illuminated by light from window; late afternoon with fill-in from sheet of white paper. 58mm *f*/1.4 (wide open), Kodachrome II, Graham Finlayson.



Tungsten color film without filter under fluorescent lighting gives decided bluish effect. High-Speed Ektachrome Tungsten (Type B).



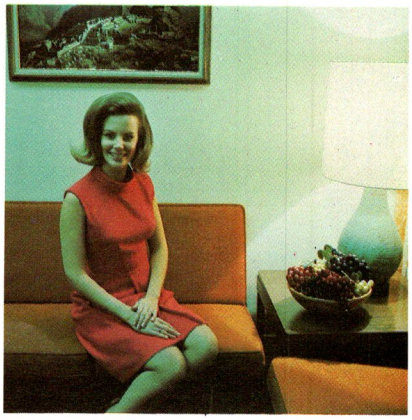
Daylight color film without compensating filter will give tinted effect, usually greenish, depending on kind of lamps used. This picture made with High Speed Ektachrome film (daylight).

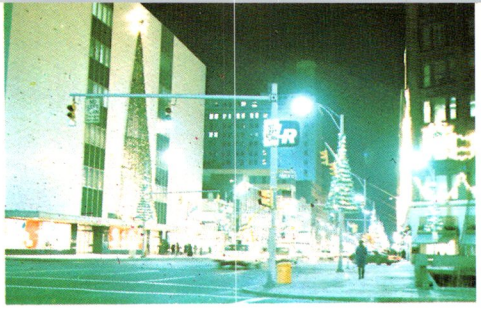


For best color rendition in fluorescent illumination use daylight color film with filter such as CC30M. High-Speed Ektachrome film (daylight) used here.

With mixture of overhead fluorescent lighting and table lamp tungsten lighting, with fluorescent predominating, daylight film is best choice, as in picture on left. Tungsten film gave unsatisfactory tint to the picture on the right.



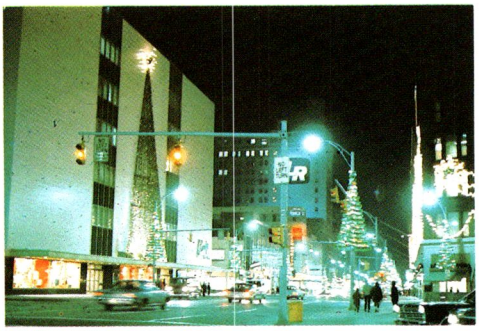




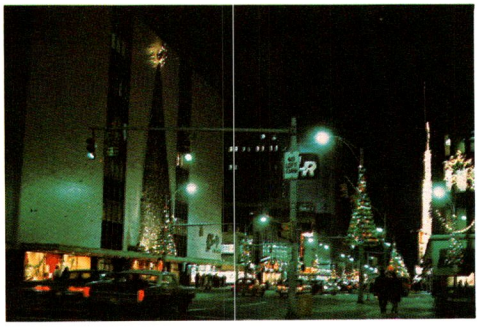
1/8 sec. at f/2.8—two stops increase.



1/15 sec. at f/2.8—one stop increase.

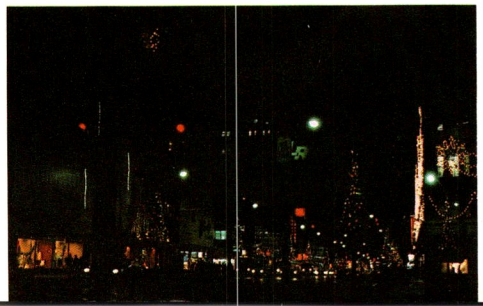


1/30 sec. at f/2.8—estimated exposure.



1/30 sec. at f/4—one stop decrease.

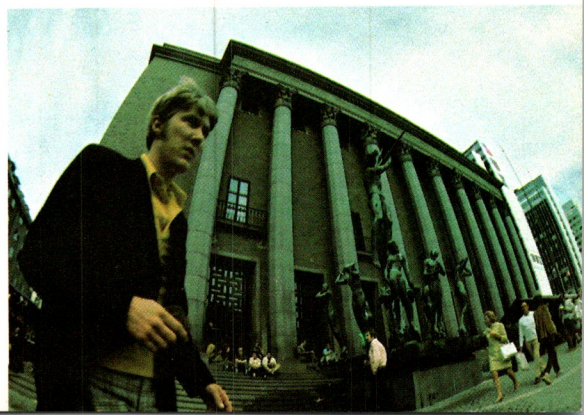
1/30 sec. at f/5.6—two stops decrease.

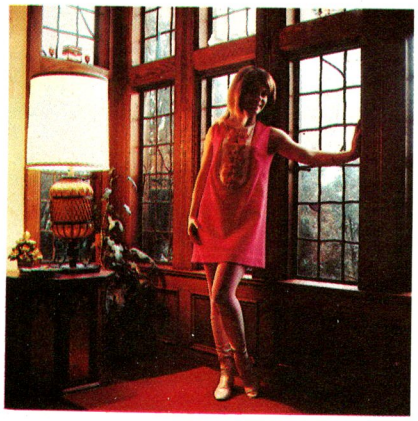


This exposure series shows results of "bracketing" exposure either to find a personal exposure index for given conditions or to increase assurance of good results. In this case, middle exposure was correct one, but one of the others could also have been the preferred one. High-Speed Ektachrome Tungsten, ASA 320, ESP-1 processing.

Note differences in sky color and in reflective properties of building front with sun and without it. Correctly exposed lower picture has drab gray appearance. Rokkor Fisheye 16mm. Joseph D. Cooper, High-Speed Ektachrome, rated at ASA 400.

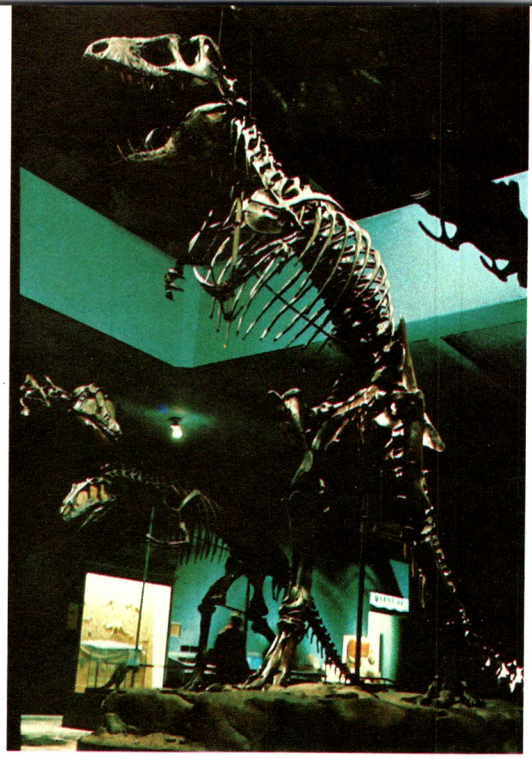




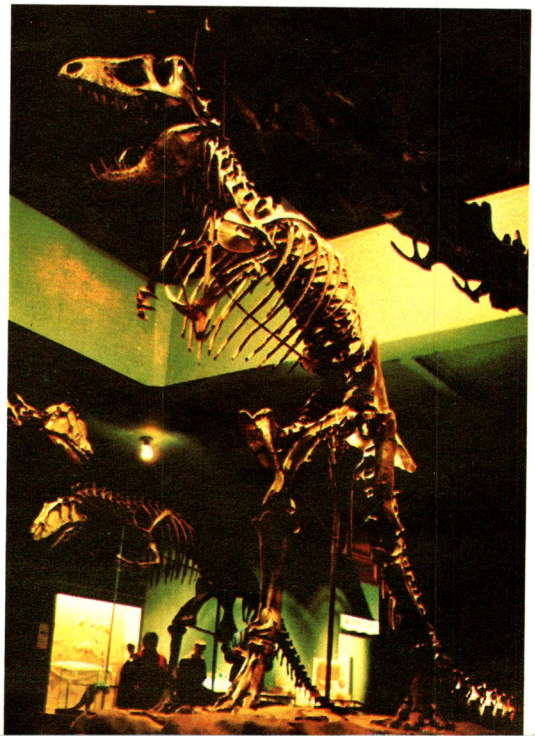


With mixture of tungsten and daylight illumination, best choice is daylight film, as shown in top picture. Tungsten film on bottom yielded bluish effect.





The picture above, exposed on High-Speed Ektachrome Tungsten (Type B) film, yielded correct color effect, but many people would prefer warmer results achieved with daylight film as in bottom shot. Color effects are influenced by personal choice in special situations.



Photographs on this and the preceding two pages are reproduced with permission from the copyrighted Kodak publication, *Adventures in Existing Light Photography.*

times a 2:1 ratio between the principal tonal areas might be adequate, but any closer ratio would look extremely flat.

Within the limits of what you might define subjectively as proper exposure, you can do some things to increase or decrease contrast, as desired. To increase pictorial contrast you can use slow films and brilliant, directional point-sources of illumination. These techniques pertain both to color and black-and-white pictures. With the latter, you can also increase contrast through slight underexposure and longer development, use of appropriate filters, and appropriate enlarging techniques in the darkroom.

To decrease contrast you would ordinarily do just the opposite. On the whole you would use the faster, softer films and diffuse or soft sources of light. With black-and-white pictures only, you could go for longer exposures and shorter development as explained further in the section on existing light techniques, and finally, you could also take advantage of soft printing papers and appropriate enlarging techniques.

Apart from the subject matter and its composition within the image frame, the management of contrast is one of the most important factors in creation of an attractive picture—whether to enhance the impression of depth, to assure that the tonal characteristics of a subject are reproduced in proper balance, or to achieve moods ranging from extreme opposition in tonal values to an almost single-tone rendition.

LIGHT, FILM, AND FILTERS

Both color and black-and-white films have certain attributes in common that bear upon pictorial effect. This section opens with a discussion of certain technical characteristics of films, including grain, definition, acutance or contour sharpness, exposure latitude, and reciprocity effect. We might also include film contrast, but this has already been sufficiently covered. References to contrast will be made, however, in the discussion of the different kinds of available film.

Some Technical Characteristics of Films

Grain. Most commonly, films are referred to as having grain characteristics that fall somewhere between fine and coarse. The graininess of an image becomes increasingly apparent with increasing magnification on paper or on a projection screen. This characteristic is the direct result of the clumping together of what otherwise would be microscopic grains of silver, which are the key photosensitive components of practically all films.

Graininess is only one aspect of the total problem of achieving good image definition or sharpness and clarity of detail in the image at whatever magnification is necessary for viewing purposes at the distance at which a picture is to be perceived. A tremendous enlargement could show a substantial amount of grain when viewed only a few inches away, but if it is meant to be seen from a distance of a few feet and at that distance details appear to be clearly delineated, it can be regarded as having good image definition. In the early history of 35mm photography, the achievement of fine-grain results was the *sine qua non* of photographic attainment with the black-and-white films then available, which by present standards were quite grainy. Today, when films are available that are practically grainless, the general notion is that for most pictures reasonably fine grain accompanied by good contour sharpness is desirable for most subjects. As a matter

of creative selection, however, the photographer might determine that he wants the plasticity that accompanies the grainlessness of slow films or that he wants the texture of a coarse-grained film. In the range of grain classifications, manufacturers use such terminology as *extremely fine, very fine, fine, medium fine, moderately coarse,* and *coarse.* These are inherent characteristics of the films subject to proper exposure and development. Overexposure and overdevelopment will impair fine-grain properties of film. The appearance of grain is most apparent in middle tones and, oddly, in blurred or out-of-focus areas. This has nothing to do with the film or its development: It is a psychological by-product of looking for detail sharpness critically and, not finding it, observing instead the grain pattern.

Acutance or contour (edge) sharpness. The quality of contour sharpness or acutance refers to how sharply dark and light objects are separated from each other. A film with excellent contour sharpness shows a knife-edged separation. When there is poor contour sharpness, the edges of objects soften and tend to blend into each other. Many photographers feel that contour sharpness is more important than fine grain. They feel that when a picture is held at a normal viewing distance, good acutance heightens the effect of image sharpness, superseding the grain pattern. At one time the property of good contour sharpness was available only in the slower, thin-coated black-and-white films. Currently, with improvements in film emulsion technology, this property has been designed into most films of all speeds. It is still, of course, a matter of degree, for the various properties of the film combine to determine what might be regarded as excellent definition or sharpness, both of which are subjective factors whose perception varies with the viewer.

Resolving power. Under ideal viewing conditions at average or normal hand-held viewing distances, the resolving power of the human eye in sound condition is about ten lines per millimeter. Beyond this point improvements in image resolution will not be appreciated by the viewer, but if the image is less finely resolved, the difference will be noticeable. It is not really practicable to consider separately grain, contour sharpness, and resolving power as elements of what overall might be termed good definition. Resolving power is probably a synthesis of both grain and acutance characteristics. The term *resolving power* relates to the ability of a film (or paper) to record fine details distinctly and separably without overlap. In the measurement of resolving power parallel lines and spaces of the same width are photographed at great reduction until a point is reached beyond which the lines will all fuse together into a solid mass. The number of clearly distinguishable lines at this point of limitation is referred to as the resolving power of the film in terms of *lines per millimeter.* Adjectival terms are also used for this purpose. The Kodak terms, to be found in the film data sheets accompanying film containers, are:

Low resolving power—below 55 lines per millimeter

Moderately low resolving power—55–68 lines per millimeter

Medium resolving power—69–95 lines per millimeter

High resolving power—96–135 lines per millimeter (medium-speed roll films)

Very high resolving power—136–225 lines per millimeter (Kodak Panatomic-X)

Extremely high resolving power—above 225 lines per millimeter (usually copying films, which have high contrast characteristics)

Exposure latitude. The term *exposure latitude* refers to the range of overexposure and underexposure within which you can obtain or make satisfactory

pictures. Black-and-white films are regarded as having much more exposure latitude than color films. Photographers rely upon exposure latitude, usually through the technique of *bracketing* (making a series of exposures above and below that which is thought correct) when circumstances do not permit the taking of careful exposure readings either through the camera or through the use of an independent exposure meter. Theoretically, there is one best exposure for any film, whether color or monochromatic, regardless of the notion of latitude. All that the latter does is to permit you to achieve acceptable rather than ideal results when your exposure is slightly off. The range of acceptability to be achieved with black-and-white films is greater with low-contrast films

Exposure was for the shadow areas, which were filled in somewhat by the reflection from the light ground. 100mm lens. Lucien Clergue.



EXPOSURE* AND FILTER COMPENSATION FOR THE RECIPROCITY CHARACTERISTICS OF KODAK COLOR FILMS

Film	Exposure Time (Seconds)					
	1/1000	1/100	1/10	1	10	100
KODACOLOR-X Film	None No Filter	None No Filter	None No Filter	None No Filter	+1 stop No Filter	+2 stops No Filter
KODAK EKTACOLOR Professional Film, Type S (Short Exposure)	None No Filter	None No Filter	None No Filter	Not Recommended		
KODAK EKTACOLOR (Professional Film, Type L (Long Exposure)	Not Recommended		See Film Instructions for Speeds No Filter from 1/10 to 60 sec			
KODAK EKTACHROME Film, Daylight Type (Process E-3)	†	None No Filter	+⅓ stop CC05M	+1 stop CC15M	Not Recommended	
KODAK EKTACHROME Film, Type B (Process E-3)	None No Filter	None No Filter	None No Filter	None No Filter	†	†
KODAK EKTACHROME-X Film	None No Filter	None No Filter	+⅓ stop CC10C	+1 stop CC20C	+2 stops CC30C+ CC05G	+3 stops CC30C+ CC10G
KODAK High Speed EKTACHROME Film, Daylight Type	None No Filter	None No Filter	+⅓ stop CC05R	+⅔ stop CC10M	+1⅔ stops CC10M	+2⅔ stops CC10M
KODAK High Speed EKTACHROME Film, Type B	None No Filter	None No Filter	None No Filter	+⅔ stop CC10R	+1⅓ stops CC10R	+2⅓ stops CC10R
KODACHROME II Professional Film, Type A	None No Filter	None No Filter	See film instruction sheet.			
KODACHROME II Film, Daylight Type	None No Filter	None No Filter	None No Filter	+⅓ stop No Filter	+1 stop CC10G	+1⅔ stops CC20G
KODACHROME-X Film	None No Filter	None No Filter	None No Filter	+⅓ stop No Filter	+⅔ stop No Filter	+1⅔ stops No Filter

* The exposure increase, given in lens stops, includes the adjustment required by any filter or filters suggested.

† See Supplementary Data Sheet packaged with the film.

Notes: The data for each film in the above table are based on average emulsions. They apply only to the type of illumination for which that film is balanced, and assume normal recommended processing. The data should be used as guides only. The adjustments are subject to change due to normal manufacturing variations or subsequent film-storage conditions after the film leaves the factory.

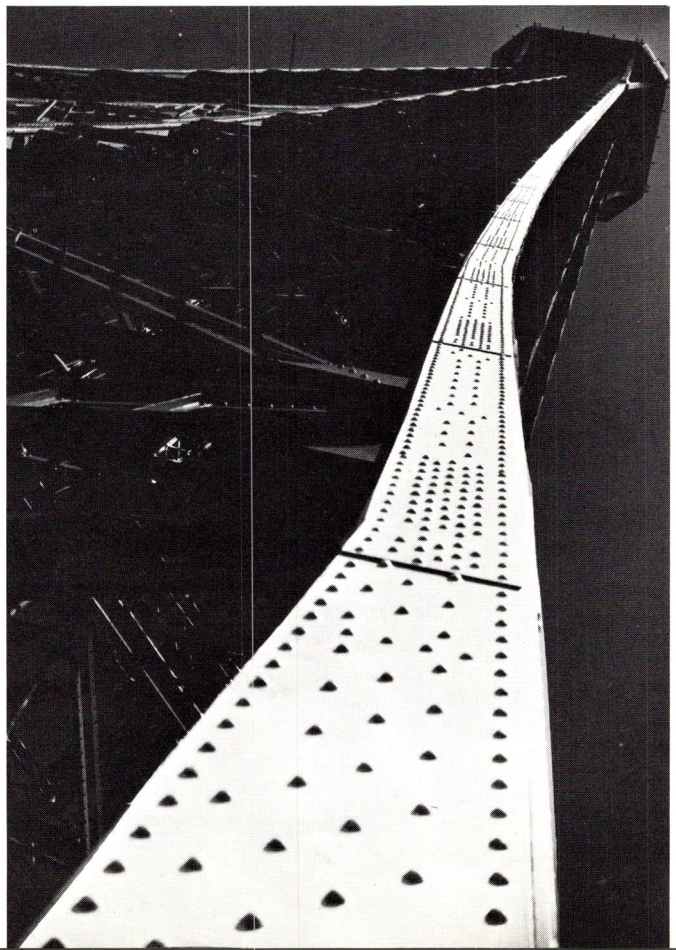
and low-contrast subjects than with high-contrast films and subjects. Since color films work within a narrower range of brightness, they can accommodate much less deviation from what one might determine to be the ideal exposure. As with black-and-white films, the faster color films tend to have more exposure latitude than the slower ones. Latitude is also related to the brightness range of the subject and the quality and direction of illumination.

Reciprocity failure. The law of reciprocity is what makes it possible to use different combinations of shutter speeds and lens apertures to achieve the same exposure effect on a given film for a given subject. That is, you can decide that instead of exposing with a combination of *f*/11 and 1/125 sec., you will open the lens two stops to *f*/5.6 and decrease shutter speed correspondingly to 1/500 sec.

Another way of expressing this is that



Right, bright sidelighting from window brings out texture of leaf. Standard 58mm *f*/1.2 lens. Tripod used 1/2 sec., *f*/16. Plus X. Below, the Eiffel Tower at midday, when the high sun sent its rays glancing off the surface of the steel girder. Red filter and polarizing filter. 58mm *f*/1.2 lens, 1/125 sec., *f*/8, Plus-X. Francisco Hidalgo.



if a single unit of light should fall on a film emulsion for 100 seconds, the ordinary working of the law would yield the same exposure effect if 100 units of the same light source were to fall on the same film emulsion for one second. However, in this latter case, although the same amounts of light would reach the film, the exposure effects would be different. Within a given range, different for each film, one can expect equivalent responses to longer or shorter exposure durations. Beyond certain extreme points, unique for each film, neither shorter nor longer exposures will register proportionately in accordance with the reciprocity law. The term *reciprocity failure* then becomes applicable.

As a practical matter, most exposures with either black-and-white or color film made within the range of shutter speeds on your Minolta SR camera can be expected to achieve exposure effects in accordance with the reciprocity law. When reciprocity failure occurs with black-and-white films, it is usually of little significance and can be expected to be accommodated by the latitude of the film. When using an electronic flash unit, which has a flash duration of 1/1000 sec. or less, you may lose a little density in the highlights of your film. This is why it is sometimes suggested that if you are shooting an entire roll of film using electronic flash, you might want to increase development time of black-and-white films in order to build up a little contrast. Longer exposures may achieve the opposite effect—a loss of shadow detail with excessive build-up of highlight density. If you should be copying color transparencies onto black-and-white films, utilizing low light level sources, for example, you would want to compensate for the contrast build-up by decreasing development.

Most commonly, reciprocity failure occurs when making long exposures with color films, particularly when using lens extension devices. What governs is not the magnification factor but the duration of exposure. The complicating factor with color films is that color balance may be affected because there may be differences in the sensitivity changes in each of the three emulsion layers of the film. Hence, in addition to increasing exposure to make up for a loss in effective speed of the emulsion, it may be necessary to use color compensating filters. Usually reciprocity information will be included in the data sheet accompanying the film. A table of exposure and filter compensations for Kodak color films is included in this chapter. Also included is a table of exposure compensations for Kodak black-and-white films.

Filters

Filters are described separately in relation to color and black-and-white films. Essentially, they are *subtractive* in that they exclude portions of the visible and invisible light spectrum in order to achieve desired color and tonal effects with a particular film. Some filters are intended for use specifically with color, some with black-and-white, and some for use with both. For achievement of special effects, some photographers occasionally will use black-and-white color filters together with color film; a red filter will produce an overall red cast, a yellow filter will produce an overall yellow cast, and so on.

Ultraviolet (UV) filters are intended to exclude excessive ultraviolet radiation in outdoor photography, particularly when there is a great deal of sky, reflection from the sky, and distance. The aim is to minimize haze, so sometimes this is called a *haze filter*. In ordinary photography the achromatic coating of Minolta lenses together with the total mass of optical glass making up the typical Rokkor lens makes the use of an auxiliary UV filter unnecessary. However, it might have some usefulness at very high altitudes, and since the

MINOLTA FILTER AVAILABILITY

Screw-thread diameters (mm)

	37.5	45	49	52	55	62	67	72	77
Yellow		√	√	√	√	√	√	√	√
UV Haze		√	√	√	√	√	√	√	√
ND×4		√	√	√	√				
Red	√			√	√				
Orange				√	√				
Green				√	√				
1A Skylight				√	√				
80B Conversion				√	√				
85 Conversion				√	√				
Polarizing				√	√				

Minolta UV filter is neutral, it can also be used as additional protection for the front surface of the lens, particularly in windy and inclement weather.

Polarizing filters are also used for all types of film for a variety of purposes. They can be used to darken the sky without altering the tonal or color properties of the rest of the scene. They are used to remove unwanted reflections from glass, water, and highly polished or bright (but nonmetallic) reflective surfaces. With color films, eliminating subtle reflections with the use of the polarizing filter helps render colors more deeply saturated. Since polarization eliminates ultraviolet rays, this filter can be used for selective penetration of ultraviolet-caused haze. Another use is to serve as a neutral density filter: the reduction in light reaching the film with the Minolta polarizing filter is 4×, or

Polarizing filter eliminates most reflection from non-metallic surfaces when camera is pointed at oblique angle. Courtesy Minolta Camera Company, Ltd.





SOME CHARACTERISTICS OF NEUTRAL DENSITY FILTERS

Density	Per cent of Transmission	Approximate Fraction of Light Passed	Approximate Increase in Stops	Approximate Equivalent Filter Factor
0.10	80	4/5	⅓	1.25
0.20	63	2/3	⅔	1.6
0.30	50	1/2	1	2.
0.40	40	2/5	1⅓	2.5
0.50	32	1/3	1⅔	3.1
0.60	25	1/4	2	4.
0.70	20	1/5	2⅓	5.
0.80	16	1/6	2⅔	6.3
0.90	13	1/8	3	7.9
1.00	10	1/10	3⅓	10
2.00	1.	1/100	6⅔	100
3.00	0.10	1/1,000	10	1000
4.00	0.010	1/10,000	13⅓	10,000

two *f*/stops. Polarizing filters can also be used in conjunction with other filters in both color and black-and-white photography. When using the polarizing filter for darkening the sky or reducing reflection from surfaces, you should observe the effect achieved as you rotate the filter in front of the lens while you look through the viewfinder. The Minolta polarizing filter screws into the lens filter mount and has an independent rotating ring, which turns the filter without affecting its secure attachment to the lens. For reduction of reflection, the most effective camera angle in relation to the subject is usually 34°, but some reflection will be eliminated at other angles.

An interesting creative use of the polarizing filter is to simulate night scenes. This is done by combining this filter with a yellow, orange, or red filter in the daytime and using black-and-white films.

Neutral density filters reduce the amount of light transmitted through the lens without altering tonal values. They are used with color and black-and-white films when the light source is too brilliant for a relatively fast film in the camera or when a larger lens aperture is needed. Minolta furnishes the ND 4× neutral density filter. It requires two *f*/stops wider lens aperture or equivalent shutter-speed adjustment. Other neutral density filters are available from independent sources for special purposes, as shown in the accompanying table.

Minolta filters are hard-coated to eliminate reflections and thereby permit a maximum passage of light into the lens. Nevertheless, each glass surface will add cumulatively to the amount of reflection. Also, the more glass you put in front of the lens itself, the more you are likely to change the plane of image focus, which tends with filters to fall somewhat in front of the film or focal plane. Hence, as a rule of thumb, no more than two filters or close-up lens attachments or combinations of any of these should be used in front of a lens.

Since filters perform a subtractive function, they reduce the amount of light reaching the film and therefore require the use of an exposure factor. This is the multiplier needed to give you the additional exposure needed to compen-

sate for the subtractive effects of the filter. Hence, if a filter has an exposure factor of 2×, you must allow twice as much exposure for the given film. With the built-in CLC exposure-measuring system, you need not ordinarily be concerned with computations, other than to know in advance that some filters will have more or less light-reducing effect so that you can determine your picture-taking strategy. However, CdS meters are relatively insensitive to blue as compared with other colors, and readings with a blue filter in place will not give you proper exposures. Hence, when you use a blue or some other dark filter, you should know the filter factor beforehand so that you can take a reading without the filter in place and then make a suitable exposure compensation with the filter attached.

Focusing should usually be done with the filter in place so as to overcome the problem of focus shift, most likely to occur with lenses at extremely wide apertures or with extreme wide-angle lenses, as well as in close-up work. With the light-tinted filters, this will present no problem, but with darker filters you may have some difficulty perceiving image details sharply. One technique is to substitute a more lightly-tinted filter in the same color series for focusing purposes only and then to substitute the required filter for exposure determination as well as for actual picture-taking.

Filters vary widely as to quality. Minolta filters are made to rigid quality standards. They are "optical flats" in that they are solid glass with both surfaces critically parallel to each other. You can use filters of independent make, some of which are of equivalent high quality, but you might also find bargain filters, which will usually detract from performance. It is very important that you satisfy yourself as to the quality of any filters you place in front of your lens, bearing in mind that it is a false economy to allow the fine optical performance of a lens to be impaired by the use of a poor filter. Quality of filters is particularly important when using them with long focus lenses, because these lenses will magnify optical distortions introduced by inferior filters. The accompanying table lists all of the available Minolta filters and their lens mount diameters. Except for the UV, ND, and polarizing filters, which may be used for both color and black-and-white films, all other Minolta filters are intended for black-and-white use only.

The same care should be exercised in handling filters as in handling the lens. Fingers should be kept off the surface of the filters, which should be kept scrupulously clean and free of dust.

The sequence of attachment to the lens, when using a close-up lens or a polarizer in addition to a color filter, is, in order of closeness to the prime lens: (1) close-up attachment lens; (2) polarizer; and (3) color filter. The use of more than two of these at a time should be avoided.

COLOR FILMS, FILTERS, AND COLOR MEASUREMENT

This section includes information on the attributes and uses of the two main types of color film, together with information on the use of filters to bring light sources and color films into proper balance. For most practical purposes, this should be sufficient for the achievement of satisfactory exposure results, but for critical professional purposes the photographer may wish to use a color meter, which more precisely enables him to select filters that will assure that desired color rendition is attained. Accordingly, this section concludes with a description

of the use of the Minolta color meter. Special uses of filters to achieve unique or unusual effects are described in the chapter on *Creative Variations.*

Color Films

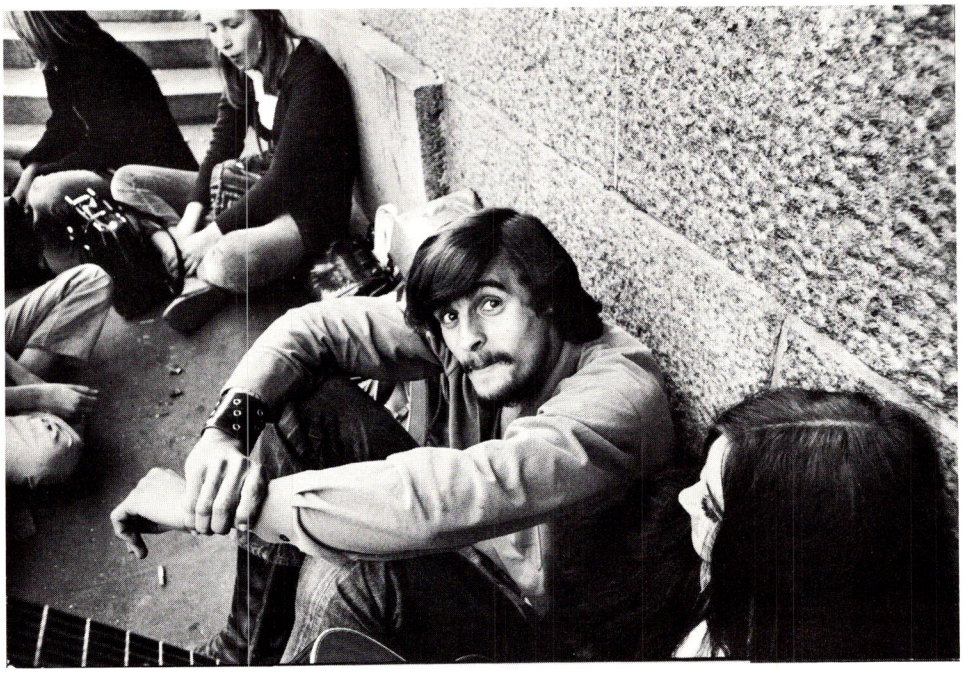
Two general categories of color films are available. One is color slide or transparency film, referred to technically as *reversal film.* The other is negative color film from which prints are made. Prints can also be made from color slides, but this is not their primary purpose, which is hand-viewing or screen-projection. An advantage of the color slide, however, is that you can make choices more easily for print-making purposes than with color negatives, because the color slides show the subjects more or less in their natural colors. It is more difficult to make selections from strips of negative color film because the color tones are all reversed. If desired, color transparencies can be made from negative color. Black-and-white prints can also be made from negative color. Only the positive color slides or transparencies can be used for projection purposes unless you deliberately want a weird-looking effect.

Color slide films are made for use with three different types of illumination—daylight, photoflood lamps having a color temperature of 3400 K, and studio lamps having a color temperature of 3200 K. The term *color temperature* refers to the ratio of red to blue in a particular light source. Light having a particularly high ratio of red has a low color temperature—as in the case of floodlight or studio lamps—as opposed to high ratios of blue in skylight and overcast daylight. The color film must be used with the light source for which it was designed or, if used with another light source, a suitable conversion filter must be placed over the camera lens. The mixing of two or more different types of lighting in the same scene should be avoided since it then becomes difficult to adjust for more than one of them.

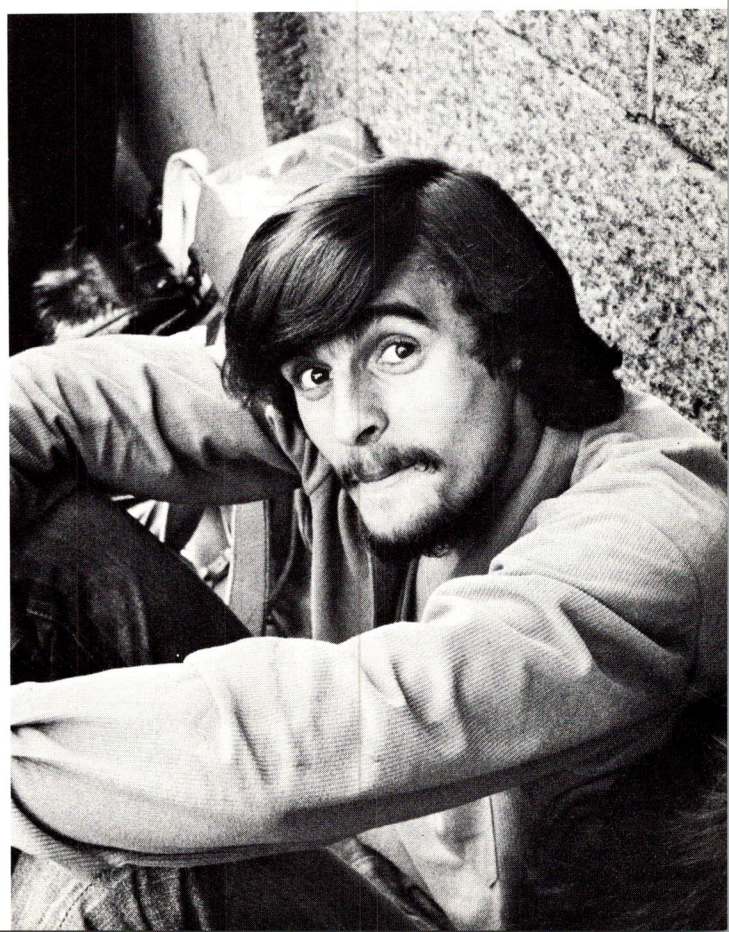
When daylight color films are to be used with artificial light sources, the conversion filters substantially reduce the exposure ratings or speeds of the films, thus adding to the difficulty of taking pictures under the comparatively less brilliant light source. Ordinarily, you would not use a daylight film with artificial light unless the camera happened to be loaded with that film.

Color slide films intended for use with artificial light are referred to as *tungsten* films. When used with suitable conversion filters, they can also be used in daylight. Although there is a reduction in the exposure index of the film through the use of the conversion filter, this is not particularly disadvantageous, because the resulting daylight rating is the same, or nearly the same, as that of similar film designed specifically for daylight use. This has led some photographers to prefer to use a single tungsten film both indoors and outdoors together with a conversion filter for the outdoor exposures. Satisfactory results can be achieved in this way, but another point of view is that when you do not have to use a filter you should not do so, since the advantages of any filter are somewhat offset by the introduction of problems of additional reflection and refraction of light. The use of tungsten films in this way will be discussed further in the section on existing light techniques.

When the term *daylight* is used for purposes of balancing a film with its light source, this also includes blue-tinted flashbulbs and electronic flash. The latter have tended to have a somewhat higher color temperature than daylight films, which are designed to match the lighting characteristics of bright sunlight at high noon. More recently the tendency has been to incorporate into the flash window of the electronic



The slow to moderate films permit maximum enlargement while retaining crisply rendered details. The picture above is the full frame; below is a blow-up of the central figure without any apparent loss of sharpness or detail. 35mm f/1.8 lens, 1/250 sec., f/8. Ilford FP4.



COLOR FILMS (SLIDE OR TRANSPARENCY), STANDARD LOADS

	Film	Film Speed		Color Balance
		Daylight	Tungsten	
AGFA	Agfachrome CT 18	50	25[1]	5500 K
	Agfachrome 50 S	50	—	5500 K
	Agfachrome 50 L	32[2]	50	3200 K
DYNACOLOR	Dynachrome 25	25	12[1]	6000 K
	Dynachrome 64	64	25[1]	6000 K
GAF	GAF 64 Color Slide Film	64	16	6000 K
	GAF T/100 Color Slide Film	—	100	3200 K
	GAF 200 Color Slide Film	200	100	6000 K
	GAF 500 Color Slide Film	500	250	6000 K
KODAK	Ektachrome-X	64	25[1]	5500 K
	Ektachrome Infrared Aero	100[6]	—	
	High Speed Ektachrome	160	50[1]	5500 K
	High Speed Ektachrome, Type B	80[4]	125	3200 K
	Kodachrome II	25	12[3]	5500 K
	Kodachrome II, Professional Type A	25[5]	40	3400 K
	Kodachrome-X	64	25[1]	5500 K

1 80B filter with photofloods (3400K); 80C with clear flashbulbs; 80A with 3200K lamps.
2 85B filter.
3 80B filter with photofloods (3400K), 80C with clear flashbulbs.
4 85B filter in daylight, 81C with clear flashbulbs, 81A with photofloods (3400K).
5 85 filter in daylight, 81C with clear flashbulbs, 82A with 3200K lamps.
6 With deep yellow filter, subject to light conditions.

COLOR FILM, NEGATIVE, STANDARD LOADS

	Film	Film Speed		
		Daylight	Photoflood[1]	3200 K[2]
AGFA	Agfacolor CNS Color Print Film	80	25	—
GAF	Color Print Film	80	25	20
KODAK	Ektacolor Professional Type S	100	32	25
	Kodacolor-X	80	25	20

1 80B filter 3400K photofloods.
2 80A filter 3200K lamps or photofloods.

unit a tinting that will bring about a closer match. As an exception to the rule about not mixing light sources, electronic flash and blue flashbulbs can be used together with daylight illumination.

Color negative films, sometimes referred to as *color print films,* are ordinarily intended to be used in daylight or with electronic or blue flash or combinations of these. The accompanying table of color films includes information on use with other light sources.

The selection of a color film within

a given ASA exposure sensitivity or film speed group from among those offered by different manufacturers is a matter of personal preference. Color film attributes vary among the different makes. Some render different color components more faithfully than others. Some tend to be cool; others tend to be warm. In the range of slow to fast, the color films correspondingly tend to show differences in grain, acutance, and contrast. The slower films have higher acutance and better contrast. The faster films are somewhat more grainy and somewhat less contrasty.

Filters for Color Film

The following types of filters are most commonly used with 35mm color films:

1. Color conversion filters to enable you to use tungsten films in daylight and vice versa. The conversion filters from tungsten to daylight are in the Wratten 85 series and are recognizable by their salmon color. These filters also screen ultraviolet radiation, although as explained above, this supplementary UV filtering is not necessary with Rokkor lenses, except when there is a great deal of skylight being reflected in the scene, which is often the case at high altitudes. The filters used to convert from daylight to tungsten have a blue tint and are designated in the Wratten 80 series.

2. Light balancing (LB) filters are designed for making minor adjustments between the color temperature of the light source and that of the film against

KODAK LIGHT BALANCING FILTERS

Filter Color	Filter Number	Exposure Increase in Stops*	To Obtain 3200 K from:	To Obtain 3400 K from:	Mired Shift Value
Bluish	82C + 82C	1⅓	2490 K	2610 K	−89
	82C + 82B	1⅓	2570 K	2700 K	−77
	82C + 82A	1	2650 K	2780 K	−65
	82C + 82	1	2720 K	2870 K	−55
	82C	⅔	2800 K	2950 K	−45
	82B	⅔	2900 K	3060 K	−32
	82A	⅓	3000 K	3180 K	−21
	82	⅓	3100 K	3290 K	−10
No Filter Necessary			3200 K	3400 K	—
Yellowish	81	⅓	3300 K	3510 K	9
	81A	⅓	3400 K	3630 K	18
	81B	⅓	3500 K	3740 K	27
	81C	⅓	3600 K	3850 K	35
	81D	⅔	3700 K	3970 K	42
	81EF	⅔	3850 K	4140 K	52

* These values are approximate. For critical work, they should be checked by practical test, especially if more than one filter is used.

COLOR FILM—LIGHT SOURCE—FILTER

(for color films not listed here, see film instruction sheet)

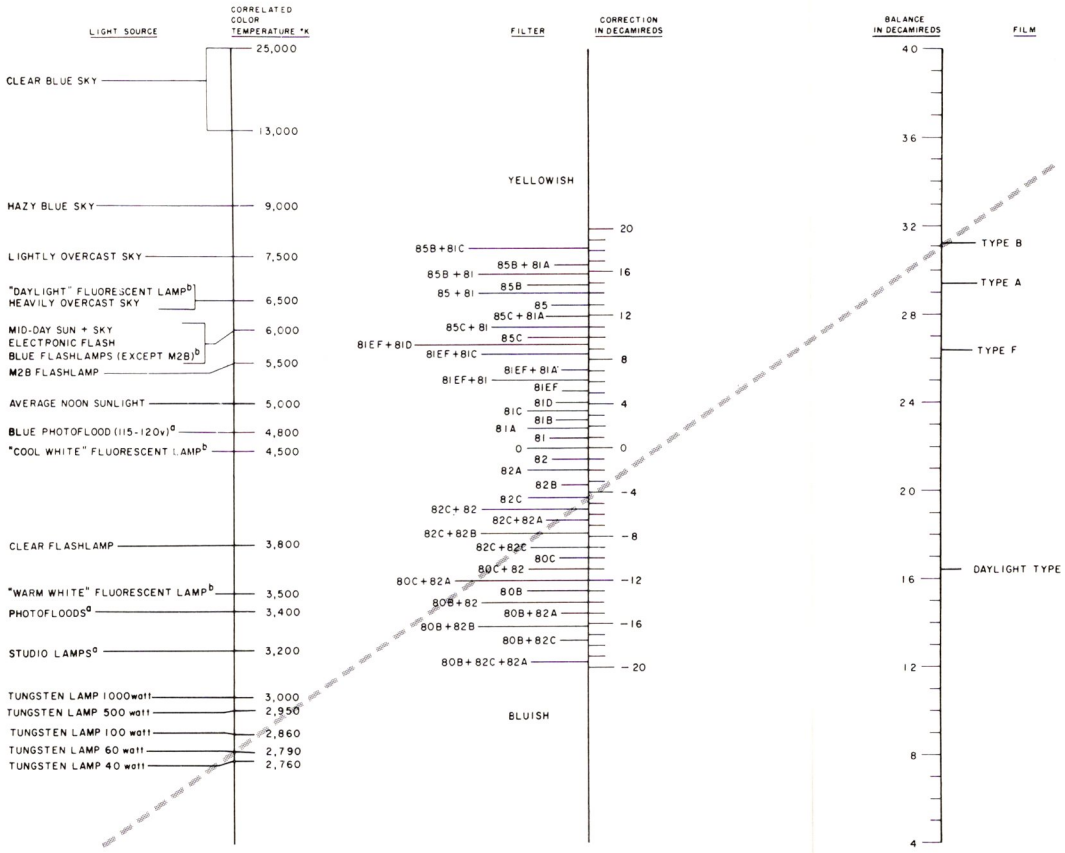
Film	Daylight		Any Clear Flashbulb		3400 K Photoflood		3400 K Photoflood		Any Blue Flashbulb or "Daylight" (blue) Photoflood	
	Film Speed	Filter	Film Speed	Filter	Film Speed	Filter	Film Speed	Filter	Film Speed	Filter
Anscochrome D/64	64	none	32	80C	20	80B	16	80A	64	none
Anscochrome D/100	100	none	50	80C	32	80B	20	80A	100	none
Anscochrome D/200	200	none	100	80C	64	80B	40	80A	200	none
Anscochrome T/100	64	85B	64	81D	80	81A	100	none	64	85B
Kodachrome II "A"	25	85	30	81C	40	none	32	82A	25	85
Kodachrome II Daylight	25	none	12	80C	8	80B	6	80A	25	none
Kodachrome-X	64	none	32	80C	20	80B	16	80A	64	none
Kodacolor-X	80	none	32	80C	25	80B	20	80A	80	none
Ektacolor "S"	100	none	40	80C	25	80B	20	80A	100	none
Ektacolor "L"	—	—	—	—	64	81A	100	none	64	85B
Ektachrome-X	64	none	32	80C	20	80B	16	80A	64	none
Ektachrome Professional Daylight	50	none	25	80C	16	80B	12	80A	50	none
Ektachrome Professional type B	25	85B	20	81C	25	81A	32	none	25	85B
Ektachrome High Speed Daylight	160	none	80	80C	50	80B	40	80A	160	none
Ektachrome High Speed type B	80	85B	80	81C	100	81A	125	none	80	85B

Note: Flashbulbs have no true Color Temperature. However, for purposes of comparison, the following approximate Color Temperature ratings may be used. Clear foil filled flashbulbs—3800K. Blue filtered flashbulbs—5500K.

CONVERSION FILTERS FOR COLOR FILMS

Filter Color	Filter Number	Exposure Increase in Stops*	Conversion in Degrees K	Mired Shift Value
Blue	80A	2	3200 to 5500	−131
	80B	1⅔	3400 to 5500	−112
	80C	1	3800 to 5500	−81
	80D	⅓	4200 to 5500	−56
Amber	85C	⅓	5500 to 3800	81
	85	⅔	5500 to 3400	112
	85N3	1⅔	5500 to 3400	112
	85N6	2⅔	5500 to 3400	112
	85N9	3⅔	5500 to 3400	112
	85B	⅔	5500 to 3200	131

* These values are approximate. For critical work, they should be checked by practical test, especially if more than one filter is used.



Color Filter Nomograph. Here's how to select the proper filter for almost any combination of color film and light source. Place a straight edge across the nomograph below so that it lines up with the color film and light source you're using. Read the proper filter at the point where the straight edge crosses the middle column. Dotted line example shows that for Type B film and 60-watt tungsten source, the proper filter is an 85C. This chart, prepared by C. S. McCamy of the National Bureau of Standards in Washington, D.C., is reprinted here courtesy of *Modern Photography* Magazine.

MIRED VALUES OF COLOR TEMPERATURES FROM 2000–6900 K

K	0	100	200	300	400	500	600	700	800	900
2000	500	476	455	435	417	400	385	370	357	345
3000	333	323	312	303	294	286	278	270	263	256
4000	250	244	238	233	227	222	217	213	208	204
5000	200	196	192	189	185	182	179	175	172	169
6000	167	164	161	159	156	154	152	149	147	145

FILTERS FOR FLUORESCENT LIGHT

Type of Fluorescent Lamp	Type of Kodak Color Film	
	Daylight and KODACOLOR-X Film	Tungsten
Daylight	40M + 30Y + 1 stop	No. 85B + 30M + 10Y + 1 stop
White	20C + 30M + 1 stop	40M + 40Y + 1 stop
Warm White	40C + 40M + 1⅓ stop	30M + 20Y + 1 stop
Warm White Deluxe	60C + 30M + 1⅔ stop	10Y + ⅓ stop
Cool White	30M + ⅔ stop	50M + 60Y + 1⅓ stop
Cool White Deluxe	30C + 20M + 1 stop	10M + 30Y + ⅔ stop

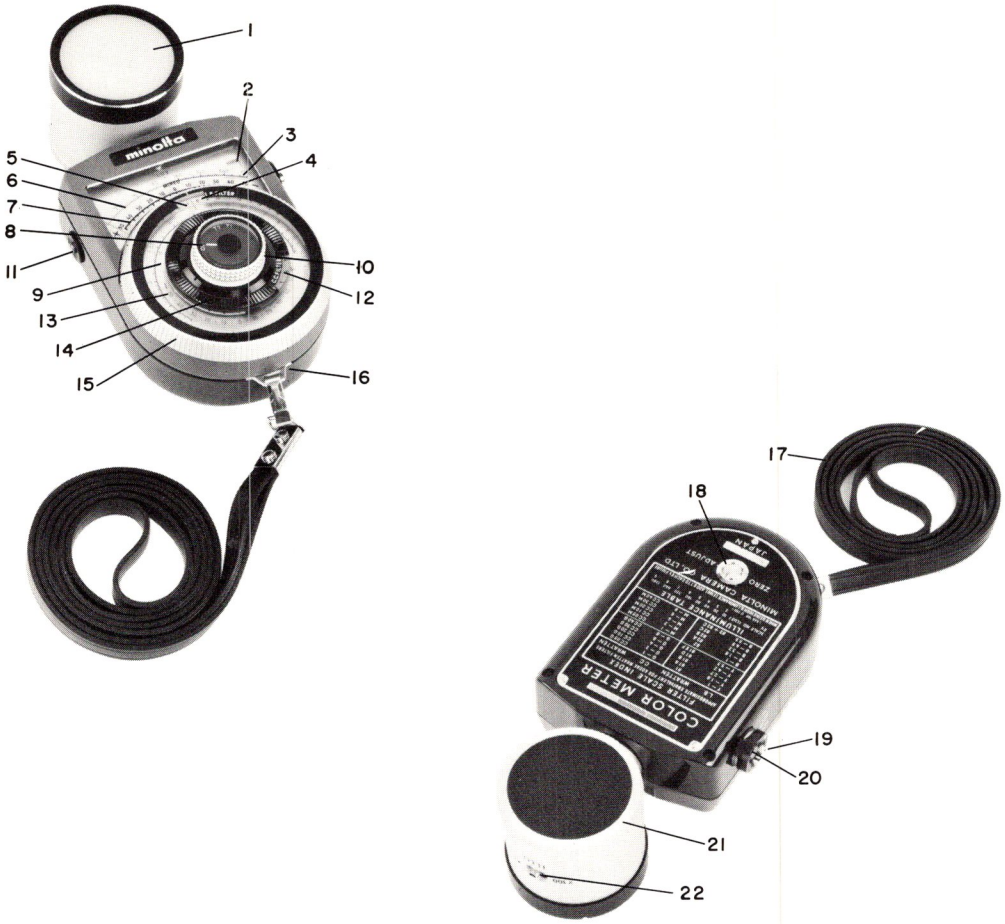
Note: Increase exposure by amount shown in table.

SELECTED PRACTICAL SOURCES OF ILLUMINATION AND THEIR COLOR TEMPERATURES

Source	Color Temperature (Degrees Kelvin)	Mired Value
Sunlight (mean noon)	5400	185
Skylight	12000 to 18000	83 to 56
Photographic Daylight*	5500	182
Crater of carbon arc (ordinary hard-cored)	4000	250
White-flame carbon arc	5000	200
Flashcube	4950	202
High-intensity carbon arc (sun arc)	5500	182
Clear zirconium foil-filled flash	4200	238
Clear aluminum foil-filled flash	3800	263
500-watt (photoflood) approx. 34.0 lumens/watt	3400	294
500-watt (3200 K photographic) approx. 27.0 lumens/watt	3200	312
200-watt (general service) approx. 20.0 lumens/watt	2980	336
100-watt (general service) approx. 17.5 lumens/watt	2900	345
75-watt (general service) approx. 15.4 lumens/watt	2820	353
40-watt (general service) approx. 11.8 lumens/watt	2650	377

* Condition of daylight which best represents that encountered in typical photographic situations.

which it is intended to be matched. This is mainly a problem in situations in which the light sources have deviated for some reason from expected standards. As a practical matter, since tungsten films are available for light sources having a color temperature of either 3200 K or 3400 K, filters are not really necessary unless fluctuations in line voltage or ageing factors in the light sources cause variations from expected color temperature. Another practical consideration is that you cannot know what the color temperature of the light source is, apart from its stated norm, unless you have some objective means of measurement. This is afforded through use of a color temperature meter such as the Minolta color meter described below.



The Minolta 3-Color Temperature Meter

1. Incident light receptor
2. Function indicator window
3. Battery check zone
4. LB filter scale
5. Main color temperature-LB filter index
6. Illuminance scale
7. MIRED scale
8. Color temperature range scale
9. Film-type index
10. Color temperature/film-type selector knob
11. Battery check button
12. CC filter scale
13. Color temperature scale
14. CC filter index dial
15. Main index dial
16. Strap attachment lug
17. Neck strap
18. Zero adjustment screw
19. Reading-lock button
20. Function selector lever
21. Battery compartment cover
22. Illuminance range selector

3. Color compensating (CC) filters are used to make changes in the overall color balance of a color exposure as well as to compensate for qualitative deficiencies in the light source. One of the most common needs is to compensate for the excessive green of fluorescent illumination. In the case of the color compensating filters, as many as three can be used in combination to achieve desired results.

In addition, there are the UV and polarizing filters described above. The 1A or skylight filter has a slightly warm tint to it and is used in general photography with color films to offset excessively blue light as found on cloudy days, in snow scenes, or at very high

altitudes, the last not being a very common occurrence.

Minolta 3-Color Temperature Meter

A color temperature meter is useful when you wish to measure the precise color temperature of any light source or combination of sources. Such a meter is not really necessary when you are certain of the color temperature output of your lighting sources, taking into account rated performance, actual performance, voltage fluctuations and their regulation, and ageing factors. A color temperature meter is of particular value to the photographer who works on location, away from his normally controlled conditions. Probably the most important use for such a meter is in assuring that flesh tones are faithfully reproduced within the range of capabilities of the film in the camera.

The Minolta 3-Color Temperature Meter gives direct readings indicating proper balancing or correction filters to be used. The meter uses blue silicon cells, which are considered more sensitive and faster-reacting than selenium or cadmium sulfide cells. The meter is hand-held at the subject position to measure the color temperature of the light sources. It has a 180° flat receptor that takes into account all surrounding conditions that affect or contribute to the color temperature of the light at the subject position. This flat, incident-light receptor rotates 320° on its axis.

The Minolta 3-Color Temperature Meter has four measuring ranges for blue-red ratios as follows:

Range T1,
400–300 MIRED (2,500–3,300 K)
Range T2,
362–263 MIRED (2,750–3,800 K)
Range D1,
270–170 MIRED (3,700–5,800 K)
Range D2,
180–80 MIRED (5,560–12,500 K)

Each of these ranges takes account of a common color temperature. For example, range "T1" is mainly for films and light sources related to the color temperature target of 3200 K. Range "T2" would ordinarily be used for films rated at 3400 K. Range "D1" would ordinarily be used for daylight films under sunlight conditions, while range "D2" would be for daylight films used under conditions when the blue content of light is excessively high.

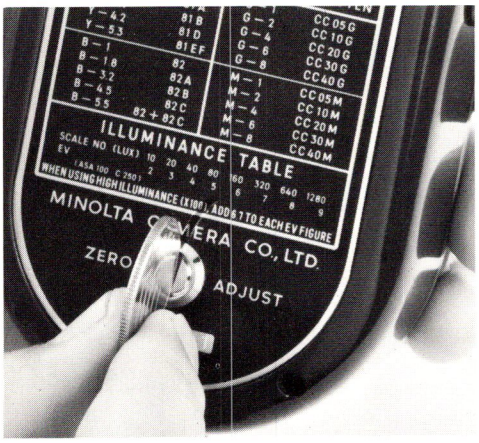
The green-red range of measurement is mainly for use under fluorescent light conditions and covers the following:

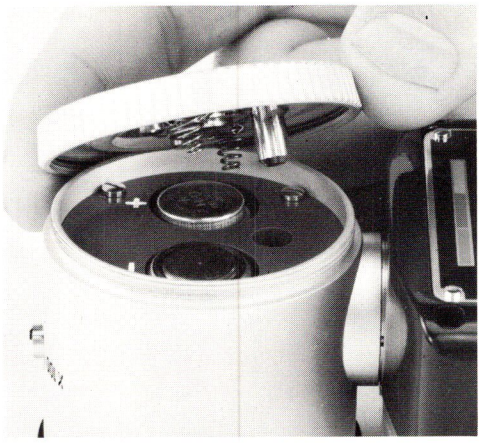
Green-Red,
300–100 MIRED (3,300–10,000 K)

The term *Mired* refers to an equivalent system for measuring color temperature derived from the kelvin scale. *Mired* stands for *micro-reciprocal degree*. The Mired equivalent of a particular color temperature is obtained by dividing the latter into 1,000,000. For example, a color temperature of 2500 K divided into 1,000,000 would give 400 Mired as shown in the scale of ranges given above. Some manufacturers offer sets of Mired filters that can be combined to achieve desired color balancing. The Minolta meter will read directly both the Mired and kelvin-numbered color temperatures. A single scale gives a direct reading from −50 Mired to +50 Mired within an accuracy of ±5 Mired.

The meter may also be used as an ordinary photographic exposure meter giving EV values or for determining illumination levels for other purposes. The illumination-intensity meter component operates within an extremely broad range from 10 to 128,000 luces. The illumination measuring accuracy is ±0.2 EV.

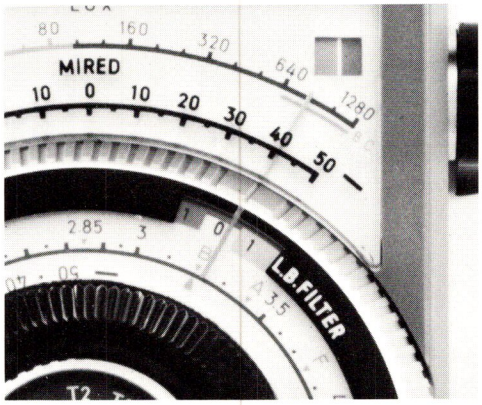
Instructions for using the Minolta color meter are given in connection with the accompanying illustrations. Some important points about setting up the meter for use are: you should check





Above left, before installing batteries in meter check zero reading by depressing reading button. If needle rests exactly on zero graduation on MIRED scale, no adjustment is necessary. If needle is to left or right of zero line, turn test screw on back of meter to achieve proper alignment while reading button is depressed. Turn the set screw only a little at a time. Above right, to install or replace batteries, unscrew battery compartment cover and insert five PX-625-type batteries into the two battery chambers with + and — signs as indicated. Below left, to check on battery condition, depress reading button and battery check button simultaneously. Battery is functioning properly if indicator needle stays within red battery check zone at right end of illuminance scale. Below right, if needle registers outside B.C. zone, replace all batteries with new ones at same time.

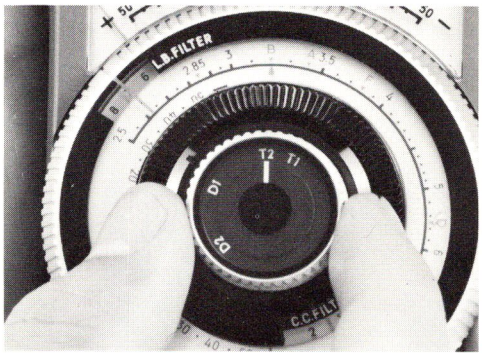


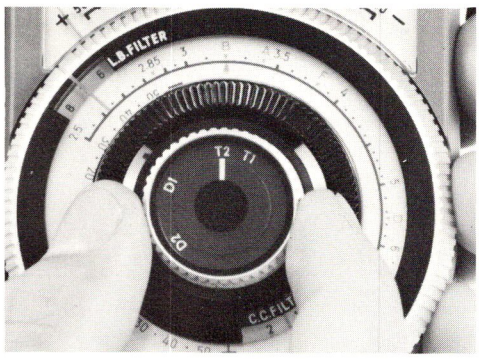


the zero adjustment of the meter before installing batteries; the five PX-625-type batteries must be carefully positioned in the battery chambers as shown in the accompanying illustration and care must be taken not to contaminate them with perspiration from your fingers; and from time to time battery strength should be checked to make sure that the indicator needle records within the red battery-check zone at the right end of the illuminance scale. If the meter is not to be used for as long as two weeks or more, the batteries should be removed and stored in a cool, dry place.

The setup procedure for using the Minolta color meter is as follows:

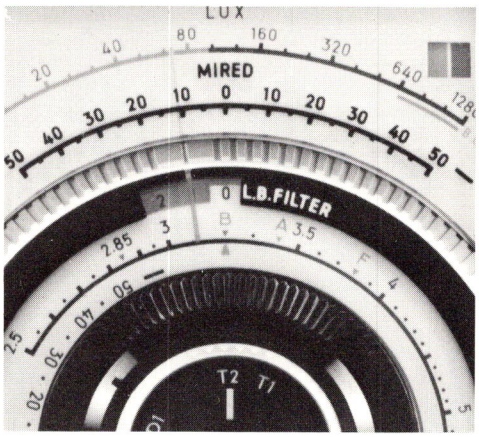
1. The first step is to set the meter for the light source or combination of light sources being used. You turn the





To set meter for light source, turn small center knob (left) to align index mark with designation of range that includes color temperature of your light source(s). To set meter for film pack, *lift up* center dial knob and turn it until small red triangular film-index pointer is set on letter for type of film being used (right).





The function selector (left) must be turned to align the index dot opposite the letter "I" to check light intensity, the letters G/R for readings under fluorescent or mixed lighting conditions, or the letters B/R for most other lighting conditions. Right, color temperature readings are taken by pointing the incident light receptor toward the light source while depressing the reading button. When needle indicator stops moving, button is released to lock needle in position. Rotate main index dial until red index line on grooved rim is aligned with scale needle. Color temperature and light balancing (LB) filter reference numbers can be read under main red index.

smallest center dial so that one of the four click-stop measuring positions ("T1," "T2," "D1," or "D2") is aligned with the small index line of the center dial. In case your selection of the "T1" or "T2" positions or the "D1" or "D2" positions should be wrong, you will discover this when the needle indicator goes completely off the Mired scale, either to the extreme left or the extreme right, as explained below.

2. The film type is indexed into the exposure meter by lifting up the center dial-knob and turning it until the small, red, triangular film-index pointer is matched against the appropriate letter in red on the film-type scale—types "B," "A," "F," and "daylight." Intermediate values can also be set for special films.

3. Before attempting to measure color temperature, you must determine whether there is sufficient light intensity

to permit accurate measurement. A minimum light intensity of 9.3 footcandles (100 luces) is needed. Set the function-selector lever beside the reading lock-button (on the side of the meter) so that the dot is aligned with the letter "I." Set the illumination-range selector on the head of the light receptor to the "IX" position. Point the receptor at the light source and depress the reading button. If the needle indicator registers within the black portion of the illuminance scale, located above the Mired scale, there is sufficient light for accurate measurement. Changes in distance from the light sources will not affect accurate readings unless you are so far away that light intensity drops below the requisite minimum of 9.3 footcandles.

For most lighting situations where there is a single type of lighting source, other than fluorescent, color-temperature measurement and balancing with filters will be done by taking of blue/red ratio readings.

The following procedure should be followed when using the Minolta color meter:

1. Turn the function-selector lever so that the dot points to the "B/R" position.

2. From the subject position, point the incident receptor toward the light source or toward a key spot between two or more light sources facing the subject. Depress the reading button and hold it long enough for the needle indicator to stop moving. Release the button to lock the needle in that position. If the needle should go completely off the Mired scale, you must switch to an alternate measuring range. If the meter is set at "D2" under daylight conditions, for example, and the needle swings to the extreme left, off the scale, you should reset the measuring range to "D1." Similarly, under tungsten light settings if the needle should swing to the extreme right at the "T2" setting, reset the measuring range to "T1."

3. Rotate the main index dial until the red index line on its grooved rim is aligned with the movable indicator needle in its locked position. The color-temperature and light-balancing (LB) filter reference numbers can then be read under the red index line of the main dial. The color temperature scale is the numerical scale ranging from 2.5 to 12.5 (multiplied by 1,000 to get kelvin numbers). The light balancing filter number can be derived from the full number, if it is so indicated, or the nearest decimal increment between two numbers on the scale, as shown in the small opening next to the legend "L.B. FILTER" on the perimeter of the main dial near the red index line.

4. To convert the LB reference number to an actual filter requirement, you first observe whether the numerical scale on the face of the dial is in the blue or yellow sector. Assuming that you get a blue LB reference number of 5.5 and look at the filter scale index on the back of the color meter, you will find listed a combination of one each of the 82 and 82C Wratten filters. The same conversion method is used for the yellow series, indicated on the scale by the letter "Y." If you should obtain an LB reference number exceeding 5.3 in the yellow series or 5.5 in the blue series, you must then combine filters to achieve the desired effect. For example, the blue reference number of 5.5 is a combination of 1, which calls for an 82 filter, and 4.5, which calls for an 82C filter. Similarly, if you were to have a filter reference number in the yellow series of 9.5, as a hypothetical example, you would need to combine 81D and 81EF. Through these filter combinations you might not always be able to obtain precise matching, but this will not be too critical. For reasons of optical performance, you should combine as few filters as possible—preferably not more than two. Better yet, you should control your light source to enable you to use only one filter.

Green/red (G/R) ratio readings are

taken mainly for fluorescent or mixed lighting conditions. The G/R reading may also be made when daylight and xenon light sources are used to achieve full color balances. The steps to be followed are:

1. Obtain the G/R ratio measurement and determine which light balancing filter is required.

2. While leaving the main index in the position to which it was set in making the G/R reading, turn the function-selector lever to the "G/R" position and press the reading button. When the needle stops moving, release the button and read the Mired scale for the G/R measurement.

3. Rotate the grooved black CC filter index dial to the left or right to align its small, red index line (which appears within the open area containing the words "C.C. FILTER") with the needle-indicated Mired value. You will obtain either a minus (−) or plus (+) value, depending on whether the needle locks on the right or left halves of the Mired scale. While making these adjustments, be careful not to disturb the main-index setting, which gives you your LB filter reference.

4. A reading in the clear portion of the CC filter scale indicates that no CC filter is needed. If you obtain a reading from either the magenta or green scales immediately beneath the red CC index line, refer to the table on the back of the meter to determine the CC filter requirements. The green filter series is indicated by the letter "G," the magenta series, by the letter "M."

For desired results you will need to combine both the LB filter(s) and the CC filter(s). This will present some problem if you should find it necessary to use three or four filters. As this is optically undesirable, you might have to make some compromises or adjust your light sources accordingly. To minimize use of filters, be sure you are using the film most appropriate to the light source. You may find that another film will require fewer filters.

Before making each reading, whether for determining the adequacy of light intensity or for making B/R or G/R ratio readings, verify that the function-selector lever is in the correct position. Also, whenever you change films or light sources or both make sure that the proper dial adjustments have also been made.

The Minolta color meter may be used as an illuminance meter to tell you light levels for the scene. Turn the selector lever to the "I" position, point the incident receptor to the light source from the subject position, and press the reading button. Illuminance readings indicated by the needle can be read directly from the footcandle scale ("FT-C") or converted to EV (exposure value) guides through use of the table on the back of the meter.

If the needle indicator swings to the right and off the scale in the course of an illuminance reading, move the illumination range selector to "100×." For conversion to the appropriate EV guide at 100× sensitivity, add 6.6 to the EV numbers shown on the conversion chart, which is calibrated for 1× readings only. For example, the table will indicate "EV 7" for a needle reading of 29.7 footcandles, or 320 luces. When you add EV 6.6 to EV 7, you will obtain a total correct reading or EV number of 13.6

The foregoing guides should be used creatively by the photographer to achieve his desired results. The color meter is simply a tool, which necessarily has been designed for measurement and calibration in terms of hypothetical norms. The photographer might wish warmer or cooler results than those indicated by the meter. If so, the meter provides him with a base from which to depart as desired. The readings obtained with the meter also provide guidance in use of lighting sources and selection of color film types. As to the



Penetrating the fog in Manchester with a standard 58mm lens. High-speed films tend to be somewhat grainy. Used creatively, they lend atmosphere. Ilford HPS. Graham Finlayson.

latter, the photographer must also bear in mind that some color films are inherently cooler or warmer than others, thereby necessitating further creative decisions as to the kinds of filter compensations to be made, if any.

The Minolta color meter is a precision instrument, which must be handled with meticulous care. Do not touch the surface of the incident receptor. If it should become soiled, blow the dust from its surface using a rubber ball blower or other air-stream source and then gently wipe the surface with a soft cloth or tissue. Protect the meter from shock or vibration, high temperature, and humidity. When the meter is stored for a protracted period of time, it should ideally be returned to its original package and sealed in an airtight container that includes a small bag of silica gel or other drying agent. The mercury batteries should be removed from the meter when it is not to be used over a substantial period of time.

Black-and-White Films

Black-and-white films are sometimes referred to as monochromatic films in that they are of a single tonal range extending from white to black with shades of gray in between. Although photography began with black-and-white films, color films today are by far the more popular. Nevertheless, the black-and-white medium is the more challenging and will always remain so, because the photographer cannot lean upon the dramatic qualities of color alone to achieve tonal effects and pictorial interest. As indicated above, pictorial contrast can be controlled or modified more readily through exposure, development, and darkroom manipulation. Also, the gray-scale rendition of different colors in the spectrum can be modified through the use of color filters specifically designed for black-and-white film usage.

Black-and-white films come in a somewhat wider range of film speeds than do color films. In general, the film speeds of black-and-white films can be correlated with the properties of fine grain, film contrast, and acutance as described above. The slower black-and-white films tend to be more contrasty but also yield practically grainless results and smooth texture if properly exposed and developed. On the other hand, the popular high speed black-and-white films in the range of ASA 400 to 500 quite definitely show a grain structure, even though it is not objectionable; they also tend to be less contrasty. Then there are films of intermediate exposure indexes, which are usually compromises between the characteristics of the slowest and fastest of the general-use films. Certain specialty films are also available at both extremes of exposure sensitivity. High-contrast copying films are used mainly for the reproduction of print and line drawings rendered at the extremes of contrast to set off black against white. (Interestingly, these films, when exposed at their normal ratings, can be developed in monobath solutions—single developer-and-fixer solutions—to yield continuous tone images that are practically grainless.) At the other extreme, very fast films with exposure indexes of ASA 1,000 or higher are used for picture-taking under difficult or low-level lighting conditions. They tend to be of low contrast and are fairly grainy.

The low contrast of the films in the higher ranges of sensitivity leads them to be used for forced, or "pushed," development in order to achieve higher exposure indexes than those normally recommended by the film manufacturers. This technique is most successful when the subjects themselves are of low contrast. The apparent contrasty appearance of many pictures taken under existing-light conditions is not attributable to film characteristics but to the fact that under those conditions there

BLACK-AND-WHITE FILMS, STANDARD LOADS

Film		ASA Speed	
		Daylight	Tungsten
AGFA	Isopan FF	25	25
	Isopan F	100	100
	Isopan SS	200	200
	Agfapan	200	200
	Isopan Ultra	400	500
GAF	Versapan	125	125
	Super Hypan	500	500
	Professional Film, type 2681[1]	250	250
Ilford	Pan F	50	50
	FP 4	125	125
	HP 4	400	400
Kodak	Panatomic-X	32	32
	Plus-X Pan	125	125
	Tri-X Pan	400	400
	High Contrast Copy Film	—	64
	Infrared Film IR-135	Note[2]	20[3]

1 Available in Pro Packs of 25 36-exposure loads only from professional photo supply houses or from GAF sales offices.
2 With No. 25 filter 1/25 sec. f/8.
3 With No. 25 filter.

may be deep shadows when the subjects are illuminated by point light sources.

As a general rule, density and grain are determined in the first instance by the amount of exposure given the film. Contrast is controlled mainly through development with due regard to the inherent contrast characteristics of the film. As a secondary effect, development also governs density and grain.

Many photographers prefer to use black-and-white films at the ratings stated by the manufacturers. Some automatically rate their films higher by one-half to one-and-a-half *f*/stops and develop them accordingly. Some prefer this procedure with the films in the ASA 400–500 range. There are many different schools of thought about such matters. A further discussion of the rating-up of both color and black-and-white films will be found in the section on existing light photography.

Special purpose black-and-white films are available for creative or professional applications, such as direct positive black-and-white films, which can be developed directly for positive projection, infrared films, and special films for scientific purposes. With the exception of the last, the film loads are usually available in 20- and 36-exposure magazines. Bulk loads are available with many of the films for use either in loading one's own film magazines or for loading the special 250-exposure magazines available for use with the Minolta motorized cameras. Some motion picture films have name designations identical to those for films expressly intended for use in still cameras. Despite the similarity of name, emulsion characteristics may vary substantially. Also, the cine films do not have the same protective backing to minimize scratching that is provided for still camera films.

FILTER SELECTION GUIDE
Black-and-White Films

Color of Subject	Filter Selection	
	To Lighten	To Darken
BLUE	blue	red or orange
BLUE-GREEN	blue or green	red or orange
BROWN	orange or red	blue
GREEN	green or orange	red or blue
MAGENTA	red	green
ORANGE	yellow, orange, or red	light green or blue
PINK	red	green
PURPLE	blue	green
RED	red	blue or green
VIOLET	blue	red, green, orange, or yellow
YELLOW	yellow, green, orange, or red	blue

Filters for Black-and-White Film

Filters are used in black-and-white photography to alter the tonal qualities of colors reproduced in monochrome. In so doing, the photographer is usually concerned with altering the contrast properties of parts of the scene. The basic principle of the filter is that it holds back parts of the light spectrum while easing the transmission of that part of the spectrum that is its own color. A red filter, for example, would hold back the blue end of the spectrum, thereby causing a blue sky to come out darker because less of the blue skylight is allowed to reach the film. Red objects within this scene would come out lighter because the transmission of red light is not impaired. Hence, a red scarf on a woman would appear lighter, as would her lips. In like manner, a green filter would cause foliage to appear lighter while darkening objects reflecting the red end of the spectrum.

The main use of filters in black-and-white photography is in outdoor work, particularly in darkening the sky to bring out cloud formations. A gray sky would not be darkened by use of yellow, orange, or red filters because there is no blue to hold back. The yellow filter is used most frequently for darkening the sky because it brings about fewer changes in other tonal properties. The orange and red filters are used when exaggerated effects are desired or when greater contrast is needed in long range photography. The effects of haze or fog—"available murk"—may be accentuated with the use of a blue filter. This filter also helps accentuate the halo effect around automobile head lamps and street lamps.

Since filters hold back light, you have to give the subject a longer exposure or open up the lens aperture correspondingly. The matter of focusing and adjusting for exposure with filters was described earlier in this chapter.

The most commonly used black-and-white filters furnished by Minolta are described below. Other filters are available through camera dealers from independent sources of manufacture, but as already mentioned, one should be satisfied that the glass is optically flat and that it is mounted in a precision retaining ring for attachment to the lens.

Yellow. This filter darkens blue sky, thereby bringing out clouds and other light objects in better contrast against

FILTER RECOMMENDATIONS FOR BLACK-AND-WHITE FILMS IN DAYLIGHT

Subject	Effect Desired	Suggested Filter
Blue Sky	Natural	Yellow
	Darkened	Deep Yellow
	Spectacular	Red
	Almost black	Deep Red
	Night effect	Deep Red plus polarizing screen
Marine Scenes When Sky is Blue	Natural	Yellow
	Water dark	Deep Yellow
Sunsets	Natural	None or Yellow
	Increased brilliance	Deep Yellow or Red
Distant Landscapes	Addition of haze for atmospheric effects	Blue
	Very slight addition of haze	None
	Natural	Yellow
	Haze reduction	Deep Yellow
	Greater haze reduction	Red or Deep Red
Nearby Foliage	Natural	Yellow or Yellow-Green
	Light	Green
Outdoor Portraits Against Sky	Natural	Yellow-Green, Yellow, or polarizing screen
Flowers—Blossoms and Foliage	Natural	Yellow or Yellow-Green
Red, "Bronze," Orange, and Similar Colors	Lighter to show detail	Red
Dark Blue, Purple, and Similar Colors	Lighter to show detail	None or Blue
Foliage Plants	Lighter to show detail	Green
Architectural Stone, Wood, Fabrics, Sand, Snow, etc. When Sunlit and Under Blue Sky	Natural	Yellow
	Enhanced texture rendering	Deep Yellow or Red

the sky. It renders yellow, orange, and red objects lighter than as perceived by the eye. The filter factor is about 2×, but this assumes bright sunlight. Late in the day, with the increasing percentage of yellow, orange, and red in the light spectrum, the effect of the filter will be negligible.

Orange. The orange filter is similar to the yellow, but it gives more pronounced effects. It darkens green foliage and lightens autumn foliage. In portraiture it subdues freckles. It has a filter factor of 3× in daylight and 2× with tungsten light. The remarks made for the yellow filter pertain to late-day photography.

Red. The red filter is used in a manner similar to that for the orange filter but achieves more extreme contrasts. It is used particularly in black-and-white telephotography at great distances to enhance contrast that would otherwise be lost because of ultraviolet radiation (but not atmospheric pollution). It is not recommended for portraiture because it washes out lip and skin tones. The filter factor ranges from 4× to 6× depending upon the subject and the time of day, as discussed above.

Green. This is a compromise filter for outdoor portraiture when some darkening of sky is also desired. Green foliage is lightened, but lips and skin tones are rendered in good texture and tone, making this filter particularly suitable for portraits of men, although it can also be used for women. The filter is 3× in

daylight and 2× under tungsten lights subject to lighting conditions and film characteristics.

The UV, neutral density, and polarizing filters were discussed above. With black-and-white infrared photography a special infrared film is needed. Some interesting creative effects can be achieved with infrared film that give ordinary daylight scenes the effect of moonlight, darken skies, and lighten foliage. From a more technical standpoint, infrared films are used with dense infrared filters to detect invisible heat radiation or the reflection of infrared lighting directed toward the source and invisible to all except the camera. With ordinary panchromatic films and either deep red or infrared filters you can simulate moonlight late in the afternoon.

LIGHT, SHADE, AND PICTORIAL EFFECT

Here we are concerned with the qualities of light—texture, direction, and subject reflectance. These influence both pictorial rendition and the mechanical settings of the lens-and-camera exposure controls. Primarily we are concerned here with the qualities of daylight, although much of what will be said is applicable also to artificial lighting.

The general attributes or qualities of light now to be discussed are important in terms of the rendering of shadows, shadow details, surface texture, and tonal contrast. As already discussed, the last has much to do with the brilliance or flatness of a subject. Through selection and placement of lighting sources or choice of picture-taking time and camera position when using a fixed source such as sunlight, you can also enhance the feeling of depth. This topic was covered in the chapter on image management.

Lighting texture means the clarity of illumination as opposed to its diffuseness. If we consider good old-fashioned sunlight as an example, at one extreme we have the full, clean, uncontaminated sunlight that is still to be found in some parts of the world. On a very clear day, when there is a minimum of particulate matter in the lower atmosphere, the brilliant sun casts clearly delineated, but rather harsh shadows. In many respects it is one of the least attractive kinds of lighting because of the contrast problems it creates. At the other extreme you have cloudy, dull days when everything seems to be flat and without form or depth because there are no shadows. In between, you find degrees of brightness and softness, which depend upon what is in the air and sky to break up, soften, and diffuse the light. The softer the lighting texture, the less harsh will be the tonal contrasts, with the particular advantage that shadow areas are rendered more translucent with better depiction of details. Of course, color temperature is also affected by variations in daylight characteristics, but this topic has already been treated in this chapter. Ordinarily, one can expect indoor light sources to provide the utmost in clarity and brilliance because of the absence of cloud interference, haze, moisture, dust, and all the rest. Actually, the texturing of indoor lighting is deliberately accomplished through a variety of techniques, often simply to offset the disadvantages of unadulterated brilliance.

Lighting direction refers to the position of the light source relative to the subject and to the optical axis of the lens. For example, a flash unit mounted on top of the camera would be almost directly in line with the optical axis, causing only a narrow angle of diversion from that axis. The same pertains to a setting sun in line with the subject and the photographer and beaming its light rays directly into the eyes of the subject. Such frontal lighting has some advantages in that it cuts out or minimizes sha-



Camera held on window sill of hotel for this night shot with standard 58mm lens. Joseph D. Cooper.

London businessmen hurrying home at dusk. The moon was added in the darkroom. 58mm *f*/1.2 lens, 1/15 sec., *f*/2. *f*/1.8, Tri-X. Francisco Hidalgo.



dows when these are not desired, but it has disadvantages in that it tends to flatten the pictorial effect because of the absence of the tonal variations caused by shadows of varying depth. On the other hand, a high sun casts deep and clearly delineated shadows, introducing contrasty effects. Many photographers prefer to take outdoor pictures before or after the high noon in order to achieve more creative effects than are normally seen in the typical bright-sun snapshot. The important thing to remember about the position of the lighting source is that, along with lighting texture, it governs shadow formation, which is so important to the creation of tonal variations and the impression of depth.

Subject reflectance relates to the extent to which different colors, surfaces, and bright or dark characteristics of the subject cause it to reflect more or less light toward the camera. These attributes have significance for exposure measurement as well as for contrasts in tonal rendition.

Overall brightness in a scene needs to be compensated by somewhat more exposure than indicated by the meter, whereas overall darkness in the subject or scene needs to be compensated by somewhat less exposure than indicated by the meter. Hard, smooth, shiny surfaces tend to be more reflective than soft or matte surfaces; therefore, the former will create problems in the positioning of light sources and the camera or both to avoid objectionable reflections. Very bright surfaces may be difficult to record in their full color saturation on color film because they tend to be overexposed as compared with the darker areas when you try to make an overall compromise. In some measure this is a problem even with the CLC exposure-measuring system, which automatically makes compromises between bright and dark areas. The really difficult problem occurs when you have wide variations in reflectance between dark and light areas. The reflectance properties of the target subject are also influenced by environmental factors such as the bouncing of light from other surfaces or sources onto the subject apart from its reflectance of light from the main light source. A subject in the snow, on sand, or on the sea will have light bouncing upward to fill in shadow areas created by a higher, direct lighting source. The blue sky will tend to give a blue coloration to subjects, particularly on snowy ground or in the open shade. Vertical or standing objects, whether placed deliberately or accidentally, will bounce light onto the subject and alter its color properties, or fill in shadow areas, or both. Thus, a subject close to green foliage will pick up a green cast; a white-sided building will cast light reflections onto an adjacent subject; a reflector placed by a photographer can fill in shadow areas or balance main lighting sources as desired.

Characteristics of Daylight

Peak bright sunlight. The hours during which the sun is at its brightest vary with the season and geographic latitude, but in general they range from about 9:30 a.m. to 3:30 p.m. Shadows are sharply delineated and have a downward cast, perhaps at an angle to one side or the other depending upon the position of the sun, the subject, and the photographer. During this high-sun period wrinkles and skin blemishes are rendered more prominent, because they have sharp, black edges on their undersides. Hat brims will throw deep shadows across the face, which will obscure detail if exposure is made properly for skin tones. Landscapes at high noon do not show separation of objects from each other in depth because of the absence of shadow configurations.

Low-angle bright sun. For landscape purposes the sun at low angle, while still bright, is ideal, because it provides necessary object separation at a distance. This

is particularly important when using long focal length lenses since these lenses tend to magnify the general tendency toward flatness and loss of contrast when objects are photographed at a distance. The sun should, preferably, be casting side shadows. Profile portraits can be made quite satisfactorily with this lighting, but the subject should not be photographed facing the sun because it will cause him to squint. If the sun is off to the side of the subject and if a full-face portrait is to be made, one-half of the face will be brilliantly illuminated while the other half will be blocked out by deep shadows. The harsh contrast cannot be accommodated satisfactorily by film under these lighting conditions.

Bright hazy sun. This is due to a thin overcast, which may consist of clouds or the haze that surrounds most metropolitan areas. It is ideal for outdoor portraiture and other fairly close or medium distance objects. The diffusion of the light reduces contrast to manageable proportions, thus bringing out better shadow detail and texture. There are no pronounced, harsh, sharply delineated shadows; only a delicate deepening of shadow tones as they trail off around the sides of curved objects, particularly in portraiture. Bright, diffuse lighting outdoors is therefore best for portraits, particularly three-quarter angle pictures. In street scenes and in quaint market places, such lighting enables you to take pictures looking down the street or market place without having one side in extremely deep shadow and the other in extremely bright relief. Subtle details of texture are more easily brought out, for there is no problem of burning or overexposing the highlights or catchlights.

Cloudy, dull lighting. The best pictures to take on cloudy, dull days with heavily overcast skies are mood pictures that capture deep or somber effects. Pictorial depth is lacking because there are no shadows to set objects apart from each other. Pictures tend to be dull, flat, and monotonous. The only thing worse than this kind of lighting (or better if you are a specialist in taking pictures under difficult light conditions) is a dull, rainy day. For color photography you may wish to use a warming filter.

Open shade. Lighting in open shade is of mixed character; you have a combination of dull, flat lighting and a downward reflection from a bright sky. The only shadows are delicate and sometimes tend to darken vertically because of the reflection from above. The open shade is created by an object in the path of the sun—a building, tall trees, or single clouds. Whether or not a cloud cover of this type creates open shade or bright, hazy sunlight depends upon the density of the cloud. If it is extremely dense and if there is still a broad expanse of bright blue sky, you have the equivalent of open shade. Such lighting offers attractive picture-taking possibilities in portraiture, since the bright reflection from the open blue sky serves as a broad source of illumination, which does not yield harsh shadow contours. You may expect some highlighting of hair because of the downward direction of the skylight. With color films, you would need to use a warming filter to compensate for the bluish cast. This bluishness is most apparent when taking pictures for snow scenes in open shade.

Sunset and sunrise. With both the setting and the rising sun you are usually more interested in photographing the sky and cloud formations than the sun itself. The sun at an oblique angle, just above the horizon, creates a dramatic glow in the sky, which is made more interesting when just the right cloud formations are present. The contrast range from sky to ground is too great to yield much detail in the latter. If you wish to illuminate some close foreground objects, you should follow the suggestions for fill-in flash in the chapter on artificial lighting. Foreground objects such as trees or buildings can aid in composi-

tion: They become silhouetted against the sky or sun or both, and they also lend a feeling of depth. Water, snow, and ice can contribute directly to the composition, since they will reflect both the sky and the early lights that begin to appear at dusk. While you may find some dramatic sunrise effects, the clearer and cleaner air that is *usually* to be found in the early morning carries less particulate matter to reflect the rays of sunlight. The more interesting effects are to be found in the sunsets.

When taking your picture you must work rapidly, for the rising or setting sun moves away from or toward the horizon line at a pretty fast pace. When you observe a sunset, notice that from the time the sun begins to approach the horizon it reaches it and disappears within 15 minutes or less. Consequently, when using an exposure meter, you must recheck your readings and your camera settings. Since you are photographing at infinity, your best tactic is to standardize on a single shutter speed and make progressive exposures at different lens apertures. In order to achieve good color saturation you will tend to underexpose, although you might also wish to bracket your exposures for reasons of safety. Remember that tonal fidelity is not the most important thing, since you are dealing with deep tones of purple, red, and orange. Your exposure should be based on a reading of the total sky area embraced within the viewfinder. You need not worry too much about the sun itself if you are using normal or wide-angle lenses, but if you want to magnify its size using a lens of long focal length, take readings of the sun and do some bracketing as a safety measure. With a fast film you might have to use a neutral density filter during the early stages of a sunset.

Backlighting. Some of the most dramatic effects are achieved when the lighting source is in back of the subject and facing the camera. You must position yourself so that the subject obscures the light. Otherwise, you will get flare effects, which will fog the image. You might also get other optical projections onto the image, which, in some cases, can be interestingly creative.

The camera elevation will be governed by that of the sun. The higher the position of the sun, the lower must be the position of the camera. One interesting dramatic effect achieved when the sun is low is for the light to turn fluffy hair into a radiant halo-like effect.

If you expose for the subject—such as a face—you must get close to it to take a reading without the light of the sun entering the camera lens or striking the surface of an independent exposure meter. Some compromise might have to be made, for if you rely upon a reading for the face alone, the illuminated ground and surface areas might be grossly overexposed. Quite a satisfactory effect might be achieved through slight underexposure of the face in order not to burn out the details of the total pictorial setting.

Translucent objects, such as fabrics, flowers, boat sails, and so on also make excellent subjects for backlighting. They become strikingly luminous when the light source shines through them to the camera. This effect is particularly striking in color photography.

Window and porch lighting. The light entering a window is quite similar in characteristics and color content to that of open shade except for its directional qualities. If you take a picture close to the window or porch opening, you will have strong, directional lighting, which will cast deep shadows. The effects are typified by the full-face portrait in which the subject has one side of his face to the window, well illuminated, while the other side of the face is in a deep shadow. One solution is for the photographer to turn his back to the window and point the camera toward the subject inside. Another solution is for someone to

hold up a reflecting surface, which could be any of the items mentioned in the succeeding section, in order to bounce some of the window light back onto the shadow area of the face. Still another solution is to have the subject fairly close to one of the other walls, using it as a reflecting surface. An ideal time for this is mid-afternoon, when strong light enters a room and is bounced around inside.

Creative Use of Bright Daylight

You can do a great deal with strong sunlight through the use of reflectors. You can buy these or make your own. In the chapter on artificial lighting you will find descriptions of a variety of commercial and self-made reflectors whose properties vary according to surfacing, coloration, and texture. These fill-in lighting sources get rid of deep shadows, whether you are doing an outdoor portrait or taking a close-up of a flower. You can use one or more reflectors for the control of highlights and shadow effects. When taking pictures against the sun, one or more reflectors can be placed in front of the subject to bounce back upon it some of the sunlight. The reflectors ideally should have bright, diffuse surfacing.

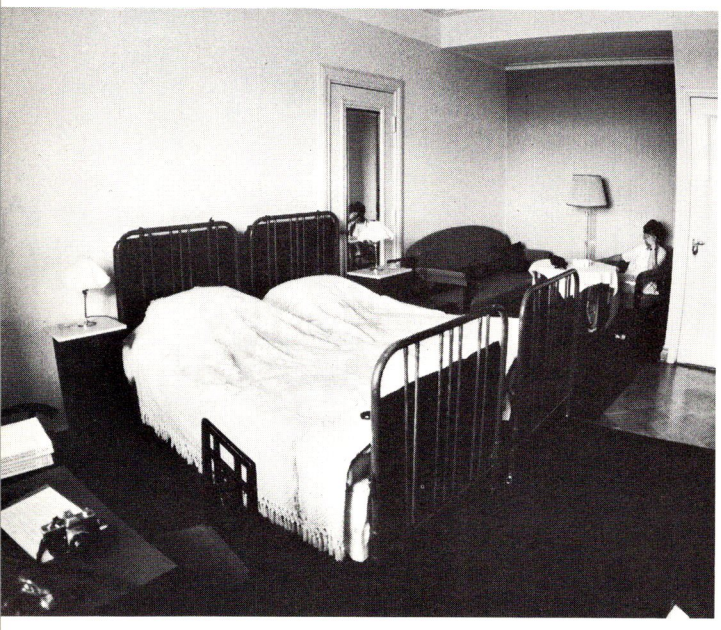
If you do not want to use the reflector technique, you can wait until the lighting changes to suit your requirements or you can come back later. You can also experiment by moving the subject around and changing your camera elevation until you find a more satisfactory lighting arrangement.



Exposure was for the ground. A sky reading would have given overexposure. No filter. 35mm lens, Ilford FP4. Richard Gee.



Example of directional effect of window lighting. 16mm lens used to record entire area of the room in a hotel in Helsinki.



EXISTING LIGHT TECHNIQUE

Existing light technique, also called *available light photography*, relates to picture-taking at low light levels using the light sources usually in place—the ordinary lighting of a room, office, factory, nightclub, theater, and so on. Mostly, existing light techniques are used indoors, but they also include picture-taking by the light of store windows, street lamps, and other artificial outdoor illumination.

Existing light pictures have recognizable characteristics, which enable one to say, "This is an existing (or available) light picture." Such pictures have a naturalness about them. Most pictures made with artificial lighting setups have a contrived look, characterized by con-

trolled backgrounds and shadows along with balanced lighting. Existing light pictures often have harsh shadows and contrasts, particularly when point-source lighting is present. When there are several sources, particularly fluorescent lighting, the illumination is more diffuse and less contrasty, but as with the point sources, the light seems to be falling down upon the subject so that it casts shadows in the eye sockets, under the nose, under the lips, and under the chin. You do not necessarily want good shadow detail if this takes away from the stark realism you might desire. You have unusual freedom of movement unless, because of special circumstances, you are confined to a particular picture-taking location.

In this section we will cover generally the applicable techniques including suitable optics, the films most suitable for this type of photography, and the often debated practice of "pushing" film speeds.

Equipment, Light Sources, and General Technique

Normal or standard lenses are used frequently in this type of photography, because they are made with the widest apertures, *f*/1.4 and *f*/1.2, thereby enabling you to use somewhat faster shutter speeds than would be the case with lenses of smaller apertures. It is sometimes possible, depending upon the in-



Old-time shop interior below, Stockholm's Scandia, made with 35mm *f*/1.8 full aperture at 1/15 sec., Ilford FP4. Above, in Paris, Ile de la Cité, proprietress photographed with 135mm lens, *f*/4, Tri-X. Joseph D. Cooper.



SUGGESTED EXPOSURES FOR KODAK FILMS

	Picture Subject	Kodachrome-X* Ektachrome-X Kodacolor-X	High Speed Ektachrome—Normal Processing Plus-X Pan	High-Speed Ektachrome—with ESP-1 Processing for 2½ times normal film speed Tri-X Pan	2475 Recording
AT HOME	Home Interiors at Night—Areas with bright light	1/15 sec f/2	1/30 sec f/2	1/30 sec f/2.8 ▲ f/4	1/60 sec f/4
	Areas with average light	1/4 sec f/2 ▲ f/2.8	1/8 sec f/2 ▲ f/2.8	1/30 sec f/2	1/30 sec f/2.8 ▲ f/4
	Candlelighted Close-ups	—	1/4 sec f/2 ▲ f/2.8	1/15 sec f/2	1/30 sec f/2 ▲ f/2.8
OUTDOORS AT NIGHT	Indoor and Outdoor Christmas Lighting at Night, Christmas Trees	1 sec f/4	1 sec f/5.6	1/30 sec f/2	1/30 sec f/2.8 ▲ f/4
	Brightly Lighted Downtown Street Scenes (Wet streets add interesting reflections.)	1/30 sec f/2	1/30 sec f/2.8	1/60 sec f/2.8 ▲ f/4	1/125 sec f/4
	Brightly Lighted Nightclub or Theatre Districts—Las Vegas or Times Square	1/30 sec f/2.8	1/30 sec f/4	1/60 sec f/4 ▲ f/5.6	1/125 sec f/5.6
	Neon Signs and Other Lighted Signs	1/30 sec f/4	1/60 sec f/4	1/125 sec f/4 ▲ f/5.6	1/125 sec f/8
	Store Windows	1/30 sec f/2.8	1/30 sec f/4	1/60 sec f/4 ▲ f/5.6	1/60 sec f/8
	Floodlighted Buildings, Fountains, Monuments	4 sec f/5.6	1 sec f/4	1/15 sec f/2	1/30 sec f/2 ▲ f/2.8
	Skyline—Distant view of lighted buildings at night	4 sec f/2.8	1 sec f/2	1 sec f/2.8 ▲ f/4	1 sec f/5.6
	Skyline—10 minutes after sunset	1/30 sec f/4	1/60 sec f/4	1/60 sec f/5.6 ▲ f/8	1/125 sec f/8
	Fairs, Amusement Parks	1/15 sec f/2	1/30 sec f/2	1/30 sec f/2.8 ▲ f/4	1/60 sec f/4
	Fireworks—Displays on the ground	1/30 sec f/2.8	1/30 sec f/4	1/60 sec f/4 ▲ f/5.6	1/60 sec f/8
	Fireworks—Aerial displays (Keep shutter open on "BULB" or "TIME" for several bursts.)	f/8	f/11	f/16 ▲ f/22	f/32
	Burning Buildings, Campfires, Bonfires	1/30 sec f/2.8	1/30 sec f/4	1/60 sec f/4 ▲ f/5.6	1/125 sec f/5.6
	Night Football, Baseball, Racetracks†	1/30 sec f/2.8	1/60 sec f/2.8	1/125 sec f/2.8 ▲ f/4	1/250 sec f/4

SUGGESTED EXPOSURES FOR KODAK FILMS

	Picture Subject	Kodachrome-X* Ektachrome-X Kodacolor-X	High Speed Ektachrome—Normal Processing Plus-X Pan	High-Speed Ektachrome—with ESP-1 Processing for 2½ times normal film speed Tri-X Pan	2475 Recording
INDOORS IN PUBLIC PLACES	Basketball, Hockey, Bowling	1/30 sec f/2	1/60 sec f/2	1/125 sec f/4 ▲ f/2.8	1/125 sec f/4
	Boxing, Wrestling	1/60 sec f/2	1/125 sec f/2	1/250 sec f/2 ▲ f/2.8	1/250 sec f/4
	Stage Shows— Average Bright	1/30 sec f/2 1/60 sec f/2.8	1/30 sec f/2.8 1/60 sec f/4	1/60 sec f/2.8 ▲ f/4 1/125 sec f/4 ▲ f/5.6	1/60 sec f/5.6 1/250 sec f/5.6
	Circuses Floodlighted acts Spotlighted acts (carbon-arc)	1/30 sec f/2 1/60 sec f/2.8	1/30 sec f/2.8 1/60 sec f/4	1/60 sec f/2.8 ▲ f/4 1/125 sec f/4 ▲ f/5.6	1/125 sec f/4 1/250 sec f/5.6
	Ice Shows— Floodlighted acts Spotlighted acts (carbon-arc)	1/30 sec f/2.8 1/60 sec f/2.8	1/60 sec f/2.8 1/60 sec f/4	1/125 sec f/2.8 ▲ f/4 1/125 sec f/4 ▲ f/5.6	1/250 sec f/4 1/250 sec f/5.6
	Interiors with Bright Fluorescent Light	1/30 sec f/2 ▲ f/2.8	1/30 sec f/2.8 ▲ f/4	1/60 sec f/4	1/125 sec f/4 ▲ f/5.6
	School—Stage and auditorium	—	1/15 sec f/2	1/30 sec f/2 ▲ f/2.8	1/30 sec f/4
	Swimming Pool— Artificial light indoors (above water)	1/15 sec f/2	1/30 sec f/2	1/60 sec f/2 ▲ f/2.8	1/60 sec f/4
	Churches—Artificial light	1 sec f/5.6	1/15 sec f/2	1/30 sec f/2 ▲ f/2.8	1/30 sec f/4
	Stained-Glass Windows, Daytime—Photographed from inside	Use 3 stops more exposure than for the outdoor lighting conditions.			
	Glassware in Windows, Daytime—Photographed from inside	Use 1 stop more exposure than for the outdoor lighting conditions.			

For color pictures of these scenes, use tungsten film for the most natural color rendition. You can also use daylight color film for these scenes, but your pictures will look yellow-red.

For color pictures of these scenes, use daylight film. You can also use tungsten film with a No. 85B filter over your camera lens. When you use this filter, give 1 stop more exposure than that recommended for daylight film in the table.

For color pictures of these scenes, you can use either daylight or tungsten film. Daylight film will produce colors with a warmer, more yellowish look. Tungsten film produces colors with a colder, more bluish appearance.

*You can take pictures on KODACHROME II Film, Daylight Type (ASA 25), by using approximately 1 stop more exposure than recommended for KODACHROME-X Film.

†When the lighting at these events is provided by mercury-vapor lamps, you'll get better results by using daylight film.

NOTE: The symbol ▲ indicates the lens opening halfway between the two *f*-numbers.
Use a tripod or other firm support for shutter speeds slower than 1/30 second.

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The three top pictures were made by window light, with a reflector filling in the side of the girl's face. The man above stood beside the window for full illumination on the face. Below, the picture at left was taken by diffuse porch light, which gave soft shadows and skin texture. Right, indoor shot by overhead lighting cast shadows downward. Standard lens. Joseph D. Cooper.





tensity of the existing light, the amount of subject movement, and the availability of camera supports, to get satisfactory results with lenses whose maximum apertures are $f/2.8$ and $f/2$. The wider apertures are to be preferred, also, because they make it easier to focus on what often are indistinct forms.

With careful exposure measurement, you should get properly exposed films, but prudence dictates some exposure bracketing—both more and less exposure than indicated by the meter—especially when there is a wide range of light intensity, highlights, and shadow areas. The bracketing technique is just so much insurance, for it enables you to see on film different effects, particularly in the areas of shadow detail.

Fill-in lighting techniques are frequently used, but one must avoid taking away from the inherent existing-light impression. You can use some fill-in flash and some reflectors to lighten up shadow areas. This is legitimate because, when the actual scene is viewed, the eyes selectively amplify shadow detail.

You should determine exposure by measurement in advance from a variety of positions in order to familiarize yourself with working ranges and flexibilities. In situations where you have to work fast and make quick choices of different lenses, you will know what you can and cannot do beforehand so as not to lose time at the inescapable moment when the picture must be taken or lost forever. When there are point sources, you can localize the area of best illumination, for you will find a rapid falloff in lighting intensity. You will find that in familiar, well-lit places there may usually be no more than a two-stop range in lighting intensity, which you can determine beforehand. Knowing the lighting conditions, you can preset aperture or shutter-speed settings so as to simplify the making of final adjustments at the moment of picture-taking.

When shooting pictures outdoors by artificial lighting, you might find individual point sources such as street lamps, light reflected from store windows, and the total illumination provided by the many different lights existing in a concentrated shopping district. The point sources will usually be fairly high and will cast shadows downward. The higher the light, the more uniform will be the distribution of illumination over the subject. If the subject is fairly close to a point source above it, there will be a rapid falloff in illumination: The lower parts will appear much darker, without shadow detail.

If you are taking pictures inside a store window with color film it should be of the tungsten type; bear in mind, however, that because of the variety of color sources used by display designers, you are not likely to get true color balance. What you are after, however, is a pleasing general effect. When taking pictures of subjects next to store windows or subjects illuminated by the total complex of lighting in a shopping street, you are likely to run into the same problem of color balance, because you have reflections of every imaginable color of neon lighting, fluorescent lighting, and tungsten lighting. Of course, with black-and-white films you do not have any of these problems. The lighting from a single store window is highly directional and presents problems similar to those discussed above under the topic of window and porch lighting. You do not, however, have the same flexibility of solution. In an open street where light strikes the subject from many different angles, you should get fairly good results with a reasonably fast lens, largely because of the filling-in of shadow details from the different angles. During the winter, with snow on the ground, you have additional fill-in reflector lighting, which helps to amplify all of the existing light sources.

Films for Existing-Light Photography

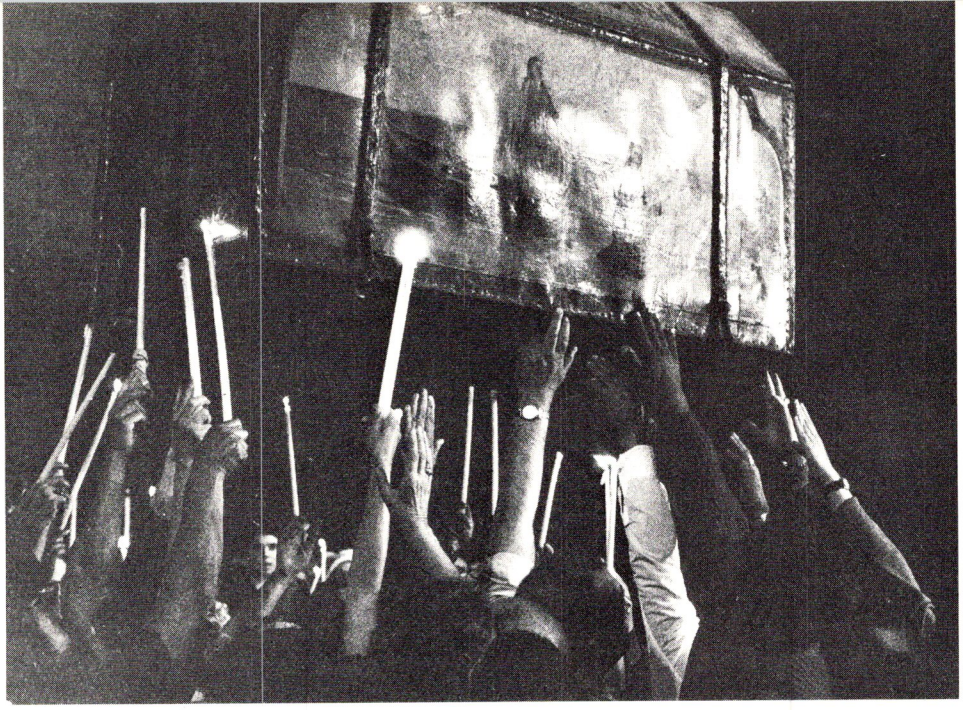
Usually, existing-light photography implies low light levels, informality in shooting arrangements (no tripods, and so on) and fairly high speed films to enable you to make hand-held exposures. Hence, in the black-and-white area, we usually think of films whose exposure indexes are in the range of ASA 400 to 500, although some special films are available with higher speeds. We also think of the possibilities of squeezing more sensitivity out of these films by appropriate exposure and development techniques, so that a normal rating of ASA 400 might be pushed to ASA 650, 800, 1200, 1600, or even 3200. All of this is possible, but there are usually some trade-offs in quality of performance. With color films, an existing-light favorite of photographers is Kodak High Speed Ektachrome, which in its daylight form has a normal exposure index of ASA 160 and in its tungsten form has an exposure rating of ASA 125. Both films can be pushed—the daylight version usually to ASA 400 and the tungsten version to ASA 320, as will be explained below. There are also faster color films, which you can use without pushing, such as GAF Anscochrome 200 or 500.

Actually, almost any film can be used for existing-light photography, provided you have enough light or can use camera supports that enable you to make long exposures. We will not go into these here, however, for they are not typical aspects of existing-light photography.

The key element that governs how much you can push film speeds is the contrast of the scene. This is governed partly by the dark-to-light ratio of the scene and partly by the lighting contrast itself: One can accentuate or moderate the other. The ideal condition for existing-light photography, when you are going to push film speeds, is the low-contrast scene, characterized by a short range of tones or brightness. The scene might consist mainly of middle tones, low tones, or high tones, but if you should have a long contrast range, it is difficult for the film to accommodate both the highlights and shadow details. If you expose for the shadow details, you tend to burn out the highlights and if you expose for the latter, you will have blackness where you should have detail. One of the results of push-processing is that it tends to build up contrast. Hence, if you start with a contrasty scene and push it even more, you will get unsatisfactory results unless you intentionally aim to achieve high contrast. On the other hand, if you start with a scene of low contrast, push-processing might actually improve the tonal qualities, although you will get some offsets in the form of slightly coarser grain. When working with black-and-white films, you can expose at a film speed one-half or one stop higher than normal without pushing through forced development. You will get a slightly thinner negative, but most of the tonal values will be retained, because black-and-white films have somewhat greater exposure latitude than do color films. This technique cannot be used with the color films.

One advantage of the black-and-white films in the ASA 400 group (a fairly standard exposure index used by different manufacturers) is that these films are inherently less contrasty than slower films. Sometimes films in the range of ASA 125 to 160 are used about one-half stop higher, but usually they are not well suited to contrasty subjects.

Developers are not, in the main, aids to better exposure or to higher exposure indexes. If you do not have shadow details, no developer in the world will bring them out, regardless of the amount of pushing. The standard advice is to follow the instructions of the film manufacturer, which usually pertains to developers made by the same manufac-



Gypsies illuminated by candlelight. Standard lens, Plus-X. Lucien Clergue.

The catacombs, Paris. Illumination by single light. 21mm *f*/4 lens, full aperture, 1/4 sec. hand-held, Tri-X. Francisco Hidalgo.



Above, note the downward drift of the diffuse commercial lighting. Taken at London's Heathrow Airport due to delay of our Pan Am 747. As can be seen, others were delayed too. Fisheye 16mm, f/5.6, 1/60 sec. Ilford FP4. Joseph D. Cooper. Below, a school volunteer shares her dancing skill with children in west side New York school. 100mm lens, Tri-X rated ASA 800. Suzanne Szasz.



turer. On the whole, the advice is good. Some independent developers are available and are claimed to have specific advantages in forced development for the achievement of higher exposure ratings. To the extent that they work, their achievement lies in an ability to work up shadow details without blocking highlights. The official Kodak recommendation regarding Tri-X Pan film is that its film speed of ASA 400 can be multiplied 4× (or two stops) for short scale or low contrast scenes; this would give an exposure index of ASA 1600. Scenes of medium tonal range or contrast can be exposed at 2.5× the standard rating, yielding a forced rating of ASA 1200. This is the equivalent of one-and-a-half stops less than normal. For long scale or high contrast scenes, the recommendation is not to increase more than 2×, or ASA 800. Anything higher, notwithstanding the developing techniques, would build up contrast without increasing shadow detail.

If you have your black-and-white films

developed commercially, you should send them only to custom photo finishers; these are laboratories that specialize in doing work for professionals and demanding amateurs. The ordinary developing and printing you can obtain from a camera shop or a drugstore will not be satisfactory, because it is standardized processing. You must tell the custom finisher the numerical exposure rating you used. Bear in mind that you must shoot the entire roll of film at the same exposure rating. The custom finisher will then adjust developing times accordingly. With some finishers you can even indicate which developer you wish them to use. Thus, with the interesting Ilford FP4, the recommended ASA rating is 160 with standard developers, but when processed in Ilford Microphen, the manufacturer recommends a rating of ASA 200. Similarly, with Ilford HP4, the standard rating is ASA 400, but with Microphen processing the recommended exposure index is ASA 650. In each case, there is only one-half stop difference, but this often is enough to give the little edge of latitude you might desire.

With forced development at the higher exposure indexes, particularly beyond ASA 1200 for films that normally have ratings of ASA 400, you will see more grain. You might not consider this objectionable if your scenes demand a typical existing-light appearance—a certain stark quality. Some photographers like to achieve special grain-textured effects by using some of the very fast films and pushing their exposures even higher. Kodak has some interesting films that are designated as 2475, 2484, and 2485. These have Estar bases, which are thinner than standard film bases, so that you can get as many as 50 exposures into a standard film magazine. The 2475 Recording Film is available in standard film magazines but only in 36-exposure lengths. You must be aware, however, that the standard developing reel will not accommodate lengths beyond 36 exposures. You would have to use special developing reels suitable for longer film lengths such as might be used with the 250-exposure back of the Minolta SR-M. Ordinarily the 2475 film may be exposed at ASA 1600, but if developed eight minutes in DK-50 at full strength at a temperature of 68° F., an exposure index of ASA 3200 may be used. For the 2484 film, available in bulk, an exposure index of ASA 2000 may be used when the film is developed in D-76 at full strength for 15 minutes at 68° F. The very grainy 2485 film may be used at unusually high speeds. An exposure index of ASA 5000 may be used with the film developed for 12 minutes in developer D-19 used full strength at a temperature of 75° F.

Agfapan 1000, available in many countries but not ordinarily in the United States, produces a slightly coarser grain than do the films in the ASA 400 to 500 group. I think it makes sense to use this film at a one-stop increase—ASA 2000—in order to have a worthwhile jump beyond what you can do with one of the standard films in the ASA 400 group. A recommended developer would be Atomal for 20 minutes at 68° F.

The color film situation is a little different. Some photographers who use both black-and-white and color films standardize on an exposure index of ASA 400 for both in order to avoid confusion when changing from one to the other. They shoot with a black-and-white film at its normal rating of ASA 400 and then increase Kodak High Speed Ektachrome from its standard index of ASA 160 to 400. This is an increase of 2 1/2× the normal exposure index or an increase of 1 1/3 stops over normal. To obtain this service from Kodak you must purchase from your dealer a Kodak Special Processing Envelope, ESP-1, which you must take or mail to the Kodak laboratory nearest you together with the appropriate Kodak Prepaid Processing Mailer. The same service is available for High Speed Ektachrome Type B, but the

PROCESS E-4 ADJUSTMENTS FOR DIFFERENT SPEEDS

Camera Exposure	Effective Exposure Index Desired		First Developer Time (Approx.)
	High Speed EKTACHROME Daylight Type	High Speed EKTACHROME Type B	
2 Stops Under	640	500	Increase by 75%
1⅓ Stops Under	400	320	Increase by 50%
1 Stop Under	320	250	Increase by 35%
NORMAL	160	125	Use normal time*
1 Stop Over	80	64	Decrease by 30%
2 Stops Over†	40	32	Decrease by 50%

* See process instruction sheet.
† Color variation from normal will be significant. Recommended only for exposure-error compensation.



The contrasts between brilliant sunlight streaming in windows are almost impossible to reconcile with the more diffuse interior distribution of light. Market in Haiti. 35mm. Tri-X. Joseph D. Cooper.

attained higher rating is ASA 320. For those who do their own color film developing, the accompanying table shows the *increase* and *decrease* in first developer time for increased speeds, as well as for underexposure, which is usually the result of exposure error.

Photographers who do their own developing have much more latitude for adjustment for special effects. Some individual custom laboratories will provide special developing services. In Washington, D. C., for example, Image will develop High Speed Ektachrome Tungsten at pushed film speed ratings of ASA 650, 800, and 1200. Best results are claimed for the ASA 650 rating; a very slight pink staining is observable when the film is pushed to ASA 1200 from its original base of ASA 125. This might be an advantage if you are taking pictures that might otherwise appear a little bluish or dull. At these higher ratings, some photographers may prefer to use High Speed Ektachrome Tungsten both indoors without a filter and outdoors with a Wratten Filter No. 85B. When using this conversion filter, you must remember to decrease the exposure index by approximately one-third in daylight. Hence, the film speeds of ASA 650, 800, and 1200 would be changed to ASA 440, 540, and 800, respectively, provided you are not using the built-in through-the-lens exposure-measuring system.

THE MEASUREMENT OF LIGHT

Making an exposure on film is making a compromise of some kind, unless you are photographing a subject made up entirely of middle tones. One governing factor is that the shutter action uniformly registers on film the light pro-

jected through the lens without being able to make any selective adjustments for either excessive or insufficient light. This problem has already been discussed. When using a reflected-light exposure meter, whether the one built into your Minolta SR camera or an independent exposure meter, you must remember that it has been pre-programmed to "read" the brilliance level of the scene as though light were being reflected from an 18 per cent gray reflectance card, which is a standard substitute for middle tone values. If the subject has only middle tones, you will get a correct reading, but if the subject is predominantly light or predominantly dark, you must make an adjustment because the meter will give you a reading that, if used in setting the exposure controls, will result in a middle-tone rendition. As explained earlier, for the great majority of photographic subjects you need not worry about this problem, for you will be dealing with subjects that tend to fall within the average range. It is for the special situation that you need to understand some of the finer points of creative use of exposure meters.

Some of the discussion that follows is applicable to the CLC exposure-measuring system; however, because the operation of the CLC system was described in Chapter 2, the material that follows will deal mainly with the use of independent exposure meters. These fall into two categories: reflected-light meters and incident-light meters. A reflected-light meter reads total scene brightness within its area of view or angle of coverage. Most exposure readings are made with this type of meter, whether built into the camera or independent. An incident-light meter measures the light sources themselves from the subject position. In addition to the coverage of these meters in general, instructions are included for the use of the Minolta Auto Spot 1° meter and the Minolta Autometer Professional, also referred to as the Minolta Prometer. While each type of Minolta meter is discussed in the relevant part of this book, you should note that the Minolta color meter can be used for incident-light readings, the Minolta Autometer Professional can be used for reflected-light readings, even though it is primarily an incident-light meter, and the Minolta flash meter, discussed in the next chapter, can also be used as either an incident- or reflected-light meter.

Reflected-Light Readings

Reflected-light meters are used most advantageously in outdoor photography, although incident-light meters can also be used outdoors. It is a matter of which is more advantageously and simply used. A reflected-light meter integrates all of the measurement of light reflected from subjects within the angle of acceptance of the meter (the angle of coverage). With the built-in exposure meter of the camera itself this angle is automatically determined by the angle of coverage of the lens and what it projects into the camera. A general-purpose exposure meter usually has an angle of acceptance corresponding approximately to that of a normal lens, although some meters might have a slightly wider coverage. The tendency has been for meters to have more selective coverage through a narrower angle of acceptance to permit the photographer to make more selective readings of the principal parts of scenes.

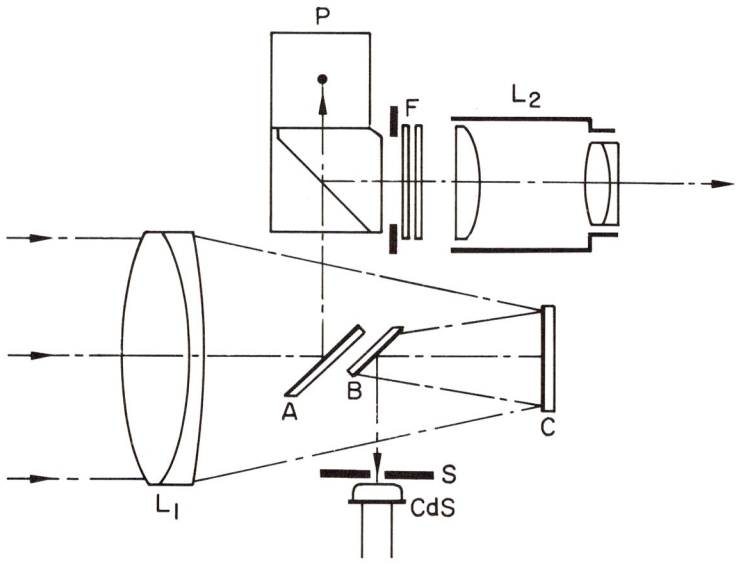
When using a general-purpose exposure meter, you can get adequate results when taking readings from the shooting position, provided the light and dark areas balance each other off. You are not likely to get correct readings if your principal subject is disproportionately small in area compared with the rest of the scene, which might be either very much darker or very much lighter. Thus, if a portrait subject is standing against a very dark background, the general-purpose

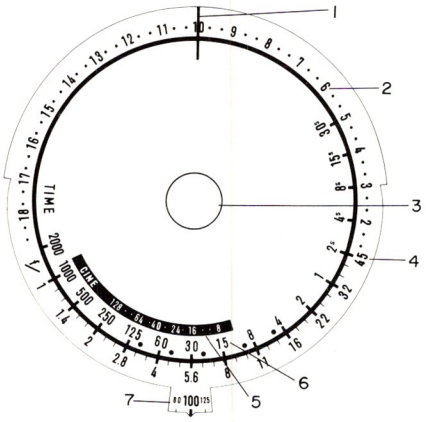
meter will tend to indicate more exposure than is needed for the face because of the predominance of dark, which the meter is unable to distinguish from a low light level. Similarly, if the portrait subject is standing in front of a very bright background, the meter reading will indicate less exposure than the subject should receive due to the predominance of brightness and the tendency of the meter to equate that with middle-gray tones. To make selective readings in such cases, you would need to get fairly close to the subject in order to exclude the extraneous reflected light. This also pertains to the use of the built-in CLC exposure-measuring system.

Another common situation is that in which the sky predominates, which influences the meter to indicate shorter exposures and therefore to cause underexposure of ground objects. The usual advice is to tilt the exposure meter downward to minimize the effect of sky illumination, but this is not necessary with the CLC metering system because compensation is built in. Another situation in which you will want to take close readings either with a general exposure meter or the CLC metering system is when the subject is backlit and you wish to get a shielded reading of the subject without getting a reading of the light source itself. Additional suggestions on creative use of exposure meters will be covered below.

Narrow-angle exposure meters have angles of acceptance that are less than the coverage of standard lenses. They are more selective, enabling you to take measurements of the principal areas of the scene that are relevant for your purpose. When used with the reflected-light attachment, the Minolta Autometer Professional has an angle of acceptance of 10°, which is somewhat narrower than the diagonal angle of coverage of one of the 200mm Rokkor lenses. Even within

Optical system of Minolta Auto Spot 1°. Light reflected from object enters through lens L_1. Twenty per cent of light is reflected on total reflection mirror A and becomes an erect image through the Porro Prism *P*. Then image appears on scale glass *F* and reaches *I* through eyepiece L_2. Size of mirror A enables all light for viewfinder to reach eye and therefore image appears bright. Seventy-five per cent of light passing through lens L_1 hits reflection lens *C* and mirror *B*; it is focused on (1°) opening of slit *S* and reaches CdS cell. As scale glass *F* and split *S* are optically conjugated, light focusing on viewfinder screen is same as that on slit *S*.





Illuminated interior scale of the meter.
1. EV pointer
2. Luminance guide number
3. Measuring area (1)
4. *f*/number
5. Frame speed
6. Shutter speed
7. ASA number

this narrower angle of meter acceptance you will still encounter differences in scene contrast, which you must interpret according to the results you wish to achieve.

A spot meter typically has an angle of acceptance ranging from 1° to 3° according to the specifications of the particular meter. With so narrow an angle of coverage, the meter enables you to take measurements of very small portions of the overall scene, which will provide you with the contrast range of significant exposure areas. The Minolta Auto Spot 1° has an angle of acceptance of 1°, corresponding to about two-fifths of the angle of coverage of the 800mm Rokkor lens and about one-half the coverage of the 1000mm Rokkor lens.

The Minolta spot meter has a measuring range of EV 3 to 17 with ASA 100 film. It has a total angle of view of 8°, within which a central circle shows the 1° angle of acceptance. The optical system of the meter provides a 4× image magnification. The optics of the meter can be focused from one meter (3.3 feet) to infinity. Focusing is very important because at the closer ranges the relative size of a small object may appear greater if it is out of focus and may therefore lead to false readings. The eyepiece has a dioptric adjustment of −5.2 to +1.7. A built-in illuminating lamp enables you to see clearly all relevant information on the computer dial inside the meter.

The ASA range of the meter is from 3 to 25,000; the *f*/stop range is from 1 to 45; and the shutter-speed range is from 1/2000 to 30 sec. (For motion picture work the meter will give readings ranging from 8 to 128 frames per second for a shutter-opening angle of 180° for 16mm cine cameras.)

One of the most striking and useful features of the Minolta spot meter is its automatic operation through the use of a built-in servomechanism. To operate the meter, first set the film speed and then focus on the target subject or tonal area. When you press the main switch button, the exposure scale will rotate automatically, coming to a stop when the correct exposure is indicated. You can then select a combination of shutter speed and lens aperture for proper exposure of the selected area. When you release the main switch button, the exposure scale automatically locks in place so that you can refer back to it at your convenience.

The sensitivity of the meter and its automatic response to the slightest shifts in subject luminance can be appreciated



Parts identification for Minolta Auto Spot 1°.

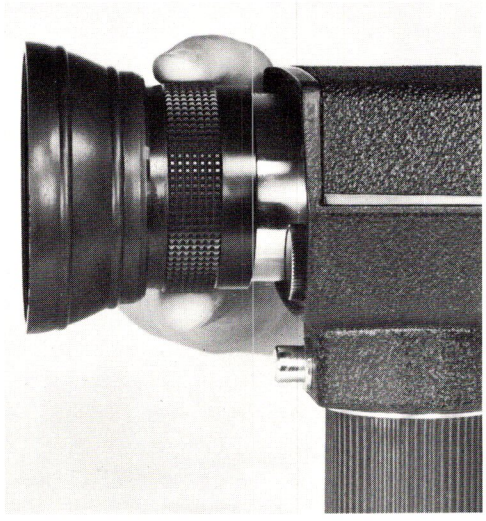
1. ASA setting knob
2. Main switch
3. Checker lamp
4. Battery check button
5. Grip (battery chamber)
6. Hood
7. Lens barrel
8. ASA/DIN scale (battery cover)
9. Eyepiece



Turn the eyepiece of the viewfinder until you can perceive the interior scales sharply.



Looking through the viewfinder, turn the ASA knob until desired ASA number shows at the bottom of the interior scale. For converting DIN and ASA notations, refer to the table at the bottom of the hand grip.



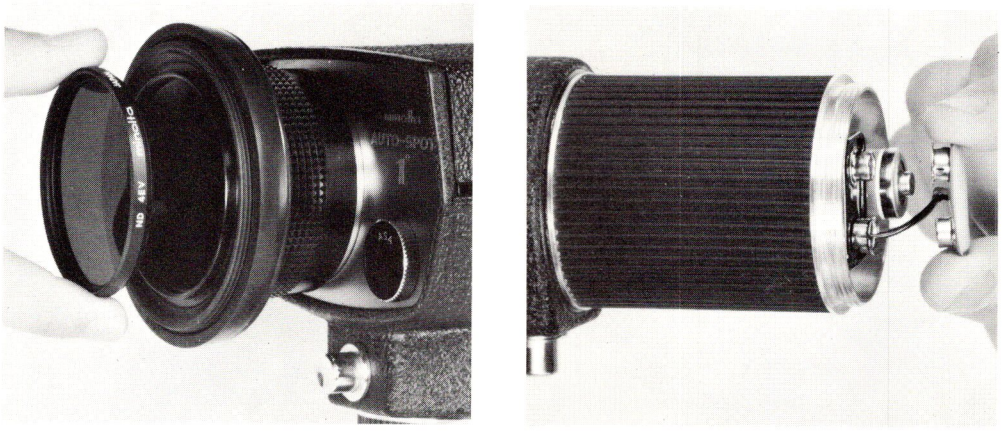
To take an exposure reading, aim at subject and turn the lens barrel until the subject appears sharp within the circle at the center of the viewfinder. CAUTION: Do not view the sun through the meter, for doing so can burn up the sensitive mechanism.



When ready to take a reading, press the main switch button; the illumination lamp will light up and the exposure scale will move to a point corresponding to the luminance of the subject. The scale will remain stationary after you remove your finger from the button. The scale will give you the combination of *f*/number and shutter speed or the luminance guide number.

only as you look through the viewfinder. If the slightest shadow falls upon the target area you will both hear and see the exposure scale changing position.

The two main kinds of information you will want to take from the meter are the brightness or contrast range and the exposure setting to use for a particular scene. The brightness range for the significant reflectance areas or spots can be ascertained by observing the range of *f*/stops for a given shutter speed or by taking readings of the luminance guide numbers in the upper half of the nonmoveable scale. The moveable dial in-



Left, with the ND filter for EV (16X), you can measure the luminance up to BV 16 (equivalent EV 21 for ASA 100 film). Four-step correction is needed for reading the scale. Right, check battery power occasionally. The lamp above the check button will light up if power is adequate. Otherwise, replace the 9v battery. If the illumination is weak, replace the 1.5v battery. To replace the batteries, unscrew the bottom of the hand grip.

side the meter contains the range of shutter-speed times, which align themselves against *f*/stops; there is also an EV pointer which aligns itself against the luminance or EV guide numbers. Each of the latter is equivalent to one *f*/stop difference in light reflectance.

The selectivity of the Minolta spot meter makes it particularly useful in close-up photography, in backlighting measurement, and in telephotography when using a camera model that does not have built-in exposure measurement. Even with the latter feature, regardless of the focal length of lens used, the spot meter will be found helpful in precise measurement of contrast ranges.

Skillful use of the spot meter lies in knowing what areas to average for a correct exposure. At its simplest, within a contrast range that your film can accommodate, you find the lightest and darkest important areas and then find an intermediate or average exposure reading. This might have to be biased in one direction or the other, according to the relative amounts of brightness and darkness being measured. To give emphasis to darker areas, you would find an average between the mid-point and the dark areas; to emphasize lighter areas, you would average the mid-readings and the light-area readings.

Some additional technical points might be noted. The collapsible rubber lenshood on the meter is intended to eliminate or minimize the effects of incident or extraneous light, which might otherwise introduce flare into the optical system. The base of the handgrip can be unscrewed and replaced with a base that has a tripod socket. This base cover is removed when you need to replace batteries. One of the batteries is a 1.5v AA-size and serves only to illuminate the viewfinder. This battery will fall out readily into the palm of your hand. The 9v battery is for exposure measurement. It is the Mallory M-1604 or the equivalent, typical of batteries used in transistor radios. This battery must be removed from its snap retainer for replacement. The unique circuitry of the meter affords stable light-measuring performance in spite of voltage variations from 6 to 9v. The battery check lamp will not light up when the voltage falls below 6v. To check the condition of the battery, simultaneously depress the main switch and the battery-checking button, which is to

the right of the viewfinder. If the lamp lights up brightly, you have adequate voltage for measurement. If it does not light up, you must replace the battery. The total life of the 9v battery is about 100 minutes when the meter is used intermittently. If used frequently within a short span of time, it will have a shorter life. The meter will tolerate a wide range of temperature conditions; it will perform satisfactorily over a Celsius (Centigrade) range of $+45°$ to $-10°$.

If the EV pointer moves beyond the measuring range on the high luminance side, you can obtain a reading by screwing in an accessory neutral density filter (ND 16X) in front of the meter optics. You can take measurements up to EV

The backlighting and selective focus created a fairyland effect. 100mm lens. Suzanne Szasz.



21 based on use of film rated at ASA 100. When using this method, you must stop down the lens four *f*/stops beyond that indicated in the meter or make an equivalent adjustment in shutter speed or both.

Incident-Light Readings

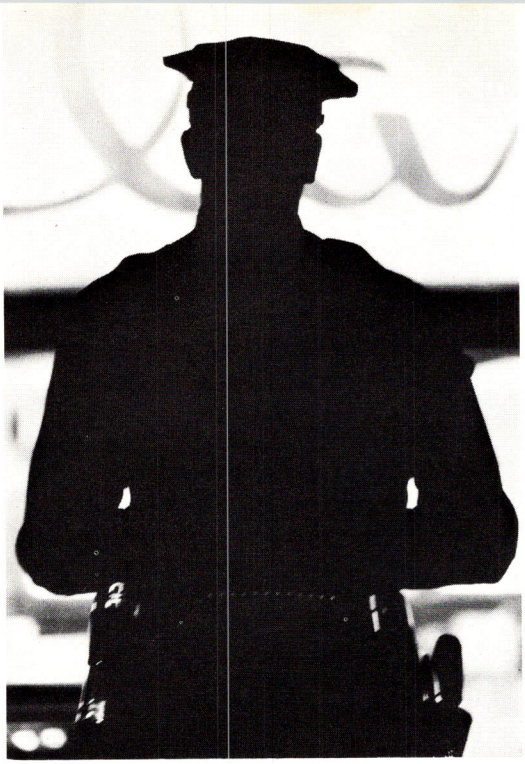
Incident light is that which falls upon the subject. When you use an incident-light meter, you take a reading of the brightness of the light illuminating the subject from the position of the subject with the meter pointed toward the camera. The main advantage of this method of exposure measurement is that the meter is not influenced by differences in reflectance from dark or light objects. Hence, if you wish consistency of flesh tones, whether under studio conditions or outdoors, you can be assured of achieving this regardless of the brightness or darkness of other objects within the range of the meter. The same holds true for other types of object photography. For this reason, incident-light meters found early favor in motion picture photography because they assured uniformity of tonal rendition of the main subject under studio conditions, regardless of changes in background. As in the case of reflected-light meters, the incident-light meter assumes, through its internal programming, that the light is illuminating a scene of average reflectance properties. Hence, with this type of meter, too, it is necessary to make compromises.

Most commonly, as in the case of the Minolta Autometer Professional, which is primarily an incident-light meter, a 180° sphere is used as the light collector in front of the meter cell in order to pick up all incident light falling on the subject from all frontal directions. The sphere may be replaced by a flat disk for measuring the effects of specific lighting sources in order to obtain contrast ratios from the brightest to the least bright source as measured from the subject position.

If a scene has average reflectance, you should get the same reading with an incident-light meter as with a reflected-light meter. Also, if you were to take a reflected-light reading from an 18 per cent gray reflectance card held at the position of the camera in line with its optical axis, the result should be the same as with an incident-light reading taken from the position of the subject pointed toward the camera. When you are working outdoors and the light falling on the subject is the same as that falling on the camera, you can take a reading from the camera position, provided the incident-light meter is directed along the axis.

An advantage of the incident-light meter is that once you have taken your reading you can rely upon that for all subsequent picture-taking of the same scene or of scenes of similar reflectance qualities, subject only to the requirement that you make adjustments if you should change your angle of picture-taking or if the subject should turn and reveal different patterns of light and shade. When taking pictures of sidelit subjects, you may wish to emphasize either the bright or the shadow areas of the subject. To emphasize the shadow areas, turn the light receptor so that it faces midway between the lighting axis (line of direction from subject to camera and beyond) and the darker area of lighting source. To emphasize the brighter side of the subject, turn the light receptor so that it picks up more of the main source of illumination.

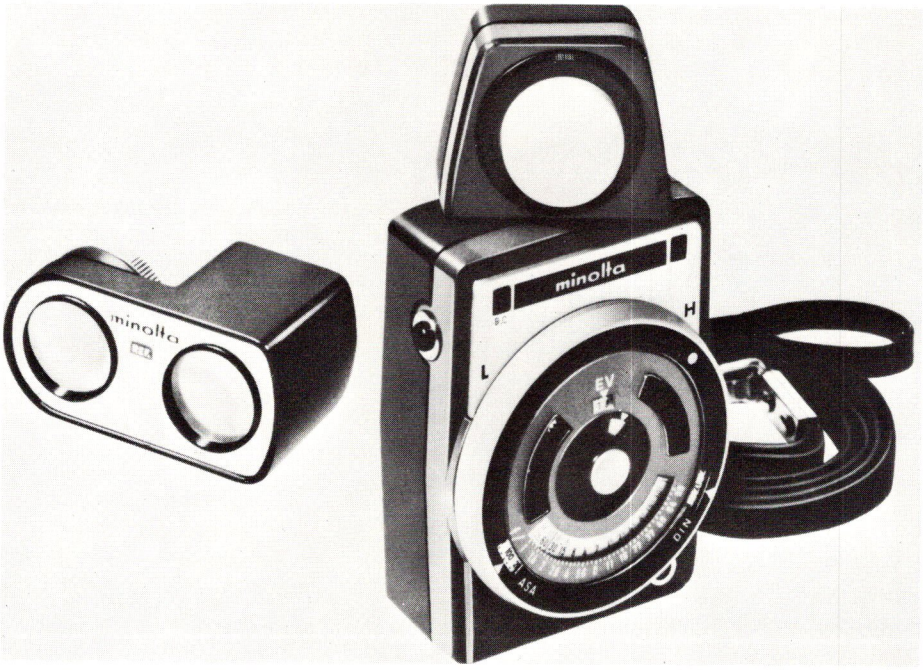
To take account of differences in scene brightness, you can open or close the lens aperture from one-half to one stop more or less than indicated by the meter. To favor brighter objects or areas, use the smaller lens openings; to favor darker areas, open the lens appropriately. With mixed scenes, one technique used by some photographers is to take a com-



Almost any exposure would have done for this, for the policeman is silhouetted against a bright sign in Times Square, New York. 135mm f/2.8 lens. Francisco Hidalgo.

Glenfinnan, Loch Sheil. Monument to Prince Charles Edward's followers. 135mm lens, 1/125 sec., f/16. Underexposed for silhouette effect. Exposure meter ignored. Ilford FP4. Richard Gee.





Minolta Auto Meter Professional is designed primarily to measure incident light with spherical diffuser, but it can also be used for measuring reflected light with accessory attachment having angle of acceptance of 10°. Accessories available for this meter extend its usefulness into darkroom exposure measurement, and pinpoint measurement of groundglass illumination.



promise reading between that achieved with an incident-light meter and that achieved with a reflected-light meter.

One of the special features of the Minolta Autometer Professional is that you can align the dials automatically merely by pushing the measuring button. There are no needles to match up or manual alignments that need to be made. The meter has two measuring ranges: low and high. When used as an incident-light meter based on a standard of ASA 100 for film sensitivity, the low range extends from −3 EV to +7 EV; for the high range it is +7 EV to +17 EV. When the meter is used in its reflected-light mode, the low range is from 0 EV to 10 EV; the high range is from 10 EV to 20 EV.

The scale ranges are as follows:
Film speeds—ASA 6 to 25,000
Lens apertures—$f/1$ through $f/90$

EV– –7 to 25

Shutter speeds–1/8000 sec. to two hours

The meter uses a 6v silver oxide battery (Eveready #544, Mallory #PX-28 or the equivalent). The battery must be inserted in the battery chamber with the "+" and "–" symbols aligned as indicated. To check on the adequacy of battery strength, simultaneously depress the measuring button on the side of the meter and the battery-check button on the back of the meter near the bottom at the right. If the battery is in serviceable condition, the battery-check lamp in the upper lefthand corner of the face of the meter next to the letters "B.C." will light up. If it does not do so, you must replace the battery.

To use the meter for incident-light measurement the spherical diffuser must be screwed securely into position on the receptor head. The function selector on the back of the meter should be turned with a coin so that the red dot appears opposite the letters "INC." (The alternative position, marked "REF," is for use when making reflected-light readings.)

The spherical diffuser should be turned toward the light source(s) in accordance with the instructions given above for use of incident-light meters. In use of the meter, the dial will be facing toward you so that you can observe all functions in operation. Note that in the upper right- and lefthand corners of the meter there are two red lamps. If the right lamp should come on, this means that you must operate at the high range; if the left lamp illuminates, you must use the meter in its low range. To make the range adjustment, turn the dial so that the raised red indicator dot points either to "H" (high) or "L" (low). If the dial should be turned toward one or the other of the two positions and neither lamp lights up, you simply read the indicated exposure from the appropriate scale when the dial stops moving. If the underexposure lamp ("L") lights up with the meter set for the low range, this indicates that the light volume is below the response range of the meter.

To use the flat diffuser disk for measurement of individual light sources, remove the sphere and put the disk in its place. The light value may then be read on the EV scale. This may be converted to the desired units by reference to the Illuminance Table on the back of the meter. If, for example, you get an indicated value of EV 7, this would convert to 320 luces or 30 footcandles.

You can take reflected-light readings by removing the sphere or disk from the rotating light receptor head and substituting the reflected-light measuring attachment. The small bracket next to the screw-in collar on this attachment should be aligned with the notch on the rotating light receptor head. Then the grooved collar can be screwed securely into the receptor socket. The function selector on the back of the meter should be turned with a coin so that the red dot appears opposite the "REF" position. "REF" should also appear in the incident/reflected-setting indicator window on the front of the meter. The meter is then used in very much the same way as a spot meter. Look through the viewfinder and locate the subject area to be measured within the bright circle. Then push the measuring button, and release it as soon as the dial has stopped moving. If either the underexposure or overexposure warning lamp lights up, make the appropriate adjustment as indicated above.

Accessories are available to adapt the Prometer for use both as an enlarging exposure meter and as a pinpoint, or small-area, measuring device to be used in taking readings on the groundglass of view cameras. A pinpoint receptor probe with fiber optics is used in the latter to determine subject or lighting contrast ratios as well as to read exposures for small areas as projected onto the groundglass.

Further Notes on Exposure Technique

Notwithstanding the best exposure meters in the world, you still must do a lot of your own interpretive thinking about the effects you want to achieve under given circumstances. The meter must be regarded as an instrument that will think for you accurately when you are dealing with average conditions and desire corresponding pictorial rendition. Otherwise, if you want to achieve any special effects, or if you are dealing with complex lighting situations, you must regard the exposure measurement indicated by the meter only as a point of departure. Photographers who want to be sure that they will get something in the face of uncertainty—particularly when they cannot go back for a second try—make generous use of the technique of exposure bracketing. This is feasible for more or less stable situations but not for fast action. The more confident you are of the situation, the less wide-ranging need you be in departing from the theoretical best exposure.

There are a few habits you should acquire in the interest of not frustrating the proper functioning of the meter and assuring that it reads only what it is supposed to read. Don't cover the meter cell, lens, or light receptor, for you will then be obstructing the full passage of light and will get a false reading. When using an incident-light meter, hold it away from your body so that you do not pick up reflections from a light shirt or garment. Don't measure your own shadow —a great risk in taking close-up readings.

If you're not satisfied with the contrast ratio of a scene, you might be able to improve on it by moving around. Take readings from different angles or positions from which you might get different patterns of light reflectance from the subject.

Remembering that the meter is preprogrammed to visualize a middling-gray scene or one of average reflectance, you can reprogram your own exposure-determining technique through previsualization. You have much more latitude for this when using black-and-white films than when using color films. Briefly, there are about four steps above and below the middle-tone area, making a total of nine. Each step is the equivalent of one *f*/stop or the corresponding increase or decrease in shutter-speed time. If you want to achieve a high-key result you can previsualize effects of one or two stops additional exposure. You can do a little of this in color photography, but you have much less latitude for doing so than with black-and-white films. In either case, you have much more flexibility if you are working with low-contrast ratios.

Since all metering systems are based on averages, you should always keep in mind two rules of thumb: First, you compensate for meter readings of *overall brightness* by opening the lens aperture or using a slower shutter speed in order to give more exposure and, second, when the scene is characterized by *overall darkness*, you give less exposure than indicated by the meter. The reason for the first is that the meter reading tends to indicate less exposure, recording the overall brightness as though it were a middle tone. In reverse, the meter tends to accommodate overall darkness by indicating more exposure.

Examples of when to increase exposure are when you are photographing in the sun, at the beach, or at high altitudes, when there is predominant light sky and when backgrounds are exceptionally bright. The exposure increase should be the equivalent of one-half to one full stop for most situations. Low-contrast situations might also be helped with an increase of exposure when using color film of about one-half stop; with black-and-white films you can experiment with even greater exposure increases, depending upon the subject.

SUGGESTED EXPOSURES FOR PICTURES OUTDOORS AT NIGHT WITH BLACK-AND-WHITE FILMS

Picture Subjects	KODAK Films	
	TRI-X Pan	PLUS-X Pan
Brightly lit nightclub or theater district scenes (like Times Square and Las Vegas)	1/60 sec f/4	1/30 sec f/2.8
Brightly lit downtown street scenes (Wet streets make good subjects.)	1/30 sec f/4	1 sec f/11
Sports at night—football, soccer, baseball, drag races, and racetracks	1/125 sec f/2.8	1/30 sec f/2.8
Christmas lighting on homes	1 sec f/8	1 sec f/4
Sunsets	1/125 sec f/16	1/60 sec f/11
Skylines (shortly after sunset)	1/125 sec f/5.6	1/60 sec f/4
Store windows	1/60 sec f/4	1/30 sec f/2.8
Floodlit buildings, fountains	1 sec f/5.6	1 sec f/2.8
Burning buildings, campfires, bonfires	1/60 sec f/4	1/30 sec f/2.8
Fireworks displays (keep the shutter open for several bursts)	f/22	f/11

NOTE: Use a tripod for shutter speeds slower than 1/30 second.

When there is a great deal of homogeneous color in landscape photography, particularly green foliage, and particularly when using color film, another one-half stop of exposure will help to brighten these areas and delineate detail somewhat better.

Decreases in exposure are the rule for subjects of dark reflectance. This would apply to dark-skin portraiture as well as to pictures taken at dusk or at dawn. In the typical dusk scene, you are lucky if the picture comes out as though it were a daylight scene unless you deliberately thinned out the exposure. This calls for a decrease of one-half to one *f*/stop or the equivalent in shutter speed. (Shutter-speed equivalents can be made only in full *f*/stops.) If you want real mood pictures, you would need even less exposure. To emphasize highlights, whether of solid objects or of water reflections, you would decrease exposure one or two *f*/stops, depending on the contrast ratio.

Substitute readings using a card or handkerchief may be taken when working under low illumination or when objects that are in contrast with their surroundings are inaccessible. For the low-light readings, you can use a matte white card placed in the same lighting as the subject while using an ASA exposure rating divided by five. In other words, if your real exposure rating is ASA 400, you would assume, for the purpose of the reading, that it is ASA 80. As a rule of thumb, also, you can

use your standard rating and open the lens aperture about two-and-a-quarter stops. As there is no 1/4 *f*/stop position, you could turn the lens to what you estimate to be 1/4 stop. A handkerchief can also be used for the same purpose. In indoor lighting 18 per cent gray card readings can be taken with the card placed in the position of the subject and the reading taken either with the spot meter or close up. When using the gray card outdoors, especially with color, you may find it desirable to raise the brightness level of average scenes by setting your exposures for 1/2 stop more than indicated by the meter. The explanation for this is that overall reflectance of average outdoor scenes is about 12 per cent as against 18 per cent for the gray card.

Spot-meter or close-up readings are indicated for individual objects when they are in marked contrast with their surroundings. Readings of average light skin should be cut back the equivalent of one *f*/stop; readings of dark skin should be adjusted by an increase of up to one stop. In general, you would make adjustments as indicated for increased or decreased exposure as given above.

From time to time you should check the performance of your meter against standard conditions. Use the rule that in bright frontal sunlight your exposure setting should be *f*/16 with a shutter speed closest to the ASA rating of the film. If your film has a rating of ASA 125, the shutter speed should be 1/125 sec. If the rating is ASA 160, the nearest setting would still be 1/125. With an ASA rating of 400, the nearest setting would be 1/500 sec. If your meter reading is substantially different, make comparisons with other meters, and if you still find significant differences, have your meter or the camera with built-in meter checked out by an authorized repair service. Against the risk of having your meter go bad when you are in the midst of shooting in situations to which you cannot return (which is usually the case), you should get to know some of the standard deviations of brilliance levels in terms of *f*/stops, as shown in the accompanying table.

When working with meters that use CdS (cadmium sulfide) cells, you may need to compensate for particular properties of such meters. In the Minolta line this would take in the CLC meter, the Autometer Professional, and the Minolta spot meter, all of which use CdS cells. (The Minolta color meter and flash meter use blue silicon meter cells.) The CdS cell is noted for its "brightness memory." If the meter is held on a bright target for any length of time, it may take several seconds before it stabilizes and gives a correct reading for average reflectance. More time might be needed for a shift from bright to low light levels. If the meter is pointed at the sun itself, it may hold to its memory position for ten minutes or longer. Hence, never push the low light button under brilliant light conditions. Also, you should turn the meter off when it is not in use. The built-in meter of the camera should have a cap placed over the lens when the meter is in the "ON" position.

CdS cells have little or no blue sensitivity and hence may give false readings of predominantly blue subjects, which call for appropriate reduction of exposure. On the other hand, they tend to be especially sensitive to red light when it is predominant, leading to underexposure and a compensatory need for providing additional light through the exposure settings. When taking exposure readings with dark filters, therefore, it is best—apart from convenience in focusing—to take the exposure reading without the filter in place and then manually make an adjustment for the filter factor.

Exposure of a dark-skinned person should be for main facial area with a little less exposure than indicated by meter. Suzanne Szasz used a 100mm lens and printed on No. 4 paper to bring out contrast.



CHAPTER VI

Artificial Lighting

In many respects, artificial lighting is a more satisfactory and dependable source than outdoor lighting. This is particularly true in portraiture, the photography of small objects, figure photography, and a variety of other posed subjects. With indoor lighting you can control backgrounds, you can put sidelighting and backlighting where you want it, and by moving lighting sources and reflectors around you can control contrast ratios, highlights, and shadows to achieve the particular effects you desire. Color temperature is more easily controlled than in outdoor photography because the sources are more standardized and predictable, except for aging and voltage variations.

A key difference between indoor and outdoor lighting is that with the latter there are usually no variations in intensity of lighting away from the source, provided there are no shadow or reflector interferences, whereas with indoor lighting one encounters the phenomenon of the inverse square law. This has to do with the falloff of the intensity of lighting as it travels away from its source.

In this chapter we cover some general characteristics of artificial lighting, attributes of both continuous and flash lighting sources including the Minolta flash units, use of reflectors as lighting sources, and some basics of lighting setups.

The techniques of exposure measurement with artificial lighting were covered in the preceding chapter, except for the measurement of flash illumination. Flash exposure by formula and by use of the Minolta Flash Meter will be covered in this chapter.

GENERAL CHARACTERISTICS OF ARTIFICIAL LIGHTING

The following material applies both to continuous-source lighting and to flash, or pulsar, lighting. Some attributes of one or the other, however, will be given greater or lesser attention as required. Other than incidental references to the color temperatures of particular types of lighting sources, this



The diminishing intensity of light as it travels away from its source is seen in this flash picture taken aboard the SS *France* with a 135mm lens and automatic Honeywell flash Unit. Joseph D. Cooper.

aspect of artificial lighting was covered in the preceding chapter in connection with the discussion of color films and the Minolta color meter. Generally, we may say that most artificial lighting sources are balanced for tungsten color films with kelvin ratings of 3200 K or 3400 K, whereas flash approaches the color temperature of daylight. The fluorescent color temperature problem was also discussed in the preceding chapter, as were the problems of mixed lighting sources.

Here we will take up the particular attributes of light falloff (involving the inverse square law), lighting sources and their effects (influencing mainly contrast ratios and shadow configuration), and problems of background management (having to do with shadows, reflectance of background color, and distracting elements).

Light Falloff and the Inverse Square Law

Common to all lighting sources is a diminution in the intensity of light as it travels away from its point of origin. The rate of falloff decreases with added distance from the point of origin. Hence, with daylight illumination there is no practical difference in intensity considering distance alone.

The law of lighting falloff, or the *inverse square law* as it is more generally referred to, may be stated as follows: *The intensity of light varies inversely with the square of its distance from the source.* If you want to compare lighting intensity between two points at different distances from the same light source you would set up the square of the distance of the first point as the numerator of a fraction while the square of the distance of the second point would be the denominator of a fraction. Then you would reduce the fraction so that the numerator becomes 1. Suppose, for example, that you are photographing objects 3, 4, 5, 6, 7, 8, 9, 10, and 11 feet away from the lighting source. The squares of each of these are, progressively, 9, 16, 25, 36, 49, 64, 81, 100, and 121. Now, suppose that you want to compare lighting intensity at distances



Continuous lighting sources as well as flash diminish in intensity of illumination. Note gradations from white shoe to white shirt to white trousers in rear. White trousers and shoe in front were "burned in" somewhat. 135mm lens at ground level, f/16, Tri-X, Honeywell Automatic Flash, Joseph D. Cooper.

of three and five feet from the same source. You would divide the square of three feet into the square of five feet, or 9 into 25. This is the same as reducing a fraction of 9/25 so that the 9 becomes 1 while the denominator of 25 becomes something less than 3. In practical effect, the comparison of numerator to denominator squared tells you that you have a lighting ratio of 1:3, or that the lighting intensity of the closer object is almost three times as great as that of the more distant object, assuming that both have the same reflectance properties.

If we take another set of distances with a separation of two feet between them, in this case five and seven feet away from the lighting source, the squares of the numerator and denominator (or of the lighting ratio) are 25 and 49, which reduce to almost exactly 1:2. In this case, the closer object receives twice as much light intensity as the more distant one.

From these examples we can derive some general observations:

1. At very close distances, exposure calculations must be made precisely. When two or more objects are being photographed they should be more or less at the same distance from the lighting source.

2. To minimize differences in exposure when objects are at different distances from the same light source you can: (a) increase your distance from the two subjects and use a lens of longer focal length; (b) place the darker object closer to the light source than the lighter one; (c) use reflectors or supplementary lighting for fill-in; or (d) a combination of these.

3. When using color films, you must be more critical in your measurements and exposure settings as well as in the making of corrective adjustments than when using black-and-white films because of the narrower exposure latitude of color films.

5. Other techniques for overcoming the difficulties of diminishing light intensity are through the use of bounce illumination or bare-bulb illumination, as described below. These impart a different lighting quality and therefore are considered separately.

LIGHTING CONTRAST RATIOS

Main and Fill-In Lights

Lighting Ratio

Main-Light Distances (feet)	1:2	1:4	1:8
2	2.8	4	5.6
2.8	4	5.6	8
4	5.6	8	11
5.6	8	11	16
8	11	16	22

Fill-In Light Distances (feet)

LIGHTING CONTRAST RATIOS

Lighting ratio	1:1	2:1	3:1	4:1	5:1	6:1	7:1	8:1	9:1	10:1
Distance multiplier for fill-in light	1	1.4	1.7	2	2.2	2.4	2.6	2.8	3	3.2

The upper chart shows how different contrast ratios are obtained by varying the distance between the main and fill-in lights and the subject. To use the bottom chart, pick a lighting contrast ratio and multiply the distance for the main light by the distance multiplier for the contrast ratio chosen; this will give you the distance for the fill-in light. The same formula can be used in metric calculations. In any case the ratios are only approximations and are based on the assumption that both lamps and reflectors are identical.

Lighting Sources and Their Effects

The brilliance or contrast characteristics of a picture are governed in large part by the characteristics of the light source(s). The light source can be concentrated or diffuse, with correspondingly brilliant or soft highlight and shadow effects. In this section we will take up the characteristics of single-point lighting, broad-surface lighting, multiple-point lighting, lamp reflectors, area reflectors, and indirect lighting.

Single-Point Lighting

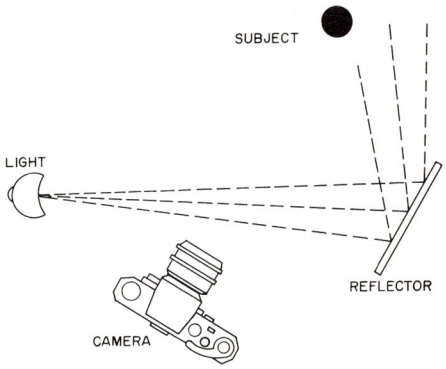
A single-point source of lighting produces many of the same effects as direct sunlight. When it is overhead, as at high noon, a subject's head will have shadows in the eye sockets, under the nose, and under the chin. When the light is off to the side, it will produce the same kind of harsh shadows as will an early morning or late day sun.

The directional characteristics of this lighting are governed by the use or absence of a reflector. If the light is suspended by a cord from the ceiling, a photograph of the room interior would show a circular or global pattern of light radiating away from the center and trailing off into a surrounding darkness. If the light is mounted at or close to the ceiling, the latter serves as a flat reflector, so the effects are of both a point source and a diffused secondary reflector or indirect source.

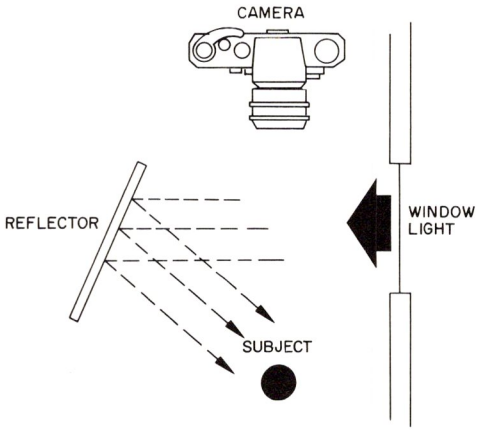
Usually, existing light sources are diffused by glass lighting fixtures or directed by lamp shades so as to broaden the surface and its shadow effects or to limit their area of coverage by the shapes of the shades.

Photoflood lamps, flashbulbs, and electronic flash units when used singly all produce the effects as just described,

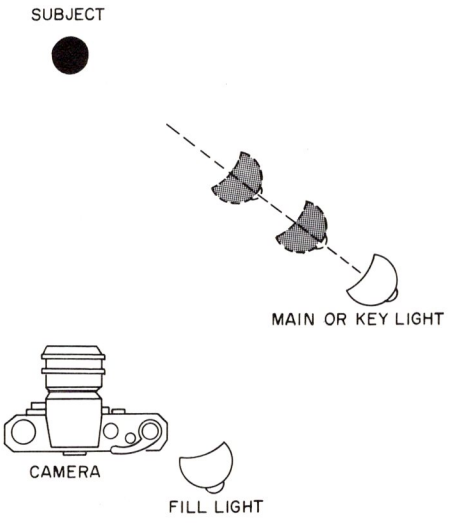
Some of the many different schemes for portrait lighting with flood or flash and with or without reflectors.



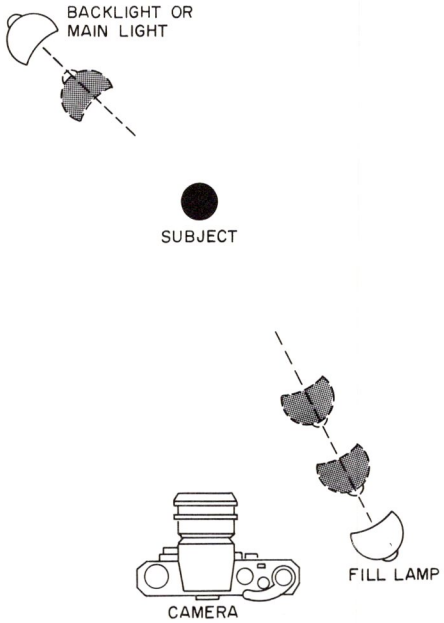
Plan for one light and reflector.



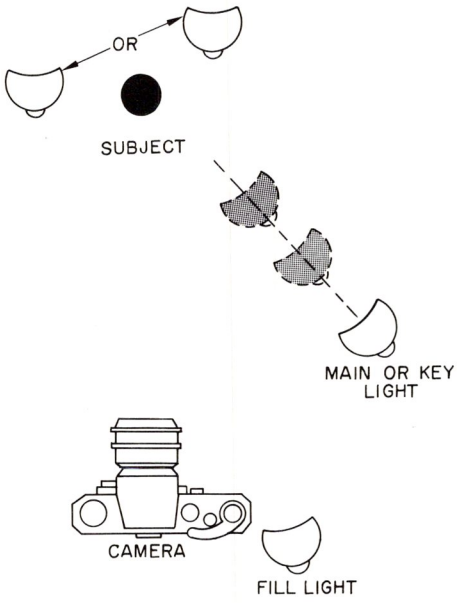
Plan for window light and reflector. In this setup you can vary the light by changing the positions of the subject, camera, and reflector.



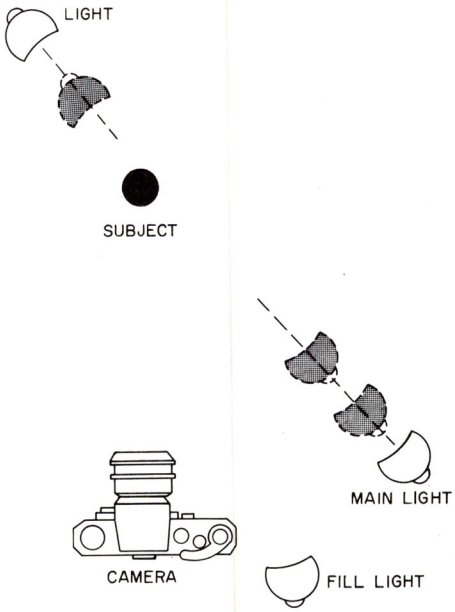
Two-light plan. (*Varying distance from subject governs the lighting contrast ratio.)



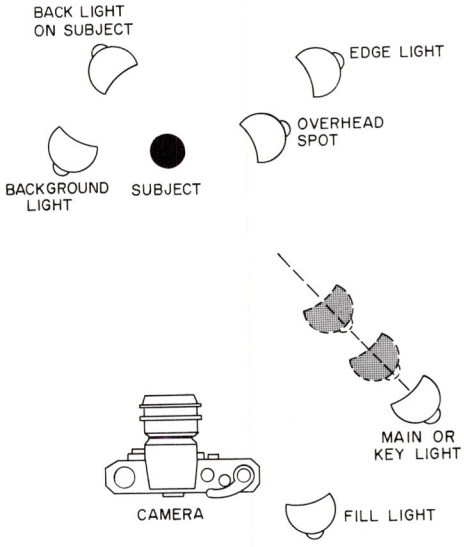
An alternate two-light plan.



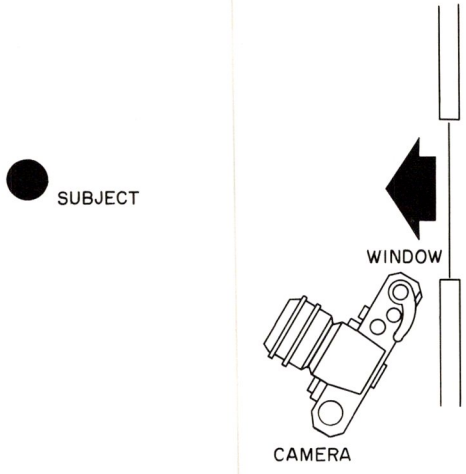
Three-light plan.



An alternate three-light plan.



Plan for four or more lights.



Window light plan, with no reflector. In this setup you can vary the mood by changing the positions of the subject and/or the camera.



The single light source in the table light reflector provided a directional-diffuse lighting that isolated the subject from the rest of the room. Standard 58mm lens, 1/30 sec., f/2.8, Tri-X rated ASA 800. Suzanne Szasz.

Statue in Vatican, single brilliant light source casting hard shadows. 135mm lens, Tri-X. Joseph D. Cooper.



subject, however, to the use of reflectors and their modification of light patterns.

For some pictures, the stark realism of a concentrated point source of lighting, especially when used to emphasize drama, tension, and austere living conditions, may be particularly desirable. Under some unusual circumstances or for creative effects you might even consider lighting from a candle or match stick as an interesting point source. Through trial and error you can standardize on exposure at a given distance for different reflectance characteristics of skin.

Broad-Surface Light Sources

When a lighting fixture has several light bulbs covered by another piece of glass whose purpose is to diffuse the light, when a single fluorescent strip is used as the lighting source, or when two or more fluorescent strips are clustered behind a single enclosure, the effect is similar to that produced by

hazy bright sunlight. There are discernible highlights and shadows, but the edges of the shadows are less sharply defined. The same effect may be achieved with a cluster of individual lights behind a diffusing cover of glass or plastic depending on the distance from the subject. The closer the subject, the more you are likely to see highlight and shadow patterns attributable to each of the several point sources, while for more distant objects these all tend to overlap in a pattern of diffusion.

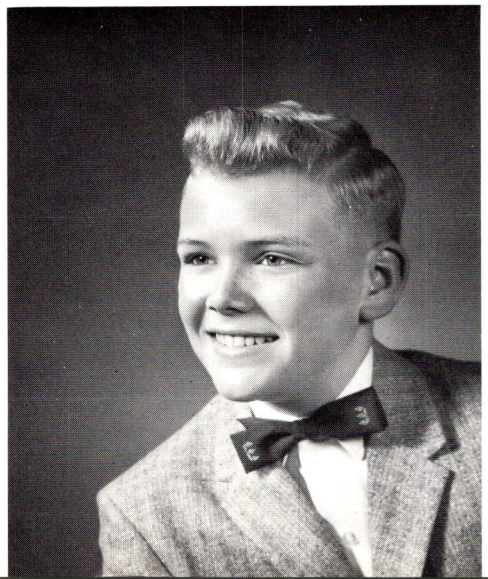
Multiple-Point Lighting

In a studio-type setup, whether in the home or in an actual studio, the more typical arrangement is to have multiple sources of lighting to illuminate and model the principal subject and to control the background, as discussed in greater detail below. The photographer is concerned with the management of contrast ratios governed by the intensity of each light source and its distance from the subject, the creation of or

Portrait effects achieved with different contrast ratios (also called lighting ratios), main light compared with intensity of fill-in light. Top left, 2-to-1 lighting ratio; top right, 3-to-1 lighting ratio; below left, 4-to-1 lighting ratio; below right, 6-to-1 ratio. Reproduced with permission from the copyrighted Kodak publication *Studio Techniques for Portrait Photography*.









filling-in of shadows as desired, and the management of the brightness, tone, and color of the background. Flexibility in placement of each lighting source is a key element.

As opposed to the controlled studio-type situation, different strategies are needed for the fixed lighting sources of an ordinary room, office, or industrial interior. The problems range from the effects created by individual light sources that illuminate small areas of the room to the typical office or industrial situation in which numerous fluorescent lighting fixtures tend to create a diffuse, shadowless situation somewhat analogous to open shade with a bright sky overhead driving useful reflectance downward. This effect is achieved if fluorescents are intermittently spaced across the ceiling or if they are placed around the edges of the ceiling, with corresponding variations in highlight and shadow effects. When there is substantial separation of individual lighting sources from each other, creating a discontinuity, shadows tend to criss-cross, but the specific pattern depends upon the number of separate lights, their placement, and whether they are point sources in reflectors or broad-surface sources.

Lighting in the typical room of a private home is irregular and non-uniform in its distribution. If you were to have a ceiling light and a single floor lamp, for example, the effect would be as though you had two competing spheres of influence, which might or might not overlap significantly. You might compare this to the widening circles in a pond caused by two pebbles thrown in. If the resulting circles are widely separated, they might not reach each other, but if they are closer, they interact at the point of contact. Similarly, the separate lights in a room might have no effect on each other or might add to each other's effects, depending upon their power and their spacing.

Lamp Reflectors

The purpose of lamp reflectors is to control the distribution of light within a certain angle (narrow to wide depending upon the curvature of the reflector) and to control the quality of light (ranging from clear brilliance to soft diffusion as influenced by the surface of the reflector).

The most efficient reflectors, designed to yield the best output of a light bulb or flashbulb, are called *parabolic* reflectors. They have a moderately deep recess leading to the lamp socket. As a general rule, the more shallow the reflector, the wider will be the angle of distribution of the light. Conversely, the deeper the reflector, the more concentrated will be the beam of light reflected by it.

Reflectors are available in a wide variety of types for professional or home studio-type setups, including both polished-surface and matte-surface reflectors, the latter for use in diffusing light.

The reflector built into the typical amateur or professional flash unit is designed to give an angle of coverage that may be adequate for a moderate wide-angle lens of 35mm focal length, although you must satisfy yourself as to the precise angle of coverage of your own equipment. Typically, flash units sold for use with flashbulbs are of the collapsible fan-type design, with an embossed pattern that helps to diffuse the light.

The standard reflector on a compact flash unit will not cover the same area as that covered by wide-angle lenses of focal lengths 28mm and smaller. In some cases, depending upon the particular flash unit, focal lengths of 35mm will not be covered, although this ordinarily should not constitute a problem. The shape of the reflector determines whether the area of illumination is circular or rectangular. The larger profes-

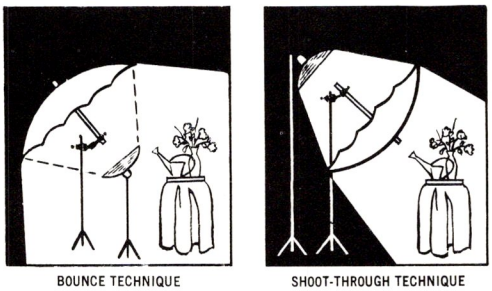
sional units are available with deep-bowl reflectors for more efficient distribution of light, but these are designed mainly for average coverage. Some flash units have been made with particularly deep reflectors in order to create an effect that one might call "teleflash" in that the light is concentrated into a narrow beam, which can reach objects at greater distances than would be the case with average reflectors.

As a general rule, the narrower the beam of light, the greater the distance it reaches effectively; the shallower the reflector, the wider its angle of coverage and the shorter its reach into distance.

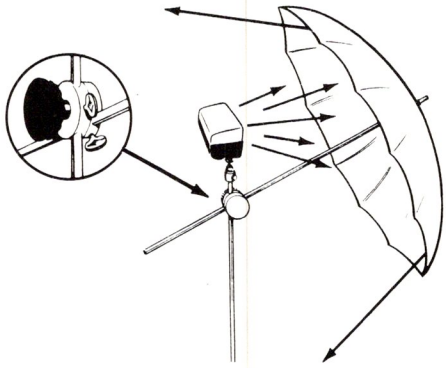
Spotlights throw a brilliant, harsh beam of light. The effect is achieved through a combination of reflector and optical design. Spotlights are most commonly available as continuous lighting sources, but at least one professional flash unit for studio use—the Calumet Elliptica—throws a beam of variable size and shape; it can illuminate very small areas and is therefore useful also in close-up photography.

Spotlights are used quite commonly in theatrical photography but they are not suited for direct use in most other types of photography unless suitably diffused. The reason for this is that harsh shadow patterns are created on the sides of facial features. In portraiture, spotlighting is used more commonly as supplementary fill-in lighting to accent the hair or to create highlights through oblique skimming of surfaces.

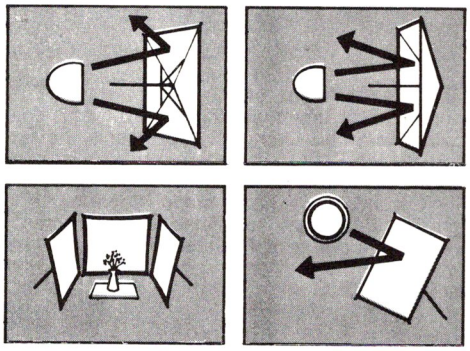
When bare bulbs, whether continuous or flash, are placed close to walls or ceilings or a combination of the two, these act as broad-surface reflectors, diffusing light directionally or multi-directionally with soft, diffuse effects and luminous shadows. If the closest surface is a wall, it will tend to bounce the light forward; if the ceiling is used, it will tend to drive the light downward as though it were bright hazy sunlight. Each type creates its own shadow patterning. When the light source is held in the angle between the wall and ceiling, the effect is more diagonal. Umbrellas specifically designed for photography as well as variations of umbrellas can be used to the same end, either as primary or secondary reflectors. As primary reflectors they are used to bounce light from a bare bulb onto the subject, and as secondary reflectors, they redirect light driven toward the umbrella from a source that has its own reflector. The

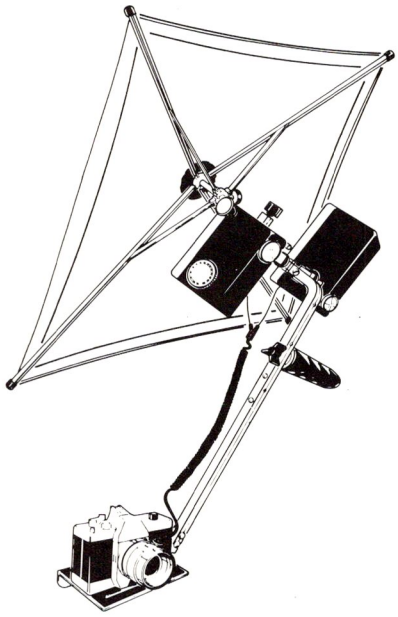


Two uses of umbrellas in artificial lighting. The bounce technique is used when large areas are to be covered with light. The shoot-through technique is used for a direct, diffuse lighting, particularly of still-life subjects. Courtesy Uncle Sam's Umbrella Company.



The mechanics of combining an umbrella, supporting stand, and flash, in this case the inexpensive Spiratone Umbrelite.





The Reflectasol umbrella (above) can be "focused" on the subject by changing the degree of opening with the light source remaining at the apex position. In its inside-out position, the Reflectasol disperses light while in its conventional umbrella configuration it concentrates light. It can also be used as a flat reflector. Courtesy Larson Enterprises, Inc. For portable use (right), the Reflectasol is mounted on its own hand-held bracket which offers classical high 45° lighting. One or two flash units can be used as shown.

latter is probably more efficient in the utilization of light, but subtle differences will be found between the two. The subject of umbrellas is treated below under the heading of area reflectors, because they also serve as bounce-lighting or area-reflecting sources when taking pictures in bright sunlight.

Professional photographers use a variety of devices to control the direction of lighting, to restrict the area of coverage of a lighting source, to soften the quality of light, and otherwise to change its brightness and color temperature. Some rather interesting terms are used to describe the devices used. A *barndoor* is a swinging sheet that widens or narrows the area of coverage of light. A *snoot* reduces the circle of light through the use of a tubular device that restricts the spread of light from its original source. A *cookaloris* is a patterned screen with cutouts causing the light to project soft shadow patterns on the subject or background. A *scrim* is a neutral filtering device used to reduce light intensity. A *half-scrim* can be rotated to control only part of the beam of light, so half is at full brilliance while half is reduced. Polarizing screens or filters are used to drive the light directionally so as to minimize unwanted reflections; they can also be used to reduce the output of light from its original source.

Background Problems

Among the background problems you must handle are shadows, contrast of the main subject with the whiteness or darkness of the background, reflectance properties of the background, distractions, extraneous objects, and reflections.

Each lighting source throws its own shadow, discernible to the extent that the source is either of point or broad-surface origin. Typically, when you use lamps, flashbulbs, or electronic flash units indoors, each causes a shadow pattern to fall beyond objects in its directional path. The shape and quality or density of the shadow can actually tell you something about the light source, such as whether it is a point or broad-surface source, how high it is relative to the subject, and whether it is clear or

diffused illumination. In portrait or figure photography, the treatment of shadows is relatively simple as compared with that in industrial, office, or other situations in which objects are at different distances from the camera and must be separately illuminated. The discussion below on basic lighting principles will include suggestions for both categories.

Whether the background is light or dark can have some influence on exposure and pictorial effects, depending upon the closeness of the main subject and whether or not light is reflected back onto the subject from the background. Otherwise, the main pictorial problem is to assure that the background sets off the subject with good contrast. This is usually accomplished either by using a dark background to set off a light-haired subject or a light background for a dark-haired subject. Lighting directed specifically toward the background will also influence tonal and pictorial contrast. In color photography backgrounds can be controlled further either with colored papers put up as backgrounds or with colored gels placed over the background light source.

Reflectance properties of the background are significant for exposure purposes only when the subject is fairly close to the background. In a large room, or when artificial lighting is used outdoors, the background will for all practical purposes be nonexistent. One problem in color photography is that



Electronic flash is used at slow shutter speeds because the full curtain aperture must be open, but the action-stopping power is governed by the duration of the flash, which is usually 1/1000 sec. This whiskey-pouring operation was taken with the Macro Rokkor 55mm *f*/3.5 lens. Graham Finlayson.

the colors of the floor, walls, drapes, ceiling, and any other large surfaces will be reflected back onto the subject, thereby altering the color properties of the light. If the walls are painted blue or pink, the subject is likely to have a corresponding tint overriding the normally expected color balance.

One advantage of using a single-lens reflex camera, particularly when the depth-of-field preview button is depressed, is that you can detect undesirable highlights or other background and foreground reflections and distractions. These can be corrected in most cases simply by moving them out of the picture area, by changing the position of the light, or by changing the camera position to one side or the other or to a lower or higher position.

CONTINUOUS LIGHTING SOURCES

Continuous lighting sources have the advantage from a technical standpoint of enabling you to previsualize results as observed through the viewfinder and as measured in terms of contrast ratios through the use of an exposure meter. You can control highlights and shadows more effectively in this manner. You can also do this with flash units, which incorporate the continuous modeling lamps described below.

The importance of any substitute modeling arrangement will be appreciated when you work for any length of time with ordinary photolamps, for they emit a great deal of heat, which is proportionate to their brilliance. With some subjects heat can literally be withering. When the subject is conscious of the heat, it is much more difficult to obtain spontaneous actions or expressions.

The problem of power drain on the existing service facilities must be considered, particularly when working in a home that usually does not have circuits that can take heavy loads. Typically, a 15-amp line can take from 1500 to 1800 watts in lighting output. Wiring of sufficiently heavy gauge, currently installed in contemporary homes, can usually support 20 amps and a wattage load of from 2200 to 2400. You cannot simply use a 20-amp fuse if the wiring is not heavy enough to support the power usage. If you have any doubts about this, you should consult an electrician. Sometimes light receptacles in the same room are wired into different circuits. If so, this will enable you to distribute lighting loads so as to avoid the annoying experience of blowing fuses. Other substantial power drains on the same circuitry should be cut off. One particular problem is that when motors cut on automatically they draw initial surges of power that can overload the circuit if other heavy demands are being made upon it.

The following brief dictionary of lighting sources pertains solely to photographic lighting sources. The matter of fluorescent lighting was considered in conjunction with the problem of measuring color temperature in the preceding chapter. It is only important to remind you that while fluorescents seem to give a daylight effect, color pictures will appear greenish unless properly filtered. As there is little standardization among fluorescents, which may be cool or warm, what will work as good filtering for one fluorescent source might not for another. This is a lighting source that is best for black-and-white films. Some special-purpose fluorescents are available that match the color of daylight, one example being Duro-Test (made by Duro-Test, North Bergen, N. J.). If you have a standard picture-taking setup in which you wish to use fluorescents, you should get the daylight variety. Ordinary domestic light bulbs

are also most suitable for black-and-white films, because they have a color temperature of about 2600 K, leading to excessively reddish results if not properly compensated with filters in the cooling or bluish series.

Photofloods and Reflector Lamps

Ordinary photofloods have the same shape as ordinary lighting bulbs. When new they emit light with a color temperature of 3400 K, but with continued use this declines, so you must either discard the bulbs when taking color pictures or make suitable filter compensations. If you have a reserve of fresh bulbs, it is far better to substitute them. The wattage of these bulbs is 250, 500, or 1000.

Reflector floods have found increasing popularity because they combine both a lighting source and a reflector within the same glass envelope. Technological improvements have led to decreases in size of these *mushroom* floods, as they are sometimes called. They are available in different combinations of characteristics, including a choice of color temperatures of 3200 K and 3400 K, wattages that range from 200 through 500, and narrow and wide angles as shown in the accompanying table.

Studio Floods and Tungsten-Halogen Lamps

Professional photographers who use flood lamps have available to them long-life lamps—up to 100 hours—rated at 3200 K for use with type B color films (also called *tungsten* type). These are more economical than the ordinary photofloods referred to above.

Tungsten-halogen lamps are improved floods that are more compact and have longer life and more consistent color temperature. They are available in many different types rated according to color temperature, output, and life. Most commonly, they are available with color temperatures of 3200 K and 3400 K, but they may be obtained with color temperatures as low as 3000 K and as high as 4000 K. The 3000 K lamps have exceptionally long lives—up to 2000 hours. From a photographic standpoint, the lights by themselves come closer to being point sources, since they have smaller filaments emitting more concentrated light. They are hot, without doubt, and therefore should be used no closer than six to eight feet from the subject. They can be used for direct illumination or in bounce-lighting. Quite commonly, they are included as components of location lighting kits as described below.

Projection Lamps

Projection lamps are small light sources used in all types of projection equipment including spotlights. If you wish to have a spotlight source and do not have one expressly intended for such use, you can employ your slide projector, but you will need to have a suitable support for it at the right height. Incidentally, the slide projector, in combination with an area reflector, can be used in close-up photography where you want to drive light into small areas for which a narrow beam is desirable. Projection lamps are available with a color temperature of 3200 K. When used in spotlights, the combination of a reflector and a Fresnel lens, with adjustment of distance between the two, controls the angle of the beam.

Lighting Kits

The Compleat Home Studio must have some background materials, supports for the background, reflector surfaces, light of different wattage output and angles of coverage, and stands to support the lights and reflectors: All of



Typical flash-on-camera shot (above) throws dark shadow onto background and illuminates face contrary to natural lighting conditions. Two flashbulbs were used (below), one about four feet away at 45° angle held high and pointed downward as the basic illumination. Second flash on camera about eight feet away used to fill in shadows. 135mm lens. Joseph D. Cooper.



this constitutes part of a basic lighting setup. The more elaborate setup will include at least one *boom,* which is a long pole reaching over the head of the subject or over the object in order to drive a light downward. The boom is usually counterbalanced on its short end with a weight. Then there are the assorted snoots, barndoors, scrims, and other accessories mentioned above. Ideally, for maximum flexibility in portraiture, you need at least four different lights, which may or may not be of the same type, although with some ingenuity these can be simplified. The four basic lights are a main light (sometimes called a *key* light), a fill light, a kicker light, and a background light. While these are explained below, they are mentioned briefly here only to suggest the range of lighting equipment needs, supplemented as necessary or desired by reflector devices, background materials, and special filtering and diffusing materials to go over the light sources.

Background materials are made either of fabric or paper, with the latter most popularly used. An obvious purpose of background paper is to simplify the background through the use of a material of uniform tonal characteristics. A second highly important purpose is to be able to drape the material continuously from ceiling to floor and continuing under the subject, eliminating the line of intersection between the wall and floor, which otherwise would appear as a distraction in the picture. Background paper is usually about 9 feet wide (sometimes wider) and may be anywhere from 36 feet to 150 feet long. In the black-and-white series the available tones range from pure white to jet black with progressive shades of darkness or lightness between. There are also different shades of other colors, affording the photographer maximum flexibility for use with either color or monochromatic film.

Background paper holders can usually be purchased from professional photographic stock houses. They are sold also by companies that make up portable lighting equipment kits for location use.

In place of lighting stands, whose bases take up floor area, you can use ceiling-to-floor tension poles, similar to those used to support lighting fixtures for the home. As an example, the Brewster Corporation (Old Saybrook, Conn. 06475) sells spring-loaded tension poles in different lengths under the trade name "Pole Cats." These can support one or more lights at different heights through use of an attachment bracket. They can also support a crossbar to hold a roll of seamless background paper. An even simpler and much less expensive technique is to use "Timber-Toppers," sold by the same company at a nominal price, so you can make your own spring-loaded poles. All that you need is the spring-loaded tops to fit over a wooden pole of 1 5/8 inch diameter, available in desired lengths from any lumber yard.

Lighting kits and fixtures are available from many different sources in different price ranges, depending upon how much use, amateur or professional, the equipment is to receive. Among the more well-known names are Smith-Victor Corporation, Acme-Light, Lowel-Light Photo Engineering, and Bardwell & McAlister, Inc. Many other lighting fixture sources are advertised in the pages of the fan magazines of particular interest to amateurs, including such sources as Ritz Camera Stores and Spiratone, Inc. Elaborate kits for professionals are also available from these sources, usually including tungsten-halogen lamps, barndoors, lighting stands, and other accessories. These are called *location lighting kits* and enable one to set up a wide variety of lighting arrangements.

FLASH LIGHTING SOURCES

Flashbulbs and electronic flash units are the two types of flash illumination. Both may be considered as pulse illumination in that they consist of a single burst of light. The short burst of a flashbulb may be as slow as 1/30 sec. to as fast as 1/50,000 sec. or less with advanced professional equipment. Most electronic flash units emit a burst of 1/500 to 1/1000 sec. duration. Consequently, electronic flash units are considered action-stopping devices. When used indoors, where existing light levels are low, ordinary moving objects will indeed be stopped or "frozen." Electronic flash must be used with the focal-plane shutter at full aperture, requiring a setting of 1/60 sec. or less. Thus, at these slow shutter speeds, if existing light levels are high enough, a double image will be recorded because of even slight camera or subject movement or both. The same problem is encountered when flashbulbs are used at slow shutter speeds. In most flash situations, this difficulty will not be encountered with either type of flash source, especially when you are working at close distances using relatively small lens apertures. You may overcome this problem, though it is not ordinarily a serious one, when you are using flashbulbs in daylight or in other high-light-level situations by using those types of flashbulb with which fast shutter speeds can be used.

Many different types of flash unit are available for ordinary amateur use as well as for heavy-duty professional use and for special purposes. The Minolta Flashgun and Minolta Electroflash, both of which are adequate for most situations in which a single flash unit is required, are described below. In addition, this section includes information on

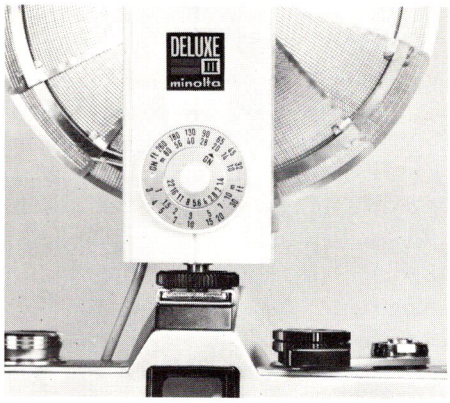
characteristics of a wide range of general and special-purpose flash units, together with information on methods of exposure computation, the use of the Minolta Flash Meter in measuring flash illumination, the use of multiple flash setups, off-camera flash, and related topics.

Except for the factors of color temperature and the brief duration of the flash illumination, the general characteristics of artificial lighting already described are pertinent, particularly in regard to the problem of light falloff (the inverse square law), reflector characteristics, and subject and room reflectance.

Flashbulb Units

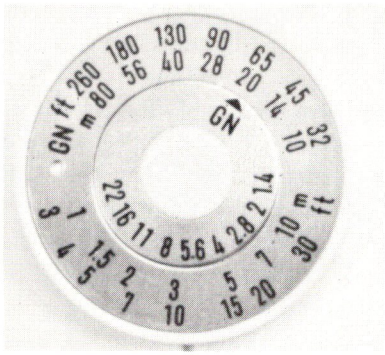
An advantage of flashbulb units for the occasional photographer is that he need not concern himself with recharging or replacement of sets of batteries.

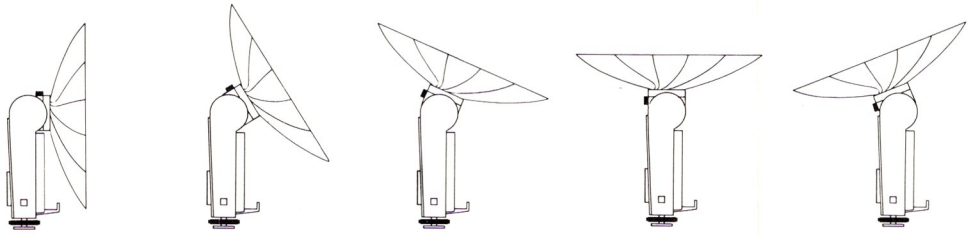




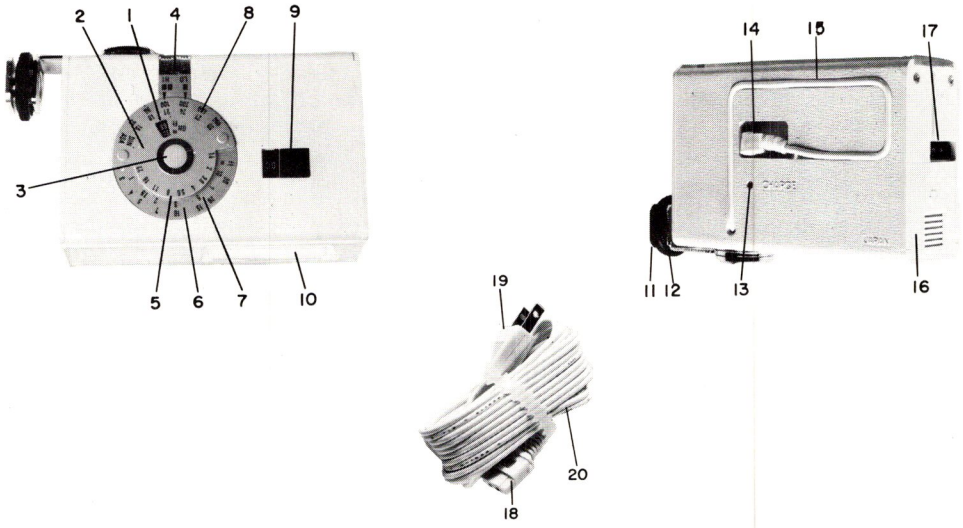


Left, Minolta Deluxe III Flash Gun. Actual size. Flash gun is attached to camera by sliding into accessory shoe and hooking cord to flash terminal as governed by type of flashbulb (top). Flash settings are made easily through use of computer dial on back of flash gun (middle). Inner dial is turned so that guide number (GN) is indexed according to feet or meters on top of dial. For given distance appropriate *f*/number is found (below).





Reflector swivels to five click-stop positions from head-on to above camera for bounce flash.



Parts of the Minolta Electroflash

1. Guide number window
2. Exposure dial
3. Independent flash button
4. HI-LO pilot lamp
5. Aperture scale
6. Distance scale (ft.)
7. Distance scale (m.)
8. Film speed scale
9. A.c.-d.c. changing switch
10. Reflector
11. Shoe
12. Shoe lock
13. Nickel-cadmium battery charging jack
14. Synch plug
15. Synch cord
16. Battery case cover
17. A.c. cord plug socket
18. A.c. plug for flash unit
19. A.c. plug for wall outlet
20. A.c. cord

Another advantage is that flashbulbs emit a great deal of illumination. The flashbulb unit is relatively trouble-free. Even if you make extensive use of an electronic flash unit, it is always good to have a flashbulb unit in reserve.

The Minolta Flashgun Deluxe III unit adequately serves most demands that may be made of a flashbulb unit for use directly on the camera or off the camera with the use of an extension cord. This unit will accommodate three types of flashbulbs: the regular bayonet base, the pinless M2 type of bulb, and the AG type of bulb. The reflector is of the collapsible fan type. It has two hooks to control the spread of the fan in relation to the type of bulb being used: the first hook for regular and pinless base bulbs and the second hook for AG bulbs. The second hook creates a deeper reflector shape for better concentration of light from the tiny AG source. The fan reflector has three click-stop positions for use either in direct or bounce flash modes. The fan may be collapsed en-

tirely so that the unit may be used vertically or horizontally as a bare-bulb source of illumination. The back of the flash unit has a convenient exposure calculator scale suitable for average subjects in average rooms. It requires a 15v battery of suitable size, available from any photo supply dealer.

You attach the flashgun to the camera by sliding it into the accessory shoe. The connector cord is inserted into the synch terminal according to the type of flash source and shutter speed. Any flashbulb can be used at the "X" position if a shutter speed of 1/30 sec. or lower is used. Certain flashbulbs can be used at faster shutter speeds with the connector cord inserted into the "FP" terminal. With electronic flash and any Minolta SR's, the connection should invariably be "X" terminal with the shutter at 1/60 sec. or less. You can also use the flash off the camera by introducing an intermediate flash extension cord as discussed below.

You need make no special adjustment when inserting flashbulbs into the reflector receptacle. Depending upon the type of flashbulb and its base, an automatic insertion is accomplished. You eject the flashbulb after use simply by pressing down on the button on top of the flashgun. The orange button at the base of the flash unit is a circuit checker. This is an important feature; if you want to make sure a bulb will fire after you install it, push the orange check button and if it lights up, you know that the circuitry, the battery, and the bulb are all operable. If it does not light up, you might have a dead battery or a defective bulb. Since the Minolta SR cameras use focal plane shutters, which have variable-width slits traveling across the image area, you need a flashbulb, ideally, which has a peak illumination period long enough to match the travel time of the curtain shutter. Thereby, you can use even the fastest of shutter speeds to stop action.

The three flashbulb types best suited to this use are the AG-1, the M3, and the FP6 or 26 for use with black-and-white films or the same types of flashbulb with the letter "B" after their designations to indicate that they are blue and are suitable for use with color films. Many photographers standardize on blue for both types of film as a matter of inventory convenience. The FP bulbs are specifically intended for use with focal-plane shutters and therefore afford the most efficient and economical use of light output. The M3 and AG-1 bulbs are intended for general use but have light peaks of sufficient duration to enable them to be used with focal-plane shutters as indicated in the accompanying table. The M3 is more efficient for this purpose than the AG-1.

Care must be taken when carrying flashbulbs so that they do not rub against each other, for this might lead to spontaneous firing induced by static electricity. Some photographers will put a flashbulb between their lips as temporary storage while taking a series of pictures. If this is done—and it is not recommended—the base should be outside the mouth, because a moist base will eventually cause the inside of the flash unit to corrode.

General-Purpose Electronic Flash Units

Electronic flash units are available in a wide range from highly compact units, which attach to the camera and are little bigger than packages of cigarettes, to heavy-duty portable and studio units used in professional photography. Some units are designed for exceptionally fast recycling after each use as a matter of convenience in journalistic work or in the use of a motorized camera, for which short intervals between flash bursts are important. You may have a need for one of the more powerful flash units when



Minolta Electroflash may be used in vertical or horizontal mode by simple swiveling.

you must take pictures at substantial distances from your subject, when you wish to use smaller apertures for greater depth of field, when you wish to use bounce flash techniques, when you are using relatively slow-speed films, or when you have combinations of these elements.

One measure of flash power frequently used is watt-seconds of output, also referred to as *joules*. As this measures output to the flash lamp, more generally accepted rating standards are the BCPS (beam-candle-power-seconds) and the ECPS (effective-candle-power-seconds) ratings. The first is a measure of light output at the center of the beam of light; the second measures total distribution across the diameter of the light beam. Manufacturers frequently use the Kodachrome II guide number as a basis of comparison, but other bases may also be used, such as the guide number for a film having an exposure index of ASA 100. There seems to have developed a standard of 200 watt-seconds as an average portable flash unit for professional or journalistic use.

The Minolta Electroflash is a compact unit that may be used with batteries or by connection to an a.c. power source in the 100 to 120v or 220 to 240v range. A particular feature of this Minolta unit is the optional use of "HI" (high) and "LO" (low) positions. When the "LO" pilot lamp is illuminated, the flash unit is ready to operate at the 70 per cent output. When the "HI" pilot lamp is lit up, the flash unit is ready to operate at full output. When the batteries are running low, it will take a longer time for the flash unit to recycle, in which case you will use the "LO" pilot lamp. This is an indication to you to replace the batteries. The "LO" position may also be used in sequence photography because it has a shorter recycling time. The unit uses four AA-size batteries, which may be carbon-zinc, nickel-cadmium, or alkaline.

The technical specifications of the Minolta Electroflash are a color temperature of 6000 K, flash duration of 1/1000 sec., recycling time of approximately eight seconds when a.c. operated and four to seven seconds under battery operation, vertical angle of coverage of 50°, horizontal angle of coverage of 60°, "HI" guide number of 60 using ASA 100 film and "LO" guide number of 45 with ASA 100 film. An optional charger is available for use with nickel-cadmium batteries. When the "AC/DC" switch is in the "DC" position, a constant low hum will indicate that the batteries are providing power. If you do not hear this hum or if the pilot lamp does not light

up, the batteries are dead and must either be replaced or, if of the nickel-cadmium type, must be recharged.

Automatic Flash

An automatic electronic flash unit is one that delivers the right amount of illumination to the target subject regardless of variations in distance of the subject from the flash and without regard to any computation by the photographer. As a practical matter, of course, there are limitations on distance governed by the output of the particular flash equipment being used and the sensitivity of the film in the camera.

The governing of exposure is accomplished in most cases by a "quench" mechanism within the flash equipment that is controlled by the amount of light reflected from the subject onto a sensor, which is usually located on the flash head. When the subject is a few feet away, the flash unit puts out less light than when the subject is at a greater distance. The automatic flash emits only enough light to expose a subject properly but assumes that it is an average subject, comparable to an 18 per cent gray reflectance card. Accordingly, even with automatic flash you must think independently and make adjustments in lens aperture if your target subject is substantially lighter or darker than the average for which the flash unit is programmed.

The amount of light emitted is in terms of duration of flash exposure rather than momentary brilliance. At their closest working distances from subjects, automatic flash units can have flash durations of as little as 1/50,000 sec., while at their greater operating distances the duration of the flash may be as long as 1/500 or 1/1000 sec. Hence, if you really want to freeze action, you should work at close distances. There is also a way, as described below, of converting your automatic flash into a manual high-speed flash unit that has a flash duration of about 1/50,000 sec. (depending upon the particular unit).

To prepare the automatic flash unit for operation, you ordinarily dial in a lens aperture corresponding to the exposure index of the film in accordance with a table provided by the manufacturer. This lens setting is then fixed on whatever lens you have on the camera and is not changed for average subjects, regardless of changes in their distance from the flash. However, if, on the basis of picture-taking experience you find that you need to open up or stop down the lens somewhat to achieve satisfactory exposures, you must do this as a matter of individual adjustment for your combination of equipment, film, and pictorial preferences. The procedure just described pertains to those automatic flash units that provide only for a single setting.

Some automatic flash units provide a choice of two, three, or five lens-aperture settings. With such units, you must set the flash unit for both the film speed and the desired lens aperture, which then must be set on the lens (subject to adjustments when you must accommodate variations from average).

One additional control factor to keep in mind is that the sensor has an angle of coverage of about 20° to 22°, corresponding approximately to the angle of coverage of a 100mm lens. Within this angle of coverage, the sensor will interpret the subject matter—whether it is light or dark—as being average. This is fine when the subject is actually of middle-tone or average characteristics. When the subject is dark, the sensor will tell the flash to keep on putting out enough light to yield an exposure that makes the subject overexposed in relationship to its actual tonal characteristics. On the other hand, if the subject is much brighter than average, the sensor will pick up the flash reflections and cut off the flash output, thus leading to underexposure. This is where your own

thinking comes into play. When working with darker subjects, you prevent overexposure by stopping down the lens a half or full stop as necessary. With lighter than average subjects you prevent underexposure by opening up the lens aperture one-half or one full stop, depending on circumstances. If you have a mixed subject, you must either rely on the averaging out effect or you must decide to favor one or the other for proper exposure.

It is important to have major reflecting objects within the angle of view of the sensor in line with each other and at about the same distance from the flash. For example, if you have a group of three people, all of whom are within the angle of view of the sensor, and if the one in the middle is at a greater distance from the flash, the exposure will be governed by the presence of the two people closer to the flash. The result would be underexposure of the central subject. The same effect would be achieved if you were shooting through a doorway that fell within the angle of view of the sensor. The sides of the door would be properly exposed, but objects beyond would be underexposed. On the other hand, when there is no center subject the exposure will be for reflecting surfaces at a greater distance; thus, important foreground objects, which may be of primary interest but which do not fall within the angle of view of the sensor, will be badly overexposed. In like manner, you will find through experience that exposure of contrasting subjects will require a whole new set of rules. Thus, a very small object of principal interest will not be averaged in against a contrasting background. In some cases you must decide to set the flash for its manual mode and be governed by the flash guide-number system, explained below.

When using an automatic flash unit that is set for only one *f*/stop, as governed by the speed of the film, you can still have flexibility in expanding depth of field through use of neutral density filters attached to the sensor. The neutral density filter has the effect of persuading the sensor that less light is being reflected from the subject. Thereby, more light is emitted, which enables you to use a smaller *f*/stop for greater depth of field, particularly when you are working at intermediate distances in which objects are spaced at varying distances from the flash.

The conversion of an automatic flash into a manual unit with a fixed flash duration of about 1/50,000 sec. is accomplished by reflecting light directly from the flash head toward the sensor. One way of doing this is to fit a piece of lucite into the sensor opening with the other end protruding just over the front of the flash head. The lucite can easily be bent by heating to enable you to achieve desired curvatures. In effect, you have created a light pipe. You might also make this from a bundle of fiber optics made suitably rigid. The operational effect is that the automatic flash unit is deceived into thinking that it is working at the closest possible distance to the subject. Through trial and error you can derive your own personal guide numbers for the films you use. You will have no doubt then that you will be freezing action.

Automatic flash units are a relatively new development, so we can expect changes and improvements from time to time, as has been the case generally in the development of electronic flash.

Bare-Bulb Flash

The bare-bulb flash unit—whether electronic or combustible-bulb flash—does not have a reflector to drive the light emitted by the flash lamp. The lamp is placed in a vertical position, so its light beams out in all directions uniformly, just as though it were the light of a candle. The effect of this type

of illumination is a combination of a point source and diffuse illumination. In effect, all of the closest walls, ceilings, and other surfaces become elements of a complex reflector, driving light from different angles onto objects within camera view. There is great evenness of illumination despite differences in distance from the camera as well as the flash.

One advantage is that the bare-bulb technique permits the use of wide-angle lenses, which otherwise would project images showing light falloff toward the edges. With bare-bulb units, the wide-angle lenses have greater uniformity of coverage.

Some electronic bare-bulb outfits are sold without reflectors, but some are available with optional reflectors, so they can be used in both ways. The Minolta flashbulb unit can be used as a bare-bulb unit by collapsing the fan and tilting the bulb receptacle so that the bulb points directly toward the ceiling.

Bare-bulb flash units are often used in conjunction with umbrella reflectors, as described below. Typically, bare-bulb units are mounted on light stands and placed in a corner of a room about one foot away from the ceiling. In this way, the three wall and ceiling surfaces act as a giant reflector, throwing diffuse illumination over the area of coverage. In some cases, for maximum uniformity, two bare-bulb units are used, synchronized either by common wiring inputs or by use of flash slave units. Of course, the units must be so placed that they are outside of the viewing range or scope of the camera lens. Be particularly careful of this when you are using wide-angle lenses.

Slave Units and Multiple Flash

Two or more flash units can be fired simultaneously either by wiring them into the same circuitry or by triggering them with slave flash units. The purpose of multiple flash is to achieve balanced lighting of a subject and to control shadows. Sometimes multiple flash is used to increase output at a single light source.

The simplest technique for wiring two or more flash units together is through use of a three-way connector that accepts PC tips from flash extension cords. The connector has a single PC tip of its own to be attached directly to the camera. This arrangement can work well, but there is always the risk that the whole unit might not remain attached to the camera or that one of the extension cords might become detached in the course of movement. An alternative is for several flash units to be plugged into a single power supply box that has a cord running to the camera synchronization terminal or to a flash unit attached to the camera. Such an arrangement is, obviously, most suitable for studio conditions, although there are portable flash outfits that operate on the same basis. On the whole, they are not appropriate for most amateur or journalistic photography.

The most recent advance in multiple flash photography lies in the perfection of slave flash units. These are triggering devices that are connected to a flash unit that is independent of—not wired to—the main flash unit connected to the camera. Hence, you can have as many independent flash units spotted around the picture-taking location as you desire, provided each has a slave trigger attached to it in line of sight of the main flash. Most flash slaves are of solid-state design using light-actuated silicon-controlled rectifiers (LASCR), although in some cases other electronic designs are used. Typically, the slave unit has a set of male prongs to fit into a female receptacle on the flash unit. These are similar to household plugs and receptacles. If the flash unit does not have a female receptacle, you can attach the slave to

the flash synch cord through the use of an intermediate PC-H converter, available from many camera dealers. This converter has a male PC tip to attach to the flash cord and a female receptacle to receive the slave unit.

The important thing to observe is that each flash slave must be in line of sight of the main flash so as to pick up its burst of light, which serves as the triggering action for all of the slave units simultaneously. The direction of the flash head attached to each slave unit does not matter as long as the slave trigger itself is within line of sight of the main flash.

A slave unit of good quality should be used—one that is highly selective in picking up the brilliant burst of the flash independent of any ambient light that might be present. The slave unit should not be triggered off by bright sunlight or by bright indoor continuous lighting. It should be responsive only to the brilliant pulse illumination of another flash unit. This can present complications, however, when several photographers are working in the same area, because a flash unit fired by another photographer may also trigger off your own slave units.

Polarity must be maintained. Polarity refers to the direction of flow of electrical current. When you hook up the flash unit to the slave, the flash should ordinarily fire, provided it is already charged. If this does not occur, the male plug should be reversed.

The principles of exposure measurement for multiple light sources are as described in the preceding chapter, but the Minolta Flash Meter provides a most convenient arrangement, as described below.

Special-Purpose Flash Equipment

One of the more common of the special-purpose flash units is the ringlight. This is an independent flash apparatus or an accessory for an electronic flash unit. The ringlight is a circular lamp that attaches to and surrounds the lens for the purpose of achieving shadowless illumination.

A common use of ringlights is in medical and dental photography, for they drive light into surgical openings, the mouth, and other body orifices without blocking out important details of tissues by casting harsh shadows, as would be the case with ordinary flash units or other point sources of illumination. Ringlights are also used in photography of small objects, particularly when shadow contrasts are not desired. Consequently, the shadowless lighting creates an effect of flatness, especially noticeable in black-and-white photography. Somewhat better contrasts are achieved in color photography when the subjects are rich and deep in tone and hue, provided they are not washed out through overexposure.

From an operational standpoint, the ringlight at the very front of the lens makes it possible to work at very close distances, particularly when close-up attachments or accessories are being used. At very close distances the ringlight must have some means of controlling light output, or there could be gross overexposure. Alternatively, neutral density filters can be screwed into position in front of the lens to reduce illumination. Still another way of reducing light output (which would require some trial-and-error exposures in order to arrive at suitable guide numbers for exposure control) is to cover equally spaced portions of the ring with black tape.

You can also tape the ringlight in order to control the direction of light output when you want shadow contrasts, as for photography of embossed surfaces, such as coins and medals. Covering up somewhat more of the ringlight on one side than on the other

provides more light output on a directional basis. Each commercially available ringlight may have its own characteristics and its own angle of coverage as determined by the design of the reflector mirror that makes up part of the ringlight lamp.

The Bowens Texturelight, a British product, is an interesting variation on the ringlight design. It is not actually a ringlight but a square arrangement of four straight flashtubes that box in the lens. The four flashtubes can be fired together or a smaller number can be fired as desired to achieve selective texture and shadow patterns.

With conventional ringlights, pictorial contrast can be improved through developing and printing techniques in the case of black-and-white films and through use of the slower color films, which have more brilliant contrast characteristics.

When acquiring or using a ringlight with your Minolta equipment you will need to have either a 52mm or a 55mm adapter ring to permit attachment to the particular lens you are using.

Another type of flash intended mainly for studio use, including home studios, has a built-in modeling lamp for purposes of previewing the light and shade patterns that can be achieved at different heights and distances from the subject. The modeling lamp is a low-level continuous source of lighting. When you observe the desired lighting pattern with two, three, or four modeling lamps, all of them supported on light stands, depress the shutter release on the camera. The flash units will be fired and will yield equivalent patterns, at the full level of light intensity. The low light from the modeling lamp will not materially alter the final exposure.

Stroboscopic flash units make multiple exposures on a single frame of film in rapid sequence. Thus, a stroboscopic picture of a golfer swinging his club at a ball would appear as a series of individual pictures showing the progressive stages of the swinging arm and golf club, each clearly and sharply delineated. Two inexpensive stroboscopic units on the market can be set to flash up to 30 times a second at a duration of about 1/10,000 sec. each. On a single negative or color transparency set for a time exposure of three seconds, you can record an action sequence in approximately 100 separate images. One available unit is the Spiralite Stroboscope; another is the Wein WP/10RF Cronoscope. The latter is the more powerful unit.

Stroboscopes are used for time and motion studies, quality control analyses, special-effect and advertising photography, and special teaching purposes. A convenient way of firing the unit so as to record the beginning of an action is to attach to it a sound slave trigger. If, for example, you wanted to catch the impact of the golf club on the ball and the continuation of the drive, the sound slave trigger would catch the very moment of impact or explosion and set the stroboscope flashing.

FLASH EXPOSURE MEASUREMENT

The key problem in arriving at an exposure for a flash-illuminated scene is to predict correctly the amount of light that will be reflected from the subject. This may be contrasted with the procedure followed in picture-taking with continuous lighting sources when you can take measurements of the actual conditions before the exposure is made. An exception to this is the use of modeling lamps, which enable you to take exposure readings under low-light-level conditions and to extrapolate from them to the more brilliant outputs from

the same lighting sources when the actual flash exposure is made. This kind of procedure, however, is best suited for professional and home studios and for more elaborate mobile lighting setups. In the material that follows we will cover techniques for predicting correct exposure through use of dials on flash units, guide numbers, and exposure tables. We will also cover the use of the Minolta Flash Meter in measuring test flash exposures that represent the actual conditions to be encountered when the exposure is made on film.

Estimating a Proper Flash Exposure

As discussed above, you have a choice of two terminals into which to plug the connector cord from your flash unit: an "X" terminal for electronic flash and for flashbulbs when the shutter setting is at 1/60 sec. and slower; an "FP" terminal for certain flashbulbs having long peak durations—AG-1, M-3, 6 and 26, and their blue-tinted counterparts designated by the letter "B" after the bulb designation.

With electronic flash, the duration of exposure—1/60 sec. or more—always exceeds the duration of a single burst of flash illumination. As a practical matter, when working indoors, you do not have to take account of ordinary light levels in computing your exposure, but in brightly-lit areas the existing light can influence exposure somewhat, particularly in filling in shadow areas. When using electronic flash as supplemental lighting outdoors you have a different problem, because you must reckon both with the more powerful daylight as well as with the flash output.

When working with continuous lighting sources you are able to take advantage of the reciprocal relationship between lens aperture and shutter speed, such as using a faster shutter speed with a smaller lens aperture or vice versa. When using electronic flash you cannot do this, since the ordinary flash duration will be in the range of 1/500 to 1/1000 and sometimes 1/1500 sec. Hence, with a given lens aperture, it would make no difference whether you set the shutter speed at 1/60 sec., 1/30 sec., 1/15 sec., and so on. You would use the slower speeds only if you wanted to pick up more of the existing light to enable it to have an influence on the final exposure. In such a case, incidentally, you would need to do some trial-and-error exposures or do some bracketing of exposures in order to achieve a variety of exposure effects in the hope that one would satisfy you. You have much the same problem when using flashbulbs other than those listed above at speeds of 1/30 sec. or slower. These are the short-peak flashbulbs. In order to take advantage of their maximum output you use the slower shutter speeds.

When using flashbulbs that have a long peak, you can use shutter speeds faster than 1/60 sec. because the flash output continues at about the same light level throughout the brief time that the opening in the shutter curtain travels across the focal plane. The faster the shutter speed, the narrower will be the opening in the shutter curtain and, hence, the less light will get through to the film.

When using flashbulbs having long flash durations, as listed above, you can take advantge of reciprocal relations between lens aperture and shutter speed beginning with 1/60 sec. and faster. In other words, if you know the correct exposure in a given instance to be *f*/11 at a distance of nine feet with a shutter speed of 1/125 sec., and if you want greater depth of field, you can set the lens for *f*/16 (one stop smaller) and a shutter speed of 1/60 sec. (one doubling of shutter speed).

A simple way of calculating flash exposure is to refer to the dial on the back of your flashbulb unit or your

electronic flash unit. In most cases, you set your distance from the principal subject opposite an index mark on the dial and then you find the correct lens aperture opposite the appropriate film exposure index, which is printed or embossed on the dial. For average conditions you should expect to obtain a correct exposure. The problem, however, is that many interior situations and subjects depart from the average, thus calling for you to exercise some judgment as to whether you need to open up or stop down the lens. This is discussed further in connection with the use of flash guide numbers.

The flash guide number is provided by the manufacturer of the electronic flash or flashbulb and sometimes by the film manufacturer as part of the accompanying instruction booklet or leaflet. In all cases the manufacturer reminds you that the guide number is for average rooms and subjects. With electronic flash you get a single guide number for use with each film exposure index.

When using combustible flashbulbs, as listed above, you need to refer to a flash exposure table to find the particular guide number for your combination of shutter speed and film exposure index. Usually, ASA exposure indexes are listed across the top of the table and shutter speeds are listed in descending order on the left. At the point of intersection of any two of these you will find the recommended exposure guide number. The recommended guide number usually assumes that you are using a polished, bowl-shaped reflector. In fact, the most commonly used combustible-bulb flashguns (such as the Minolta Flash Gun) have fan-type reflectors, which afford wider angles of coverage and more diffuse light and are better suited for most picture-taking situations. The fan-type

FOCAL PLANE GUIDE NUMBERS

Use FP Synchronizer Setting

AG-1 WITH 2 INCH POLISHED REFLECTOR

ASA Film Speed	25	32 40 50	64 80 100	125 160 200	250 320 400	500 640 800	1000 1250 1600
1/30 or slower	75	95	135	190	270	370	530
1/60	80	100	140	200	280	400	550
1/125	55	70	100	140	200	280	400
1/250	40	50	70	100	140	200	280
1/500	28	35	50	70	100	140	200
1/1000	20	25	35	50	70	100	140

AG-1B WITH 2 INCH POLISHED REFLECTOR

ASA Film Speed	25	32 40 50	64 80 100	125 160 200	250 320 400	500 640 800	1000 1250 1600
1/30 or slower	65	80	110	160	220	320	450
1/60	70	90	125	180	250	350	500
1/125	50	65	90	125	180	250	350
1/250	35	45	65	90	125	180	250
1/500	25	32	45	65	90	125	180
1/1000	18	22	32	45	65	90	125

M3—WITH 3-6 INCH POLISHED REFLECTOR

ASA Film Speed	25	32 40 50	64 80 100	125 160 200	250 320 400	500 640 800	1000 1250 1600
1/30 or slower	125	160	220	320	450	650	900
1/60	120	150	210	300	420	600	850
1/125	85	105	150	210	300	420	600
1/250	60	75	105	150	210	300	420
1/500	42	55	80	110	160	220	320
1/1000	30	40	55	80	110	160	220

M3B—WITH 3-6 INCH POLISHED REFLECTOR

ASA Film Speed	25	32 40 50	64 80 100	125 160 200	250 320 400	500 640 800	1000 1250 1600
1/30 or slower	110	140	200	280	400	550	800
1/60	100	125	180	250	350	500	700
1/125	70	90	125	180	250	350	500
1/250	50	65	90	125	180	250	350
1/500	35	45	65	90	125	180	250
1/1000	25	32	45	65	90	125	180

NO. 6—WITH 4-6 INCH POLISHED REFLECTOR

ASA Film Speed	25	32 40 50	64 80 100	125 160 200	250 320 400	500 640 800	1000 1250 1600
1/30 or slower	125	160	220	320	450	650	900
1/60	90	110	160	220	320	450	650
1/125	65	80	110	160	220	320	450
1/250	45	55	80	110	160	220	320
1/500	32	40	55	80	110	160	220
1/1000	22	28	40	55	80	110	160

NO. 6B/26B—WITH 4-6 INCH POLISHED REFLECTOR

ASA Film Speed	25	32 40 50	64 80 100	125 160 200	250 320 400	500 640 800	1000 1250 1600
1/30 or slower	100	125	180	250	350	500	700
1/60	70	90	125	180	250	350	500
1/125	50	65	90	125	180	250	350
1/250	35	45	65	90	125	180	250
1/500	25	32	45	65	90	125	180
1/1000	18	22	32	45	65	90	125

reflector calls for use of a smaller guide number, which is found by multiplying the indicated guide number by 0.7. Some film instruction sheets give guide numbers for the most common types of reflector-flashbulb combinations.

Once you have the guide number, the next step is to find the distance from the main flash source to the principal subject. This distance (not that from camera to subject) is divided into the guide number to give you the appropriate *f*/stop. For example, with a guide number of 80 and a shooting distance of ten feet you would get *f*/8 as the indicated *f*/stop. Intermediate *f*/stops not shown on the lens mount can be set by turning the lens-aperture setting ring to an intermediate setting.

You may wish to personalize your guide numbers for the films you most frequently use under your most common picture-taking situations. A simple procedure to follow is to take a series of pictures at a distance of ten feet from your subject. One picture should be taken at the *f*/stop derived from the standard or average guide number recommended by the manufacturer. Then, two pictures should be taken at successively smaller *f*/stops and then two at successively larger *f*/stops. This procedure is best carried out with color transparency films, which are developed on an assembly line. When you inspect the series of slides after development, pick the one with the most pleasing result and multiply the numerical value of the *f*/stop used to take that picture by ten, representing the distance. The result is your personal guide number for those shooting conditions with the particular light source and color film. For other films you can find appropriate guide numbers for the same lighting source and similar picture-taking situations according to the procedure that follows.

Assume that you have derived a personal guide number for a particular combination of flash, film, and situation, and you wish to convert this for another film. Divide your personal guide number by the original guide number for average conditions recommended by the manufacturer. This will give you a ratio index factor, or multiplier, which will enable you to convert any other guide number to a personal one for any combination of film or shutter speed in conjunction with the same flashbulb or electronic flash used in finding your personal guide number. Assume, for instance, that your personal guide number is 56, while the original recommended guide number is 80; 56 divided by 80 will give you 0.7 as the multiplier. Now, you can use this to multiply any other standard guide number using the same flash source.

In another situation, suited to faster films or to pushing black-and-white or color films, you again need to find a guide number multiplier. The procedure can work either for personal guide numbers or for standard (average conditions) guide numbers. Divide the faster film rating by the known standard film rating to find out the number of "times greater" the faster film is than the known slower film. Assume, for example, that you will rate a film at ASA 400 for exposure and development purposes, even though its nominal rating is ASA 160. Dividing 400 by 160 gives you 2.5. In the accompanying table of multipliers corresponding to this "times greater," this would fall somewhere between 1.4 and 1.7. Since there is a nonlinear relationship in the guide numbers, you would interpolate to find a multiplier of 1.6. This multiplier can then be used with any of the guide numbers for the regular film rating with which you started.

Although it is simple to divide distance of subject from your principal lamp source into the guide number in order to find the appropriate *f*/stop, you must also take account of several other factors, such as size of room, brightness

of reflecting surfaces, brightness of subject, and shape and texture of the flash reflector. For large rooms, darkly decorated rooms, or outdoor flash at night, open the lens one *f*/stop. If two or more light-diffusing or light-consuming elements are present, open the lens aperture even more. Conversely, a small, bright room would call for stopping the lens down one *f*/stop more than indicated or perhaps more if you have a really small bright area such as a kitchen.

Sometimes you will find a fast film in your camera combined with a particular flashbulb giving you an indicated exposure beyond the range of *f*/stops for your lens. You can reduce light on the subject through the old handkerchief trick: A single thickness of a white handkerchief in front of the flashbulb (but not touching it) increases the allowable exposure by one *f*/stop. A double thickness increases the exposure by two *f*/stops.

You could also increase the travel distance of the flash source. One way is to put a longer focal length lens on the camera so you can move back to increase lamp-and-camera distance from subject by 50 per cent (or, with an extension cord, you can move the lamp back the same distance). This enables you to use an aperture one *f*/stop greater; for two *f*/stops greater the lamp (with or without lens change) would have to be moved back to a distance twice that of the original.

Light reduction can also be accomplished by firing the flashbulb without a reflector (bare-bulb technique). With all of the flashbulbs suitable for use with the Minolta Flash Gun, this would reduce the guide number for average conditions, based on use of a polished reflector, by two-thirds. For example. a guide number of 120 would be reduced to 40. Still another technique of reducing light output, as described below, is the bounce flash technique.

If you are not getting enough light on the subject, you can move closer or use more powerful lamp sources or you can use a lens with a wider aperture. By reducing the distance of the lamp from the subject by 25 per cent, you can use one *f*/stop smaller. By moving the lamp in halfway, you can reduce the originally required *f*/stop by two full positions.

Another means of personalizing or modifying guide numbers is on the basis of actual results. If your flash pictures are frequently underexposed or overexposed, change your working guide number for the particular flash, film, and shutter speed combination by the indicated multiplier according to the accompanying table.

On-Camera/Off-Camera Flash

Most run-of-the-mill flash pictures are taken with the flash unit mounted on the camera so that both camera and flash are at the same distance from the subject. This affords greatest mobility because you do not have to worry about

MODIFYING GUIDE NUMBERS

If you switch from a slow film to a faster one . . .

Times Greater	Multiply Guide Number By
2	1.4
3	1.7
4	2.0
5	2.2
7.5	2.7
10	3.2
12	3.5
16	4.0

If your flash or flood pictures are frequently . . .

Underexposed by	Multiply Guide Number by	Overexposed by	Multiply Guide Number by
½ f/stop	.8	½ f/stop	1.2
1 f/stop	.7	1 f/stop	1.4
1½ f/stops	.6	1½ f/stops	1.7
2 f/stops	.5	2 f/stops	2

extension cords, light stands, and people to help you move equipment when you want to change positions. From a creative standpoint, however, this produces pictures that leave much to be desired, since they do not duplicate the natural lighting conditions under which most subjects are observed. The effect with on-camera flash (unless you tilt the flash unit for a bounce-light effect as described below) is a frontal lighting punch, which casts a deep shadow directly behind, above, or below the subject, depending upon the shooting angle.

If the camera is held level and is pointed directly at the subject's eyes (or if otherwise the lens and subject's eyes are aligned on the same axis) you may get the notorious "red eye" effect, which in color photography is caused by that frontal lighting thrust penetrating the eye and illuminating the retina. Another problem is glare from highly reflective or shiny surfaces such as polished furniture, mirrors, bright metallic objects, or glass surfaces. For both the red eye and the reflection problem you can shoot at an angle or get the subject to look away from the camera. In the latter case this restricts picture-taking freedom. In the case of red eye, when the flash unit is extended some inches away from the lens and you are fairly close to the subject, being aligned with his eyes as seen through your reflex viewfinder will assure you that the light source is at an angle to the optical axis and therefore is not likely to produce the red eye effect. The further away you get from the subject, however, such as when using a long focus lens, the narrower will be the angle and the greater will be the possibility of achieving the undesired effect.

While these problems do not relate directly to estimation of exposure, they are inconvenient trade-offs for the simplicity of on-camera exposure computation. With the flash at the camera all you need to do is divide distance into guide number to obtain the *f*/stop, subject to modification up or down depending upon conditions or variables described above. An alternative is off-camera flash, which enables you to place the main flash source at any position that will give you the desired highlight and shadow effects. Typically, when using one flash unit away from the camera you hold it in your left hand, high and to the side, with your left arm extended rigidly at an angle. The flash is connected to the camera by a flash extension cord. This connects to the tip of the flash-unit cord and at the other end connects to the appropriate flash terminal on the camera. The only problem you might encounter is that a loose-fitting connector cord may become detached. Some flash extension cords are designed to be slip-proof. Ask your camera dealer about these.

When shooting with the flash extended in your hand so that you do not materially change the distance of the flash from the subject, compute the guide number as if the flash were on camera. If you are increasing distance from the subject—usually something close to you and lower than your own line of sight—compute exposure based on your estimated distance of flash from subject.

If the flash is placed on a stand closer to the subject (but out of the field of view of the camera lens), compute exposure based on distance of lamp from subject rather than of camera from subject.

Incidentally, when holding the camera with one hand and the flash in the other, it is a good precaution to have a neck strap in place to keep the camera from inadvertently slipping from your hand. Also, instead of a light stand or a handy human helper for the off-camera flash, you might use a clamp (available from most well-stocked camera shops) to

attach the flash unit to a convenient lamp stand, bookcase, door frame, or other available support.

Multiple Flash

Multiple flash is the taking of pictures with two or more flash units. The exposure problem is to calculate the cumulative output of the flash sources in terms of their reflective volume, considering that the latter is what ultimately governs your choice of exposure. Some of the techniques of multiple flash have already been discussed in connection with the description of lighting sources, including slave units. Additional information will be provided below in the discussion of basic lighting techniques. A few notes are given here on how to compute exposure.

Exposure depends upon placement of the flashbulbs. If more than one flashbulb or electronic flash is aimed at the subject from a main picture-taking position in order to increase light output, such as when working at a considerable distance from the subject or in a large room, the computation formula for obtaining a new guide number is to multiply the guide number for one lamp by the square root of the number of lamps being fired. For two bulbs, this would give you a multiplier of 1.4; for three bulbs or flash lamps, the multiplier would be 1.7, while for a cluster of four identical lighting sources the multiplier would be 2.

If one flash lamp is used as a main light source with others used for filling in shadows or providing supplemental highlights, exposure is based on the distance of the main lighting source from the subject. In other words, the use of supplemental lighting sources does not alter the exposure computation, since it is governed by the effect achieved by the principal lighting source. You need only make an adjustment when working in a small, brightly decorated area in which some of the additional flash illumination may be expected to bounce back onto the subject. In that case, you might have to set the lens aperture from one-half to one full *f*/stop smaller.

In a wired arrangement of multiple flash units, all will be fired simultaneously when the shutter-release button is pressed. Hence, you can use the "X" or "FP" flash terminals as appropriate to the type of flash source together with allowable shutter speeds. With electronic flash, using the "X" terminal you can have a shutter speed of 1/60 sec. or

SYNCHRONIZATION FOR MULTIPLE FLASH

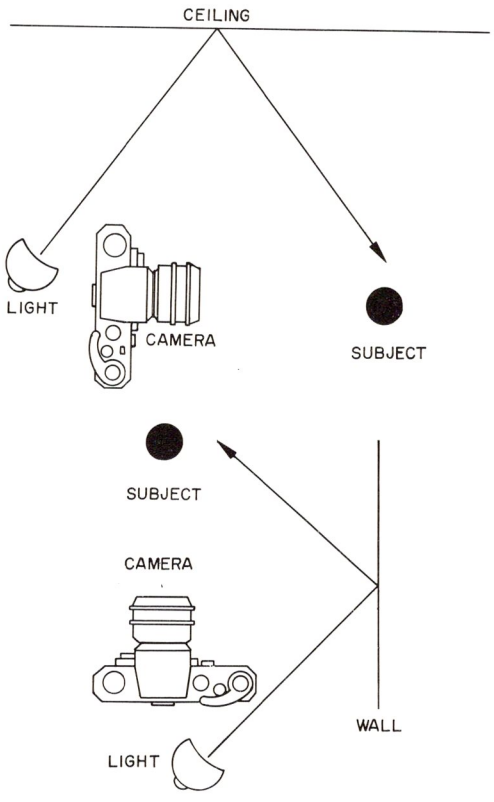
Multiple-Flash System	Type of Flash Lamp at Camera	Type of Flash Lamp at Extension	Set Sync on Camera	Shutter Speed (sec)
				Focal-Plane Shutters
WIRED	Electronic	Electronic	X	Up to 1/60
	Class M	Class M	M	Up to 1/30
	Class FP	Class FP	FP	Any
SLAVE	Electronic	Electronic	X	Up to 1/60
	Electronic	M-2 or AG-1	X	Up to 1/30
	M-2 or AG-1	Electronic	X	Up to 1/500
	Class FP	Electronic	FP	Up to 1/60

slower. With class FP bulbs (6 or 26) you can use any shutter speed. With AG-1 or M-3 bulbs (and their FP equivalents in some countries) you can also use any shutter speed with the "FP" terminal. With all other flashbulbs you would use the "X" terminal and a shutter speed of 1/30 sec. or slower.

In a flash slave system there is an inevitable lag between the firing of the master unit and the time the slave units go off. Hence, the safest procedure is to use a shutter speed of 1/30 sec. or slower, although when using an electronic flash or a class FP bulb to fire electronic slaves, you can use any slow speed up to 1/60 sec.

Bounce Flash

In bounce flash you point your flash equipment so that the lamp is targeted toward a point on the ceiling from which the light is reflected onto the subject. This is the most common approach. The Minolta Flash Gun and some electronic flash units are designed for tilting to make bounce flash more convenient. You can also obtain bounce-flash adapter brackets from camera dealers to be fitted to the base of your flash unit. Their effect is to diffuse the light, thereby taking away from its harshness, and to extend its distance of travel so as to achieve greater uniformity of exposure.



Two kinds of bounce lighting.

Bounce flash can also entail use of walls and other reflecting surfaces as giant, secondary reflectors. The inverse square law, described earlier in this chapter, is still applicable: If you bounce light off a single surface, it will illuminate subjects over a wide area in some depth, but the light will still tend to grow weaker with its travel distance.

When the flash is bounced off the ceiling at an angle, it gives the photographer much more latitude for movement toward and away from the subject without having to make fine lens-aperture adjustments.

Unusual effects can be achieved by bouncing a flash off the wall facing the subject or off the wall behind the subject. In the latter case, it is necessary to use a secondary reflector or a fill-in flash. A flat reflector or a very shallow one, when pointed toward the ceiling, will spill some light directly at the subject. The effect is to fill in shadows under prominent features—eyes, nose, lips, and chin—which otherwise might be darkened excessively by light reflected from above. When using this technique you should have the reflector at the same level as the subject's face.

Exposure is influenced by the reflective properties of the wall or ceiling, distance from flash unit to reflecting surface and from there to the subject, and reflective properties of the subject itself. There are no certain procedures

that will guarantee precisely correct exposures every time because each room and its contents have their own reflective properties in relation to the distance of the flash unit from reflective surface and subject. The ideal solution is to use the Minolta Flash Meter because this takes account of all the variables operating simultaneously through a test exposure.

A rule of thumb, first, is to use sufficiently sensitive films—medium- and high-speed black-and-white films and high-speed color films. (Incidentally, color films will pick up the tint of the reflective surfaces. You might be able to use a compensating filter, but not always.) From here on out, various rules of thumb are used to find the best lens aperture when you have to compute exposure by formula rather than through the use of a flash meter. You can calculate the combined distance of flash to secondary surface to subject and then divide this into the guide number. For good measure, you would open the lens an additional *f*/stop. Another rule of thumb is to calculate the *f*/stop needed for the distance across the open space between flash and subject (as though you were using straight flash) and then open up two additional *f*/stops. Depending upon the darkness of the reflecting surfaces, you could open up one or two more *f*/stops, providing you have this latitude. Conversely, in an exceptionally bright room you might have to cut back on the size of the lens aperture.

An additional use for the bounce-flash technique is to fill in shadows when taking existing-light pictures. The flash fill must be much weaker in light output than the existing light source—perhaps in the ratio of 1:2—in order to retain the existing-light effect. Each subject has its own solution as to choice of reflecting surface for flash fill-in. If necessary, use the handkerchief procedure described above for reduction of light output.

Ordinary room light should be taken into account if reasonably bright, because you will be using wider lens apertures, which permit existing light to register on the film. Take an independent exposure reading of the subject under existing light conditions to estimate how much effect it will have. If the room is dimly lit you need not bother with this technique.

Exposure can also be computed by the simulation method, in which you use a continuing light source. Point a flood lamp at the reflective surface toward which you will subsequently point the flash source. Then take an exposure reading from a principal subject. Now, point the same flood toward the subject. Find the ratio between the two types of lighting. Then, when using bounce flash, calculate the exposure for direct flash and reduce it by as many *f*/stops as would have been necessary if you used flood. This technique will hold for the particular situation, but after a while you can derive enough experience from many situations to obtain your own rule of thumb for making bounce-flash exposures.

Fill-In Flash

The *fill-in flash technique* is used outdoors to soften hard shadows formed by the brilliant directional lighting of the sun. One of the more dramatic applications is in portraiture when the subject's back is to the sun with flash used to fill in the dark side of the face in front. The hair comes out luminescent, even fiery, depending upon the brilliance and angle of the sun and the color of the hair. News photographers make a great deal of use of flash outdoors since they cannot control the direction of the lighting or whether or not a subject may be wearing a wide-brimmed hat, which throws a deep shadow over the face. Fill-in flash is also used outdoors to give punch and depth to subjects that are illuminated by flat, shadowless light.



The soft lighting of the model was provided by bounce flash, which overcomes harsh shadowing. Robert Dehesdin used the 300mm f/4.5 lens with an extension ring for closer focusing. For the textured appearance, Kodak Recording Film No. 2475 was used, developed in HC110.



Bounce flash used selectively can be directed toward the subject. For a smooth texture, Robert Dehesdin developed Agfapan 100 in Atomal. 50mm Macro Rokkor.

Blue flashbulbs should be used with color film; blue or clear flashbulbs can be used with black-and-white film.

The first step is to find the daylight exposure for the sunlit area. Then divide the *f*/stop into the exposure guide number to find the middle distance at which you should work. If you want the fill-in to be brighter, move forward; if you want it to be darker, move backward. Under this system, if you want to maintain control over image size, use interchangeable lenses. You can also try covering the flashbulb with one thickness of handkerchief, which is the equivalent of moving forward about one-third of the distance.

Another way of controlling the amount of flash illumination recorded on the film is to change the shutter speed and *f*/stop combinations and use FP-type flashbulbs. These will not affect daylight exposure if you make normal compensating changes: faster shutter speeds cut down on the amount of flash illumination and slower shutter speeds allow more flash illumination to be recorded.

Another technique, recommended by the Eastman Kodak Company, uses reference tables that work for any film speed because they are based on the *ratio* of flash to sunlight. The following steps are involved:

1. Your subject is placed with his back or side to the sun.

2. Consult the accompanying flashbulb table for the proper combination of reflector, flashbulb, and shutter speed. This will lead you to the desired working distance from the subject. Within each block of the table you will find a range of three distances. At the near distance you will get a 2:1 lighting ratio, at the middle distance the lighting ratio will be 3:1, while at the far distance you will get a slight fill-lighting ratio of 6:1.

3. Set the camera shutter and lens opening as indicated and shoot the picture.

4. To get closer use handkerchief thicknesses, as described above. You can also vary subject size in the viewfinder and on the film by using lenses of appropriate focal lengths.

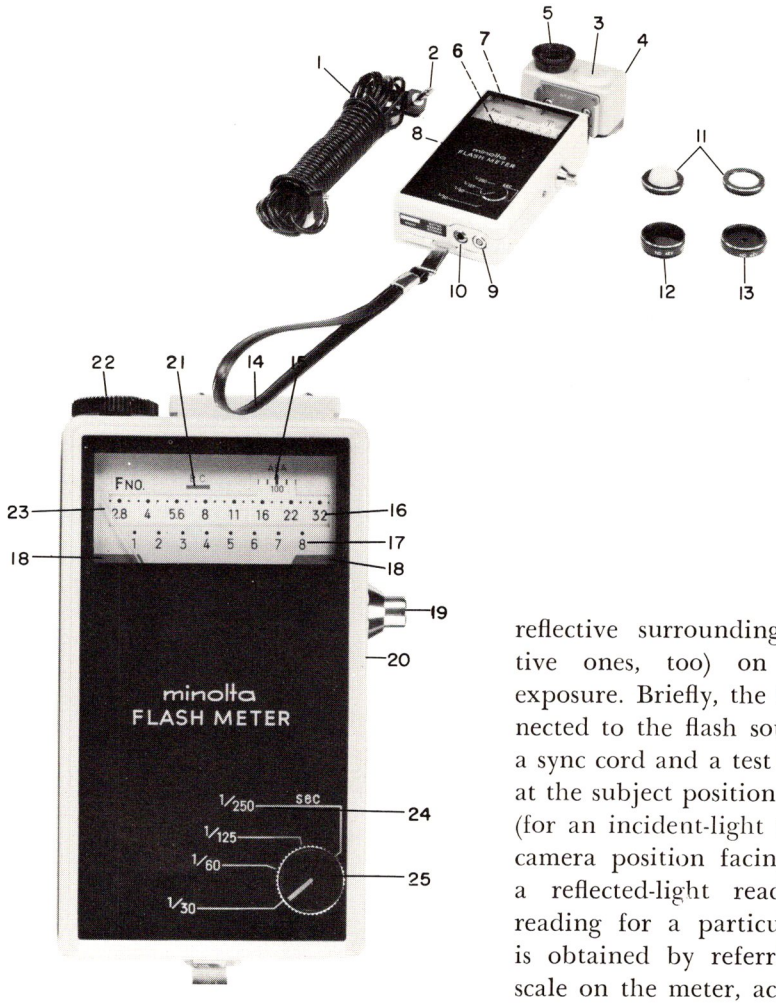
Your fill-in flash should tend to be on the side of slight underexposure to protect the overall effect. With black-and-white film, when the negative is printed, an overexposure of an important foreground subject would cause the rest of the outdoor scene to seem dark and underexposed. With color slide film the overall scene would tend to be properly exposed while the particular object which was "painted" with fill-in flash would, if overexposed, look excessively thin and washed out.

The Minolta Flash Meter

The Minolta Flash Meter is a professional instrument that enables you to take readings for all the light that will fall on your subject under actual conditions of exposure at predetermined shutter speeds. With this meter you can dispense with guide numbers and with subjective estimates of the influence of

SUBJECT DISTANCES FOR FILL-IN FLASH WITH ELECTRONIC FLASH (Distance in Feet)

Output of Unit BCPS (or ECPS)	Shutter Speed with X Synchronization	
	1/30	1/60
350	1½-2-3½	2-3-4½
500	2-3-4	2½-3½-5½
700	2-3-4½	2½-3½-6
1000	½2-3½-5½	3½-5-8
1400	3-4-7	4-5½-9
2000	3½-5-8	5-7-11
2800	4-5½-10	6-8-13
4000	5-7-11	7-10-15
5600	6-8-13	8-11-18
8000	7-10-15	10-14-20



Parts of the Minolta Flash Meter

1. Synch cord
2. Synch cord plug
3. Cell window
4. Reflected-light receptor-viewfinder
5. Viewfinder
6. Incident-light receptor
7. ASA number scale lock
8. Battery chamber cover release button
9. Synch terminal
10. Synch cord jack
11. Incident light diffusers
12. Glass ND filter for incident light
13. Diaphragm-type ND filter for reflected light
14. Accessory bracket
15. ASA number scale
16. f/number scale
17. Reference numbers for accessories
18. Measuring range limits marks
19. Measuring button
20. Battery check button
21. Battery check mark
22. ASA number setting knob
23. Indicator needle
24. Measuring times (shutter speeds)
25. Measuring time selector

reflective surroundings (and nonreflective ones, too) on a formula-based exposure. Briefly, the flash meter is connected to the flash source or sources by a sync cord and a test firing made either at the subject position facing the camera (for an incident-light reading) or at the camera position facing the subject (for a reflected-light reading). When the reading for a particular shutter speed is obtained by referring to the *f*/stop scale on the meter, actual exposures are made with the corresponding lens and shutter settings. That is all there is to it, except that there are other jobs the Minolta Flash Meter can perform, as described below.

The Minolta Flash Meter has an ASA range of 12 to 1600. Direct *f*/stop readings are obtained without needle-matching or other computations through the direct pointing of a sweep needle to the appropriate or intermediate *f*/stop. The rapid response of the meter to pulse illumination is made possible through the use of a blue silicon cell. Without the spot attachment, the meter weighs 14 ounces with batteries; with the spot attachment the weight is 17 ounces. The meter is powered by five Mallory PX-13 batteries or equivalent for operation and one Mallory 15-P penlight cell or the equivalent for scale illumination. Shut-

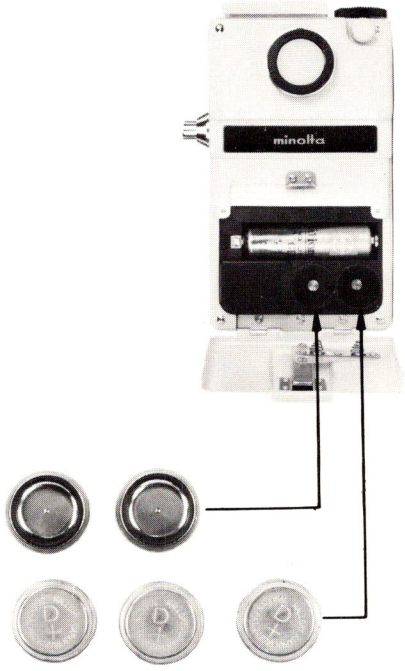
ter speeds that can be set are 1/30, 1/60, 1/125, and 1/250 sec.

The incident-light range is 22 to 2800 lux-sec. The reflected light range is 1–128 cd. sec./m^2. The response time of the silicon blue cell is ten microseconds.

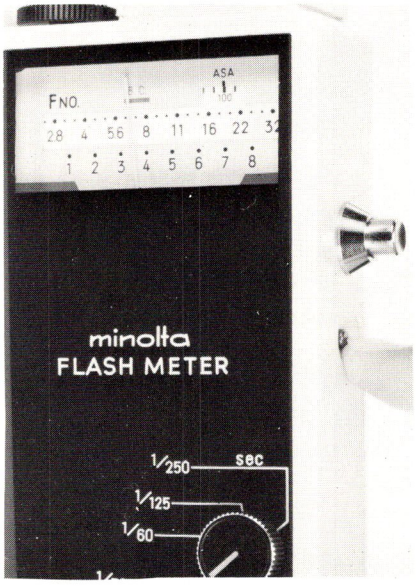
To install or replace batteries, slide down the release button on the battery chamber cover; the chamber cover will then spring upward so that it can be tilted back completely. Insert the five batteries in accordance with the "+" and "–" indications embossed inside the battery chamber. To do this correctly, drop three mercury batteries with the "+" sign facing up into the deeper compartment on the right and two mercury batteries with the "+" sign pointing down into the smaller compartment on the left. The "+" and "–" signs are at the upper right when the meter is observed with the battery chamber at the bottom. The long compartment is for insertion of an AA 1.5v penlight cell with the + and – ends of the cell positioned as indicated by the markings in the battery chamber.

The batteries should be removed from the compartment and kept in a cool dry place when the flash meter will not be used for more than a month. To check on the activity of the batteries in order to know whether or not they should be replaced depress the small red battery check button on the side of the flash meter. If the indicator needle falls within the range of the red "B.C." line on the reading scale, you will know that the batteries are delivering enough power for accurate measurement. If the indicator needle falls outside of the red checking range, replace *all* the mercury batteries with new ones. The penlight battery should be replaced when the illuminator light becomes dim.

Only two settings must be made for a flash measurement–setting the ASA film speed and setting the camera shutter speed on the meter to measure flash duration.



To install batteries, open battery chamber cover, slide release button down, and lift cover. Insert batteries in accordance with + and – indications. Five 1.35v mercury batteries must be put where shown; one penlight battery is inserted in long compartment.



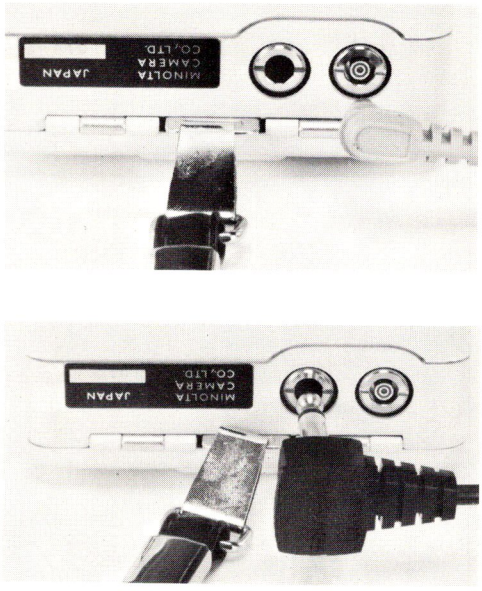
Check battery power from time to time. Depress battery check button: if indicator needle is outside red "B.C." mark, replace all mercury batteries with new ones. Replace penlight battery when illuminator light becomes dim.

The ASA number is properly indicated by turning the flat knob on top of the flash meter. To loosen the ASA-setting knob, turn the small lock button, which is just to the right of the light receptor. Once the ASA number is positioned under the small indicator mark in the scale opening, lock it in place by turning the lock button clockwise. Do not attempt to change the ASA number while the scale is locked.

When using the Minolta Flash Meter with a Minolta SR camera and electronic flash, turn the measuring-time or shutter-speed selector knob to the time value or shutter speed actually to be set on the camera—either 1/30 sec. or 1/50 sec. When using flashbulbs appropriate for focal-plane shutter speeds faster than 1/60 sec., you can use any of the four measuring times. With all other flashbulbs the measuring time should be set at 1/30 sec.

The next decision to be made is whether you will take an incident-light reading or a reflected-light reading. The relative advantages of the two methods of exposure measurement were covered in the preceding chapter. With multiple flash you may want to use the incident-light reading, particularly when you have an opportunity to stand at the subject position. Ordinarily you would use the spherical diffuser in measuring all sources of illumination, since it provides a 180° range of measurement. A flat diffuser is available for measuring a particular source of illumination. The advantages and uses of both are described in the chapter on exposure measurement. Whichever diffuser is used, you simply screw it into the receptor ring.

The 20-foot sync cord of the meter terminates into two connector cords, one with a male PC tip and one with a female PC tip. If you plan to use the meter connected solely to the flash setup, you need only to connect the male tip to the end of the flash-unit cord. If you will be making successive readings and do not wish to be bothered with connecting and disconnecting the flash equipment from the camera, you can use the second outlet of the 20-foot cord to connect both flash and flash meter to the camera through its own sync terminal.



Synch cord arrangements for incident light measurement (above) and reflected light measurement (below).

When taking an incident-light reading from the subject position, then, you would fire the flash by pressing the measuring button on the meter. The camera shutter will not be activated. To find the appropriate *f*/stop, hold the measuring button in its depressed position while you read the *f*/stop scale. When you release pressure on the button, the needle will return to zero. The *f*/stop reading on the meter should be transferred to the lens. That is all there is to it, except that you must exercise some judgment as to how to point the light receptor of the meter. Again, this was discussed in the chapter on exposure in connection with the use of incident-light meters. Some photographers like to take two readings—one with the meter pointed toward the cam-

era and another with the meter pointed toward the main light source—and then use the average of the two. This gives you a range of choice with slightly underexposed pictures resulting when you point toward the main light source and progressively more exposure as you point toward the camera. Whether the intermediate position or the one in which the meter is pointed directly toward the camera is the correct one is a matter of personal preference, although, technically, pointing toward the camera should be the correct one.

When the flat disk is used to obtain illumination values of individual light sources, the accompanying table should be used. This table shows illumination values in luces. The same table is used in conjunction with readings made with the two micro-disk receptors.

When taking reflected-light readings you will need the optional reflected-light receptor-viewfinder. This slides onto the accessory bracket on top of the flash meter and simultaneously disconnects the incident-light measuring circuit. This viewfinder has a reading angle of 10°. The area of measurement is delineated within a circle as observed through the viewfinder. The flash meter should be used at the camera position, unless you are taking selective measurements to achieve individualized effects. Instead of using the 20-foot connector cord, you can attach the flash cord directly to the meter. If you do not want to be bothered with connecting and disconnecting, you can use the same set-up as discussed for the incident-light reading.

Keep in mind that a reflected-light reading is based on average reflectance and that you must make adjustments for the reflectance characteristics of the subject, setting a little larger lens aperture for brighter subjects and a somewhat smaller lens aperture for darker subjects, again depending upon the effects you want to achieve.

When using the meter to take outdoor fill-in flash readings or to measure existing daylight, be careful not to point the receptor-viewfinder at the sun.

Regardless of which method of light measurement you use, you may find that the meter does not register enough light and the indicator needle remains in the red zone at the left when the measuring button is pressed. This means that you need to have more light on the subject, which can be achieved by: (1) decreasing the flash-to-subject distance, (2) using more flash units or more powerful flash sources, or (3) using a slower shutter speed to take advantage of ambient or prevailing light. You may also use a combination of these techniques.

Conversely, if the indicator needle remains at the right end of the scale, in the red zone, you will need to decrease the light falling on the subject by: (1) increasing the flash-to-subject distance, (2) decreasing the amount of flash illumination either by using less powerful units or by using thicknesses of handkerchief or some other translucent material over the flash, (3) using a faster shutter speed (limited in the case of electronic flash), or (4) attaching a neutral density filter as described below. Again, you may also combine two or more of these techniques.

As discussed above, to find a guide number for a particular situation, you need to find the *f*/stop indicated for use at a given distance from the subject and multiply this by that distance. You must be sure, however, that you are in line with the camera and the subject.

If you wish to measure existing light levels for a given shutter speed, within the range of the flash meter, first set the shutter speed and then depress the measuring button to find the *f*/stop.

If you wish to determine how much fill-in flash is needed, first use the meter without it being hooked up to the flash circuit to measure the light on areas of the subject other than those to be

filled in. Then connect the flash to the meter and measure the impact of the flash illumination on the areas to be filled in. The ratio between the two will tell you whether you need to increase or decrease the amount of flash illumination falling on the subject.

The neutral density (ND) filters are optional accessories that are used when there is too much flash illumination to measure. In the incident-light mode, remove the diffuser and screw in the neutral density filter. Then screw the diffuser into the ND filter ring. In other words, the ND filter is inserted between the meter and the diffuser disk.

When measuring reflected light, screw an ND filter of the diaphragm type over the CdS-cell window of the receptor-viewfinder.

Since both of these ND filters have a four-stop exposure factor, you must add the equivalent of four-stops exposure to the value shown by the indicator needle on the meter. Alternatively, you can set the ASA number four stops higher than that of the film in use. You can then use the *f*/stop indicated by the needle on the meter.

The micro-disk receptor is intended mainly for use when light is too weak for measurement with the incident-light receptor. It can also be used to find illumination levels on small subject areas for a variety of purposes through reference to the conversion table mentioned above.

Two micro-disk receptors are available. The 1H receptor is 4EV more sensitive than the infinite-light receptor of the flash meter; the 2H receptor is 5EV more sensitive. To use either receptor you first slide the accessory connector shoe onto the flash meter accessory bracket and then connect it to the desired micro-disk receptor cord. The ASA number should be set for a corresponding number of stops lower than that of the film in use or, alternatively, you must subtract a corresponding number of stops from the *f*/number indicated by the needle. In measuring illumination levels set the measuring or shutter-speed time at 1/30 sec. The reference number located under the *f*/number scale should be obtained and used in conjunction with the aforementioned conversion table.

For other applications, the accessory pin-point receptor is used together with the slide accessory connector shoe in the same manner as the micro-disk receptor, except that the reference numbers are used without *f*/stop adjustment by reference to the conversion table. As mentioned above, this application is solely for measuring light values on a ground-glass screen.

BASIC LIGHT ARRANGEMENTS

Here we take up the problem of directing light onto a subject to achieve a desired pictorial effect, which is governed by the characteristics of the subject and the lighting sources. Although most of what follows is applicable to the illumination of indoor scenes generally (and in some measure to outdoor scenes) its main use will be in the lighting of individual objects—people or things. This discussion covers both continuous sources of lighting as well as flash lighting. The use of reflectors will also be taken up: In a sense, these are also lighting sources.

Reflectors

A primary reflector is a surface, generally curved, located immediately behind an individual light source. The reflector serves to drive the output of that light source toward a particular target. Usually this is the main subject, although sometimes the aim might be to bounce the light off a secondary

reflector and from there onto the subject. Small primary reflectors that are integral parts of flash units were described above. The use of the ceiling or the intersection of two walls with the ceiling as a primary light source in bare-bulb flash was also described. Here we take up the use of umbrellas made of reflective materials to drive light toward the subject.

The umbrella-type reflector and modifications of it have come increasingly into favor with both amateurs and professionals, because they overcome certain disadvantages of direct flash and bounce flash. The disadvantage of direct flash is that it produces too much contrast between highlights and shadows and tends to burn out and lose detail in each. This is overcome somewhat through the use of bounce flash, but with this type of illumination a color tint may be reflected from surrounding surfaces onto the subject, and exposure computation is rather complicated except when flash exposure meters are used.

The umbrella reflector solves these problems, because it has a pure white reflecting surface (or one of silver) and does not alter the color temperature of the light sources. This means you can also standardize your exposure factors.

The particular advantage of umbrella lighting is in its compromise between being a directional source and emitting a soft illumination that seems to flow around the subject, tapering off ever so gradually. One or more umbrella reflectors can be used at different distances from the subject, depending upon the results desired, as described below. The lighting source can be either a flash unit or a continuously-burning lamp. The lamp is usually attached to a long rod, like the handle of the umbrella, so that the center of the lighting beam points toward the center of the reflector. The distance between the light and the umbrella is determined by experiment, but generally the aim is to illuminate the entire inside spread of the umbrella, thereby making maximum use of the light output. The lamp-umbrella assembly is usually attached to a lighting stand, although it might also be clamped to the back of a chair or a ceiling-to-floor pole. Through test exposures, made while maintaining a fixed distance between the inner surface of the umbrella and the lamp, you can arrive at a guide number for that lighting source. Thereafter, you can use this dependably, subject only to adjustment if you should be working with subjects lighter or darker than average.

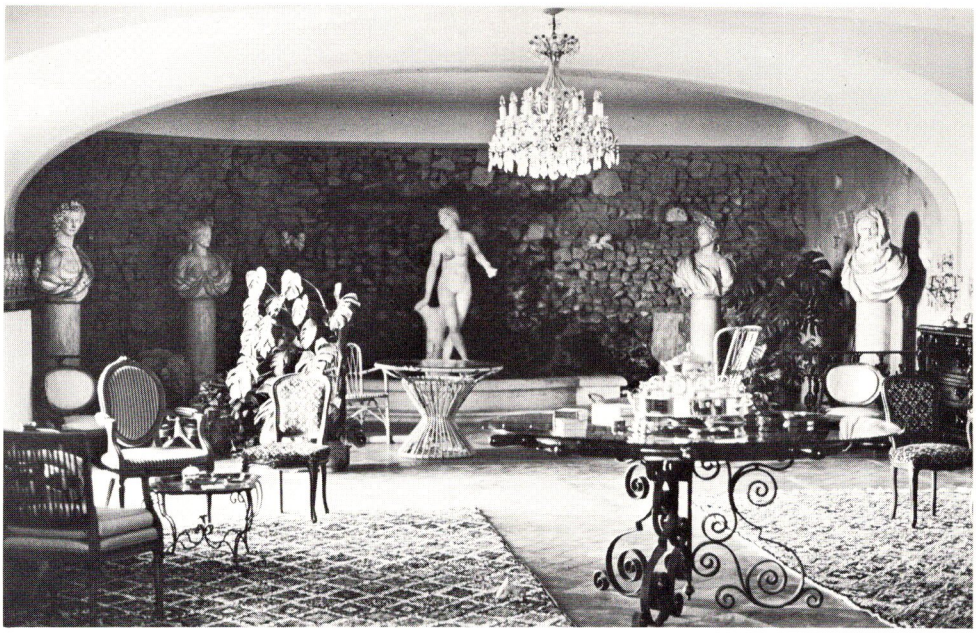
Umbrellas for photographic use are available in different sizes and fabrics. Some fold down for maximum portability. Some will also lock in a variety of positions to get different angles of reflection and diffusion. You can also place umbrellas so that the rounded exterior is pointed toward the subject and the light source drives through the fabric, which acts as a diffuser. In this case, there is a substantial loss of light output.

One inexpensive umbrella unit for general amateur use is the Spiratone Umbrelite. Spiratone products are regularly advertised in photographic magazines. Another source is Uncle Sam's Umbrella Shop, 110 W. 45th St., New York, N. Y. 10036. The Reflectasol is a rectangular-shaped umbrella that is adjustable for concave, convex, and flat positions in three different sizes with silver, gold, and black fabrics. The gold fabric provides a warming effect, thereby lowering color temperature. A black Reflectasol can be used as a side shade to prevent unwanted light from entering the lens. It can also serve as a background for a brightly lit subject, or it can be used to block illumination selectively. Reflectasols are marketed by Larson Enterprises, Inc., 17125 S. Western Ave., Gardenia, Calif. 90247. A British product is the Paraflash (The Paraflash Company, Box 10, Tunbridge Wells, Kent, England). This is a stan-

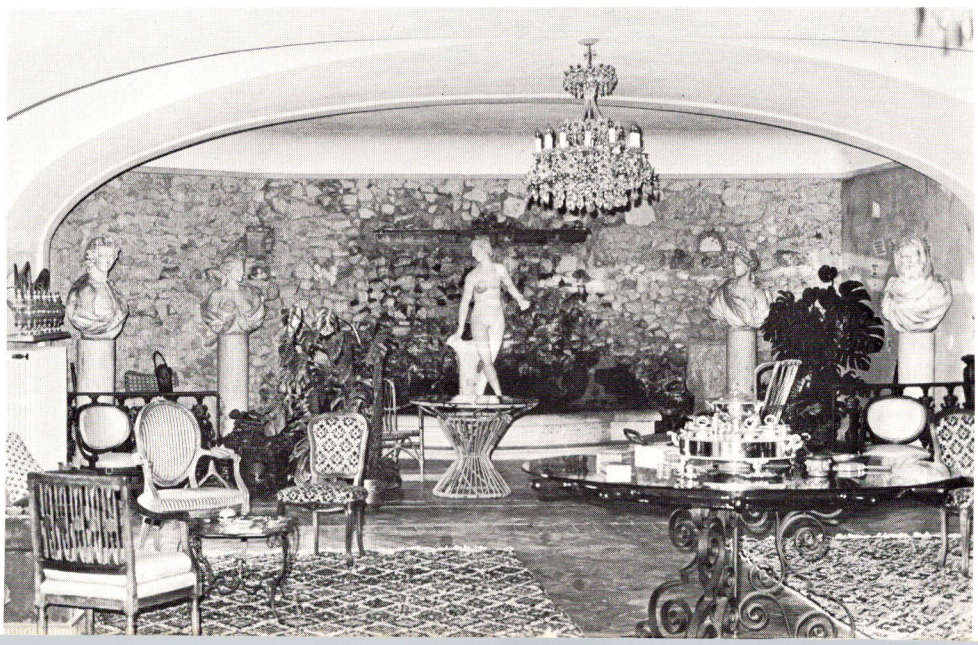
dard umbrella design available in junior, standard, and studio sizes, together with appropriate clamping and floor-supporting equipment. You can get umbrella reflectors from many other sources, because they are so popular, but the aforementioned companies are representative.

If you are to use a hot source, such as a tungsten-halogen lamp, you must have a fabric that will withstand heat without scorching or discoloring the reflector fabric.

The positions of umbrella reflectors will vary with the subject and the intended effect. A typical portrait set-up for a Rembrandt-type lighting effect is to place the umbrella unit off to the side



The upper photo, made with existing light coming through a broad window, conveys a naturalness not seen below. In the lower shot, illuminated mainly by bounce flash, the rather flat effect is because of the large area within which the flash was diffused. Tri-X. Joseph D. Cooper.







Existing light picture at left was made in a private home in Italy. The sunlight streaming in created a harsh contrast. To fill the shadow area while not detracting from the existing-light look, a small flash was bounced off the ceiling (right). 58mm lens, Tri-X. Joseph D. Cooper.

at approximately 45° to the subject-camera axis and also above that axis at an angle of 45°. With this as a single light source, a supplementary reflector can be positioned to throw some of the light from the unit back into the shadow areas.

With a single umbrella flash for this Rembrandt-type lighting and a single flat reflector for fill, a gray, shadowless background will be achieved if the subject is midway between the umbrella and a white background. For a darker background, lighting source and subject would need to be moved further away from the background. For a lighter background, an independent light would have to be thrown onto the background. You can achieve variations in lighting effects by placing the umbrella light in different positions. Instead of a flat secondary reflector, another umbrella without a lamp in it can also be used to concentrate the secondary reflection.

In making exposure tests for loss of light through use of an umbrella reflector, assume that you will lose about one *f*/stop. To express this in a lower guide number you would divide by 1.4. Thus, if your guide number ordinarily would be 112, it would be reduced to 80 after division by 1.4.

Secondary reflectors can be used to redirect light from another source toward the subject. When walls and ceilings are used in bounce flash, they function as secondary reflectors. Any light surface can also serve as a secondary reflector—a light cardboard, a sheet of newsprint, a pillowcase, a piece of beaded screen material, aluminum foil that has been crumpled and flattened out on a sheet of supporting cardboard, and so on and on.

One of my favorite portable reflectors is the one made by Rowi. It folds to less than 5″ x 8″ and opens to somewhat more than 23″ x 27″. It consists, when opened, of 20 reflecting sections that, being separated from each other and not being totally in parallel, tend to break up the light as it reflects toward the subject. One model is coated with gold reflecting material for warm-tone effects and another has a silver surface.

The brightest reflectors have a hard, shiny surface, but they are likely to reflect hot spots on the subject. A good compromise for most subjects, both black-and-white and color, is a satin finish silver material; a dead white or matte white surface, giving the softest reflection, is less efficient. As to efficiency, the closer to the subject the reflecting

surface is held, the more light it will reflect usefully. This is easily seen when you have a subject illuminated by a single source and you hold a sheet of newsprint up to it. You can discern visually how the dark area brightens up.

Single-Source Lighting

The characteristics of flash on the camera punching straight ahead and casting its shadows behind the subject have already been discussed. When a single source is used, without reflectors or auxiliary lighting, the best solutions are bounced lighting and bare-bulb flash, as already discussed. This is equally true for continuous sources of lighting. Another solution, touched upon briefly, is for the flash mounted on the camera to serve as a fill-in light while another flash, positioned more closely to the subject, off to the side and somewhat higher, acts as the main source of illumination. Other solutions that have been presented as we have progressively examined the various lighting sources include the use of extension flash high and to the side, which also would be applicable to a single source of tungsten illumination.

One solution that can work only with immobile or inanimate objects is to paint with light. The first requirement is a rather dim or almost dark environment with the camera supported on a tripod or other solid surface. You make your principal exposure—that which is closest to the object to give it its directional source of lighting—and then, while the shutter is held open with a locking cable release, you make successive exposures from different angles to fill in shadow areas, but these should be at a greater distance than that of the main modeling light. One exception would be if you were to expose from behind the subject in order to outline it with a rim of brightness. In that case, you would have to be sure that the light is not within range of the camera lens. The same technique can be used with continuous tungsten illumination.

Another interesting technique for single flash is to fire the unit toward a reflector board. The reflector in turn bounces light back onto the subject to give a soft, diffuse illumination.

You can also use the single flash as a fill-in when taking pictures outdoors in order to soften the shadows, but keep in mind that the standard guide number will be much less inasmuch as there are no reflecting surfaces, which are taken into account when computing guide numbers.

Multiple Lamp Sources

The use of wired and slave unit configurations of multiple flash have already been discussed. Continuous sources of illumination are wired and present no problem. Here we are concerned solely with the effects to be achieved with the progressive building up of different types of lighting. You can work with a single source, but two lights are much better than one, particularly when you have the advantage of reflectors for additional fill. A third light is quite handy for controlling background illumination, while a fourth light can be used for accenting the subject. You can use even more lights, but it is generally recognized that a three- or four-light arrangement is the best. Such arrangements will be discussed here.

Lights and reflectors are arranged to achieve pleasing lighting ratios appropriate to the subject. The lighting ratios are the comparisons in brilliance of the most prominently illuminated to the least prominently illuminated significant areas. A 3:1 ratio is average and is particularly suitable for color photography. You will have greater latitude in selection of lighting ratios with black-and-white films than with color films. In either case, you are likely to favor a 1:2 or 1:3 lighting ratio for babies, young women, floral arrangements, del-

icate objects, and others that you might consider on the light or gentle side. As you proceed to the 1:4 through 1:6 lighting ratios, you are beginning to involve yourself in the rendition of stronger contrast appropriate to men, industrial objects, and those in which power or punch seems desirable. These are generalizations, of course; for an individual situation you might want to depart from them according to the subject matter, the background, and the total effect desired.

Some photographers start with the fill or splash light, whose purpose is to provide general illumination for the main subject but at a light level about three times less than that of the proper exposure later to be achieved. The purpose of this light is to provide a base that, together with a main light, will provide open shadows with clear details. The fill or splash light is usually placed fairly close to the camera position when you have a three- or four-light arrangement. It is placed off to the side when you have a two-light arrangement.

You can control the output and the lighting ratio achieved with the fill light by using a diffusing material in front of that light. This makes it unnecessary to move the light toward or away from the subject for the control of lighting ratios. If you do have to move lights, the use of diffusing material, which should be heat resistant, is equivalent to moving the lamp further away from the subject. (This is another application of handkerchief-thickness control, discussed earlier.)

The key, or main, light is usually higher than the camera and off to a side. Typically, it is the Rembrandt type of arrangement of 45° to the side of and 45° above the camera-to-subject axis. Naturally, you can vary this according to the subject by lowering the light position and moving it further away from or closer to the camera.

The key light is the one that is most important in creating the pictorial effect best suited to the particular subject. It is highly directional. It creates the dominant pattern of light and shade. The shadows cast by this light accentuate or moderate facial or other characteristics.

The background light is important when you have anything other than a dead black background. Its purpose is both to control background intensity and tone and to eliminate shadows cast by either the key or fill lights. With a white background, the positioning of the background light (out of view of the lens, near the floor and pointing to the area immediately behind the subject) will provide a white-to-dark gray, depending upon distance. Background tone is important, for it provides suitable separation or contrast for the main subject, depending upon its light-or-dark properties.

Finally, an effect, or kicker, light is used to provide a highlight or special effect. For example, you might want a light behind the subject's head to illuminate the hair, or you might want a light suspended from a boom directly above the subject's head to put a splash of lighting there. Kicker lights can be used also to supplement the main light to achieve effects that cannot be accomplished through use of one main source. Although each of the four basic light sources should be used creatively, the main, fill, and background lights generally serve to light-model the subject as a whole. The kicker light (or lights if necessary) add creative touches.

In addition to the placement of lights, you must also consider the use of reflectors as fill sources and, as discussed above in the section on continuous sources of light, you can curtail light through use of a variety of attachments to the lamp reflector. That is, you may want to reflect light and you may want to block it from reaching the subject as perceived through observation of effects on the focusing screen of your Minolta SR camera.

CHAPTER VII

Close-Ups, Macrophotography, and Copying

One of the more exciting areas of photography is the taking of pictures of small objects or of parts of larger objects to record their fine details and to bring out interesting textures. What makes close-up photography particularly fascinating is that you see objects reproduced in an unaccustomed scale, which provides pictorial impact with appropriate subjects because they will be displayed out of the context of the ordinary. Psychologically, it is the reverse of miniaturization, whose fascination through the ages stems from extreme reduction of ordinary objects. While pictorially it is often of interest to see the head of a pin rendered as though it were the head of a railroad spike, the more important uses have been in the photography of biological objects and specimens and generally in commercial, industrial, and professional photography.

Although the term close-up photography is used conveniently, it is applicable only to one main range of reproduction—from a fraction of original size up to the same size or a ratio of 1:1. When the original image on film (or on the viewing screen) is greater in size than the object being photographed, the correct term is macrophotography. Expressed as a ratio, the first number is always greater than 1 while the second number is always 1, as in 2.5:1 or 3:1.

Close-up work, including the making of macrophotographs, is made relatively simple through the use of the various lenses and extension devices described in this chapter. At one time, close-up photography had its forbidding aspects, for it meant taking critical measurements and making mathematical computations to determine exposure. The latter has been simplified through the use of the built-in exposure-measuring feature of Minolta SR-T cameras; regardless of how much the lens is extended away from the camera body and the film plane, thereby calling for adjustment of exposure settings, the amount of light entering the camera can be accurately and simply measured.

This chapter describes the capabilities and methods of use of the various optical and mechanical devices available for your camera. In addition, it provides instructions on techniques for photographing small objects, for slide-copying, and for reproduction of non-transparent originals (reflection copying).

CLOSE-UP LENSES

Three types of close-up lenses are available: supplementary close-up lenses for attachment to regular camera lenses in the range of 35mm through 135mm, the close-focusing Macro Rokkor 50mm and 100mm lenses, and the Auto Bellows Rokkor for use with the various bellows extension devices.

You should, however, take full advantage of the close-focusing capabilities of Rokkor lenses without the use of supplementary devices. The important thing, as discussed below, is the image ratio attainable with the lens at its nearest focusing distance.

Near-Focus Capabilities of Rokkor Lenses

For many purposes, the regular camera lens can be used to photograph small objects and to make reproductions of book and document materials, without additional accessories. Thus, if you should wish to photograph a business letter for record purposes, you could use any of the Rokkor lenses in the range of 35mm through 200mm at their nearest focusing distance. Consider, for example, the problem of copying an 8″ × 10″ document or photograph in the original size (approximately 200 × 250mm). In order to include all of the original, using the narrow dimension as your guide, you would need an image ratio of 1:8 or 1/8. The simple arithmetic shows that 1/8 of eight inches is one inch, which corresponds to the narrow dimension of the film (approximately 24mm). In the lens data sheets you will find a reference to "ratio of object to image size at nearest focusing distance." For the 35mm *f*/2.8 lens this is stated as 1:8, which would suggest to you that you could just about cover the 8″ × 10″ document to the very edge of the film frame at the closest distance. You might want to use a slightly greater working distance in order to have some margin around the document, which then would be slightly reduced in size on the film. This might be important, for example, if you were making a slide reproduction and needed to provide room for the mask of the slide mount.

Lenses of the same focal length may vary in their near-focusing capabilities. Thus, if you should use the 35mm *f*/1.8 lens, you could fill the image area of the film with a smaller object, for the image ratio with that lens at its closest to the subject is 1:5.4. Hence, for many different uses this is a highly versatile lens.

The standard 55mm and 58mm Rokkor lenses have image ratios, respectively, of 1:7.5 and 1:8. With their wide apertures they are conveniently used for reproduction of books, magazines, and other documents at meetings, in libraries, or on other occasions when you might wish to make photographic records.

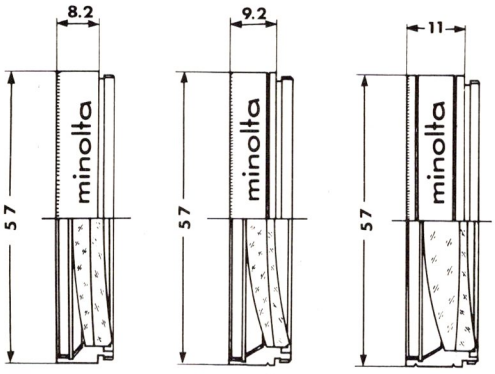
For most ordinary purposes the results may be entirely satisfactory when working at the closest focusing distances, but if edge-to-edge sharpness is needed, it is recommended that you stop the lens down to about *f*/11. The reason for this is that most lenses are designed for photography in the range of one meter (about three feet) to infinity. Exceptions are the special Macro Rokkor and Auto Bellows Rokkor lenses, which are designed particularly for close-up work, although they can also be used in general photography.

Supplementary Close-Up Lenses

All close-up devices achieve their effects by bringing the camera lens closer to the subject. The choice narrows down to some form of extension between the camera lens and the body or to a sup-



Two of the three close-up attachment lenses designed specifically for Minolta camera lenses. Consisting of two lens elements each, they correct for chromatic aberration.



Dimensions of Minolta supplementary close-up lens attachments. Left to right, No. 0, No. 1, and No. 2.

plementary lens that attaches to the front of the regular camera lens. The supplementary lens has the following advantages:

1. It is as compact and as easily attachable as a screw-in filter.

2. It can be used without any changes in exposure settings.

3. It is inexpensive.

The following disadvantages of the close-up attachment lens must also be noted:

1. It causes a slight loss of optical quality (which, however, can be minimized as explained below).

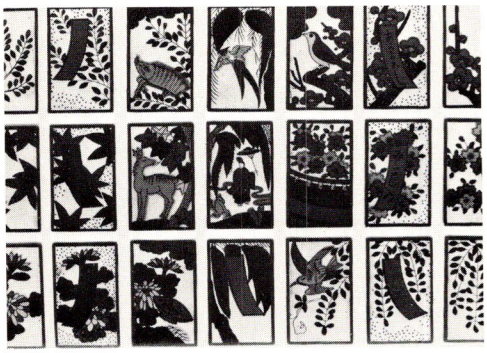
2. It does not permit as much magnification as can be achieved through extension devices.

Minolta has its own series of supplementary close-up lenses designated as no. 0, 1, and 2. Each of these consists of two elements cemented together as a single optical group designed to eliminate chromatic aberrations. Accordingly, except for the most critical work, the Minolta close-up attachments produce pictures that will satisfy most ordinary requirements, even in work at full aperture. When critical edge-to-edge sharpness is needed, as in copying flat materials, the Minolta attachments should be used with the prime lens stopped down to $f/8$ or smaller. For many quick-record purposes, however, where legibility alone is desired and where you can tolerate a very slight fall-off of image quality toward the corners, satisfactory results can be achieved at full aperture.

The Minolta close-up attachments are not to be confused with the simple meniscus lenses sold commonly for use with most single-lens reflex cameras both as direct screw-in types and as standard series lenses for use with filter adapters. Meniscus lenses are single-element lenses of varying degrees of curvature, one side being convex and the other side concave. Commonly, they range in magnification power from +1 through +10. These numerical designations refer to diopters, which are optical units expressing focal length and magnifying power. The Minolta designations of 0, 1, and 2 are merely catalog numbers, which could just as easily have been represented by a, b, and c. (The translation of the Minolta designations into diopters and focal lengths is given below.)

The weakest of the simple meniscus lenses can be used satisfactorily, subject to the warnings that they perform best with centered three-dimensional objects and that, for photocopying, lens apertures should be reduced to $f/11$ or smaller. The more powerful of the simple lenses, particularly at and above +5, should be limited to use with subjects where edge-to-edge sharpness is not critical.

Supplementary close-up lenses can be used singly or in combination. When used in combination, the dioptric power



Area covered with 55mm lens at maximum extension.



Area of coverage with 55mm lens and supplementary close-up lens No. 1 at maximum extension.



Area of coverage of 55mm lens and supplementary close-up lens No. 2 at maximum extension.

is additive, meaning that when a +1 and a +3 lens are used in combination, the optical power in diopters is +4.

The recommended range of use of supplementary close-up lenses is with focal lengths from 35mm through 135mm. The no. 1 and no. 2 Minolta close-up attachments are recommended for use primarily with lenses in the range of 35mm through 85mm; the no. 0 close-up attachment is recommended for use in the range of 85mm through 135mm. Information on the magnifications, image areas, and working distances attainable with the Minolta close-up attachments singly or in combination is given in each of the lens data sheets in the lens chapter of this book.

Used alone, the supplementary close-up lenses are best suited for moderate increases in picture size appropriate for most commonly encountered small objects, particularly in hand-held picture-taking. When the no. 1 and no. 2 Minolta close-up attachments are used in combination (additively) with the standard 55mm and 58mm camera lenses, image ratios of about 1:3 to just under 1:2 can be achieved. With longer focal length lenses, you can obtain higher magnifications with the use of these two close-up attachments in combination. In the case of the 85mm $f/1.7$ lens this combination of attachments makes it possible to achieve magnifications in the range of approximately 0.48 to 0.60. Ordinarily, the use of all three close-up lenses is not recommended, but satisfactory results can be achieved with lenses in the range of 85mm through 135 mm. The 85mm $f/1.7$ together with all three Minolta close-up attachments offers the magnification range of approximately 0.55 through 0.67.

You can obtain much greater magnifications when using lens extensions in addition to the supplementary close-up lenses. This is most conveniently accomplished with the Macro Rokkor lenses, but you can also make use of extension tubes and bellows attachments.

Each of the Minolta supplementary close-up lenses is available in 52mm and 55mm filter-mount diameters.

When you are using more than one close-up lens, you should place the more powerful one closer to the camera lens.

If a filter is used, it should be on the outside.

Focusing can be done with the lens at its widest aperture, although with the longer focal length lenses, particularly when the more powerful close-up attachments are used, you may find it more convenient to focus with the lens stopped down. When using the longer lenses, especially with combinations of close-up attachments, you may find it convenient to use the Minolta Focusing Rail. Once you have achieved an approximate focus with this accessory, described below, finer adjustments are made through movement of the entire camera-and-lens assembly without altering lens (or lens-and-bellows) settings.

Theoretically, a close-up attachment converts the maximum aperture of the camera lens to a wider *f*/value because the focal length is reduced when prime lens and attachments are combined. Practically, this can be ignored since the differences are small with the 35mm and standard lenses and there are also offsetting light losses because of reflections from the additional optical surfaces. Besides, the use of the through-the-lens exposure-metering system makes it unnecessary to have precise optical calculations.

A knowledge of the dioptric power of any of the supplementary close-up lenses or combinations of them can be helpful, when you do not have reference tables available, in knowing the approximate distance at which the camera must be placed from the subject. The key element here is that the camera-to-subject working distance, measured from the front of the supplementary lens closer to the subject, is governed by the focal length of the supplementary lens rather than by the camera lens. Accordingly, subject to variations in lens configurations, the working distance should be about the same, regardless of the focal length of the camera lens. This does not affect the image area, which will be greater for shorter camera lenses than for longer ones. The following table shows the dioptric and focal-length equivalents of the three Minolta supplementary close-up lenses:

No.	Diopters	Focal Length
0	0.95	1058mm
1	2.00	500mm
2	3.80	263mm

The focal length of a one-diopter lens is one meter (39.3 inches). This is derived by dividing the power in diopters of the supplementary attachments into one meter, or 100cm.

To find the combined focal length of the camera lens and the close-up lens(es) added to it, you must solve the following formula in which *Fc* is combined focal length, *F* is camera lens focal length, and *D* is power in diopters:

$$Fc = \frac{1000mm}{\left(\frac{1000}{F} + D\right)}$$

Assume that you wish to find the combined focal length where you know that the camera lens is 58mm (*F*) and the dioptric power being used (*D*) is 3.80 (No. 2), you would solve the foregoing formula as follows:

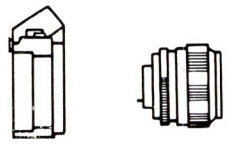
$$Fc = \frac{1000mm}{\left(\frac{1000}{58} + 3.80\right)}$$

$$Fc = \left(\frac{1000mm}{17.24+3.80}\right) = 47.6mm$$

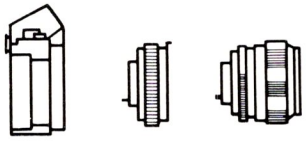
Macro Rokkor Lenses

The two Macro Rokkor lenses are complete close-up systems within themselves, permitting magnifications of 1:2 with the lens and its focusing mount alone and life-size magnifications of 1:1 with the macro extension tube furnished with each lens. The Macro Rokkor lenses are designed specifically for close-up work, but they also perform exceptionally well at distances in the range

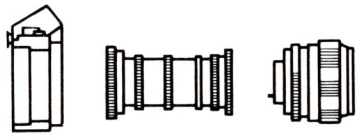
Modes of use of Macro Rokkor 50mm f/3.5 lens.



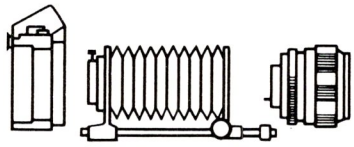
Lens alone.



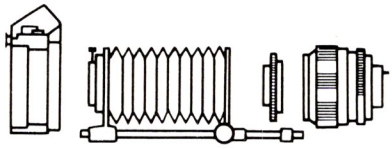
Lens plus 1:1 adapter.



Lens plus extension tubes.



Lens plus bellows.



Lens plus reverse adapter and bellows.

of three feet to infinity. These lenses are fully coupled to the automatic diaphragms and built-in exposure meters of the Minolta SR-T cameras. In use of macro extension tubes, diaphragm and meter coupling are maintained.

The two Macro Rokkor lenses are the Macro Rokkor 50mm *f*/3.5 and the Macro Rokkor 100mm *f*/3.5* As with all other lenses in focusing mounts, the rated full aperture of each lens is theoretically applicable only when the lens is focused at infinity. When the lens is extended progressively away from the camera in order to focus at closer distances, the relative aperture decreases. Apart from the optical theory that explains this phenomenon, it is readily apparent in the loss of brilliance on the viewing screen. For all practical purposes, however, the loss of aperture value is ignored on the assumption that small shifts in illumination values are accommodated through both the built-in exposure-measuring system and the exposure latitudes of films.

In the case of the Macro Rokkor lenses, the extension is so great as to require compensatory adjustments in *f*/stop settings whenever the built-in through-the-lens exposure-measuring system is not used. The relative aperture of each lens is decreased one full stop at maximum extension of the focusing mount without the addition of the macro extension tube. For all practical purposes, the maximum effective aperture at full extension may be considered as *f*/5.6. The addition of the macro extension tube is the equivalent of the loss of another *f*/stop. When the basic lens is at its infinity position and the macro extension tube is added, there is



The Auto Bellows Rokkor 100mm f/4 lens, with its short mount, can be used as a telephoto lens in hand or in close-up work in conjunction with a bellows unit, extension rail, and other close-up accessories.

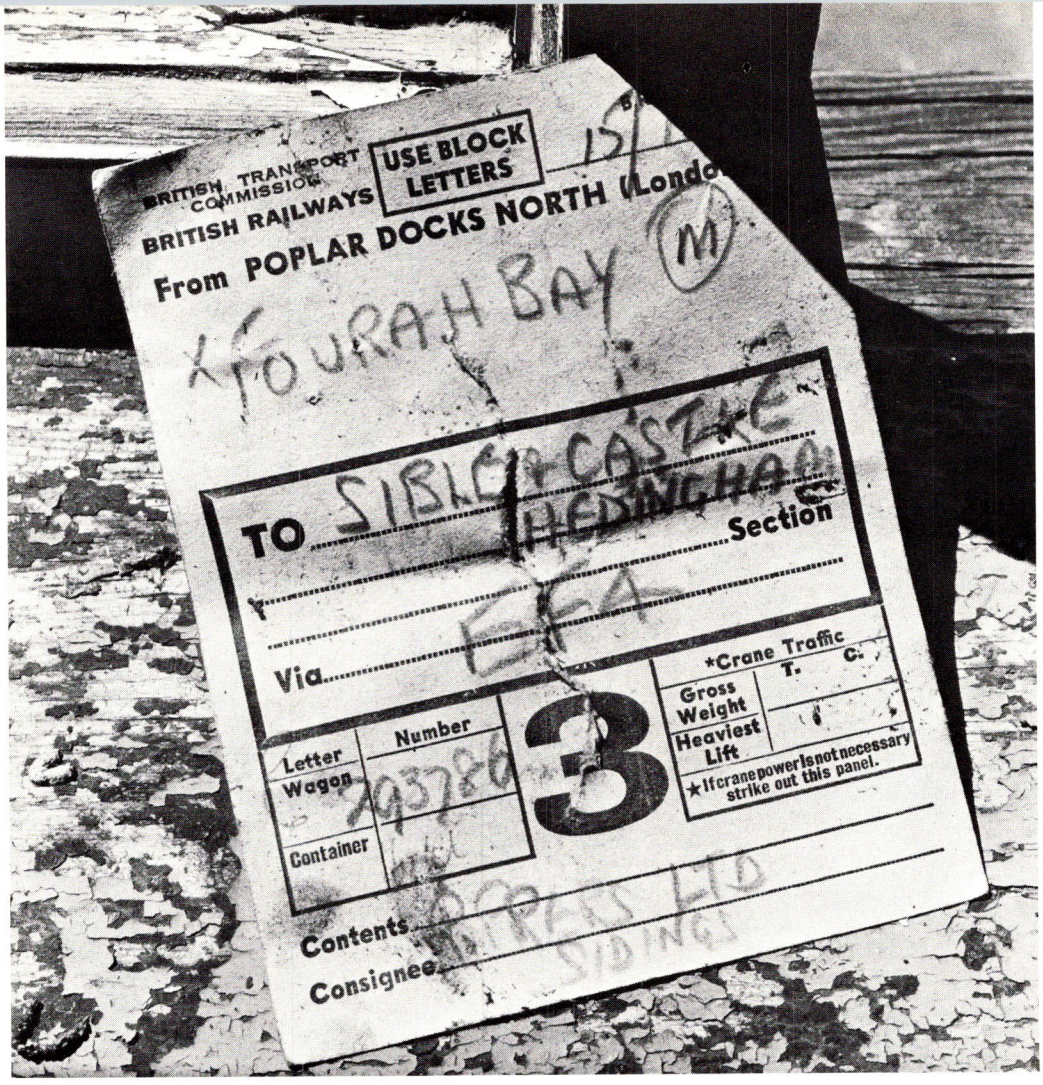
* At the time of publication the Macro Rokkor 100mm *f*/3.5 was not yet available for distribution.

a loss of one *f*/stop; when the lens mount is fully extended and the macro extension tube is added, the combined light loss is equivalent to two *f*/stops. Again, at this point it is only necessary to note these compensatory adjustments as a matter of information as to how the system works. As in the case of all lens extension arrangements—extension tubes, bellows, or arrangements built into the lens—the necessary exposure settings appropriate to the given light conditions are automatically indicated through activation of the behind-the-lens exposure-measuring system. Only when you use a camera model with manual exposure controls is it necessary to make computations. But even these are made automatically, as described below, through rotation of the focusing mount of the Macro Rokkor lens.

The focusing procedure when using a Macro Rokkor lens with any Minolta SR camera is aided by the table of engraved magnification ratio numbers on the lens barrel. If you have some notion of the relative size of the photographic image as compared with that of the actual subject, you set the desired magnification ratio and then move the camera as a whole back and forth while looking through the viewfinder until you have precise focus. Usually, unless you definitely want a 1:1 ratio or a 1:2 ratio, you will make adjustments both in the extension of the lens barrel and the distance of the camera from the subject until you achieve the best framing of the subject within the image area.

When used with a Minolta SR camera model that does not have a through-the-lens exposure-metering system, the Macro Rokkor automatically indicates the necessary exposure factor for any given magnification. Two sets of engraved reference numbers will be found on the lens barrel. The right-hand set, consisting of a table of image ratios and a table of exposure factors, is for use with the lens alone mounted on the camera. The left-hand reference numbers are for use when the lens and its macro extension tube are used in combination on the camera. The exposure factor for manual setting is indicated by the alignment of the front edge of the rotating focusing ring with one of the intersecting vertical lines. These are expressed in a series of +¼, +½, +¾, and +1. If the edge of the focusing ring intersects the line designated as "+½," this means that you must adjust the aperture setting so that it is one-half *f*/stop wider than your independent exposure calculation based on the nominal *f*/stop of the lens. At the "+1" vertical line position, you would need to make one full *f*/stop compensation. For example, if your exposure reading, which does not take account of lens extension, calls for a setting of *f*/8, you would turn the diaphragm ring one-half *f*/stop, so the index mark on the lens barrel appears between *f*/5.6 and *f*/8. For a full *f*/stop adjustment, you would align the index mark with *f*/5.6. The ¼ stop adjustments should be resolved by using the nearest appropriate full or half stop.

When using the macro extension tube, you follow a similar procedure, except that you refer to the left-hand engraved information on the lens barrel and you use the aperture ring of the macro extension tube instead of the one on the lens itself. You will note that the aperture ring of the macro extension tube has a range of *f*/5.6 through *f*/32, which automatically compensates for the extension provided by this tube. The additional aperture adjustments indicated on the lens mount are transferred to the aperture scale of the macro extension tube. This is accomplished through a shift in reference sources, for you would still make your adjustments by turning the aperture setting ring of the lens. The latter causes an index mark to appear opposite the extension tube scale with its "built-in" compensation of one *f*/stop. In effect, the latter tells you that



The highly versatile Macro Rokkor 50mm *f*/3.5 lens can be used as an all-purpose optical tool on a tripod or hand-held for pictures of small life-size objects or general scenes. Without accessories, it can most conveniently have its focusing mount extended to photograph small items of interest, such as this baggage ticket in an abandoned railway station. Ilford FP4. Graham Finlayson.

at full aperture the lens is either the 50mm *f*/5.6 Macro Rokkor or the 100mm *f*/5.6 Macro Rokkor. Exposure adjustments based upon these aperture values are then made in the same manner as for the lens alone when in extended position on the camera.

The 50mm Macro Rokkor can be used in its reverse position to achieve greater magnifications than 1:1. This is accomplished through use of a bellows extension mounted on the camera with the lens attached to the bellows in its reverse position, as described in the succeeding material on Minolta bellows extension units. When used this way, the Macro Rokkor permits magnifications up to five times normal subject size. Since the lens is reversed, its diaphragm- and meter-couplings are sacrificed. The macro extension tube is not used under this arrangement which, also, is not applicable to the 100mm Macro Rokkor. Exposure computations must be made through the camera itself or, in the case of manual exposure controls, through mathematical computation. Further information on exposure computation is provided in a succeeding section of this chapter.

AUTO BELLOWS ROKKOR 100mm F4 CLOSE-UP TABLES

Meters

Magnification	Bellows extension (mm)	Distance from subject to lens (mm)	Distance from subject to film plane (mm)	Exposure multiple
0.1	51.5	1,078	1,208	1/3
0.2	61.5	578	718	1/2
0.3	71.5	411	561	2/3
0.4	81.5	328	488	1
0.5	91.5	278	448	1 1/3
0.6	101.5	244	425	1 1/3
0.7	111.5	221	411	1 1/2
0.8	121.5	203	403	1 2/3
0.9	131.5	189	399	2
1.0	141.5	178	398	2
1.1	151.5	179	399	2
1.2	161.5	161	401	2 1/3
1.3	171.5	155	405	2 1/3
1.4	181.5	149	409	2 1/2

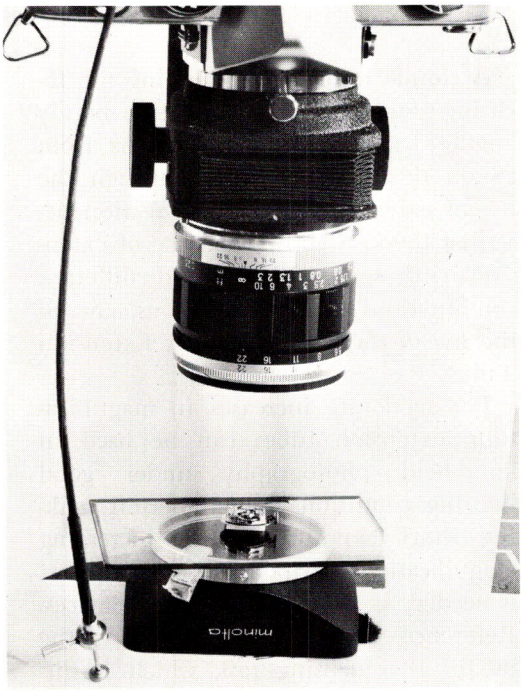
Feet

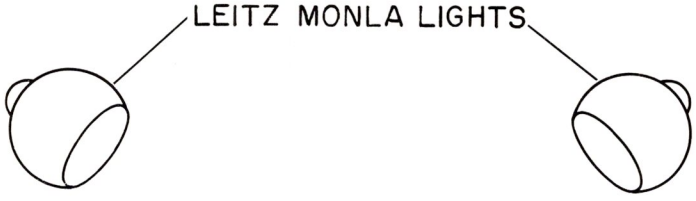
Magnification	Bellows Extension (inch)	Distance from subject to lens (inch)	Distance from subject to film Plane (inch)	Exposure multiple
0.1	1/32	42 7/16	47 7/16	1/3
0.2	2 7/16	22 3/4	28 1/4	1/2
0.3	2 13/16	16 3/16	22 1/16	2/3
0.4	2 7/32	12 7/8	19 3/16	1
0.5	3 5/8	10 7/8	17 5/8	1 1/3
0.6	4	9 1/16	16 11/16	1 1/3
0.7	4 3/8	8 11/16	16 3/16	1 1/2
0.8	4 3/4	8	15 13/16	1 2/3
0.9	5 3/16	7 7/16	15 11/16	2
1.0	5 9/16	7	15 5/8	2
1.1	5 15/16	7 1/16	15 11/16	2
1.2	6 3/8	6 5/16	15 3/4	2 1/3
1.3	6 3/4	6 1/8	15 5/16	2 1/3
1.4	7 1/8	5 7/8	15 1/16	2 1/2

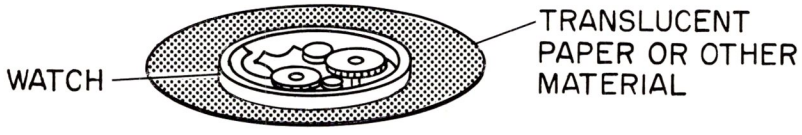
Rokkor Auto Bellows 100mm *f*/4 Lens

This lens was designed specifically for close-up work, primarily for use together with the Minolta Auto Bellows I. The lens has automatic diaphragm coupling, as does this bellows unit, thereby making it possible to preset the lens for a desired aperture while retaining the ability to focus and compose at maximum aperture. The advantage is that, having completed these two steps, you do not risk making the slightest displacement by having to turn the aperture-setting ring manually. When you have worked with large or extreme magnifications, you will appreciate the sensitivity of the camera to the slightest touch and the effects thereof on image displacement.

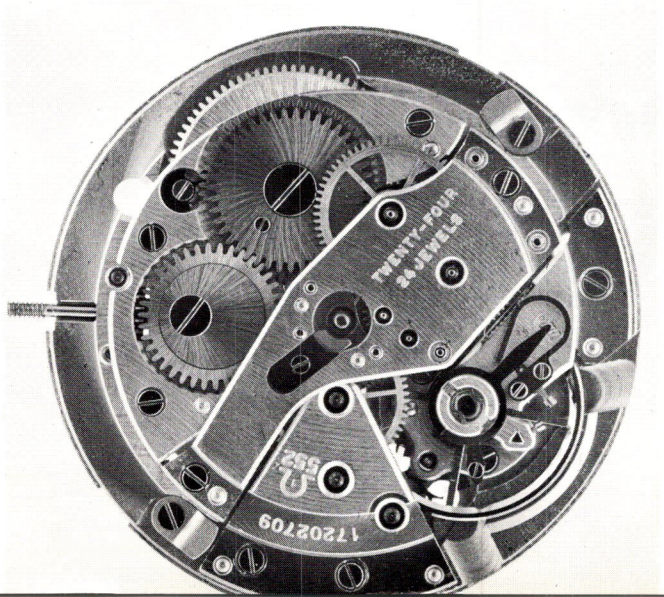
Because this lens can be focused at infinity and closer, it can be used as a medium telephoto or portrait lens when combined with a bellows. When used with a non-automatic bellows it operates as a manual lens, which requires exposure to be computed by formula.







Lighting setup used to photograph watch movement. Earlier model of the Macro Rokkor 50mm *f*/3.5 lens, at *f*/22, 10–15 sec., Adox KB-14. John Otto Callisen.



EXTENSION TUBES

A simple means for extending the focusing range of any Minolta lens, mainly among lenses with focal lengths from 28mm through 300mm, is through the use of extension tubes. This section describes the availability and use of extension ring sets, which afford different combinations of lens extensions, and of the use of the Macro Rokkor Extension Tubes.

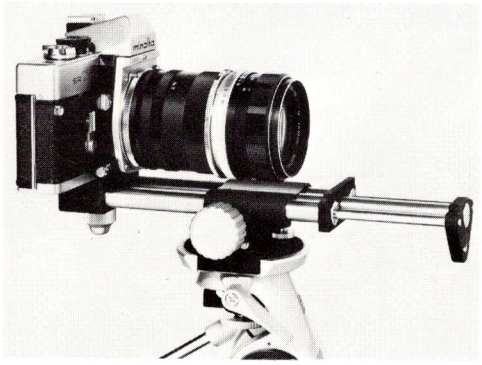
For moderate increases in magnification, extension tubes can be used in hand-held photography under good lighting conditions, which permit making short exposures. With increasing magnification a tripod or solid support is needed, as with other close-up devices. Reference should be made also to the use of the focusing rail, which is discussed in the section on bellows extension units.

Short extensions add to the versatility of telephoto and long focal length lenses, for they make it possible to get comfortably close to subjects without the introduction of aberrations at wide apertures, which would be the case with powerful supplementary close-up lenses.

Combinations of extension tubes, supplementary close-up lenses, and bellows extensions can be used with various lenses to achieve convenient and flexible arrangements suited to the photographer's needs as well as for the achievement of high magnification.

Minolta Extension Tubes

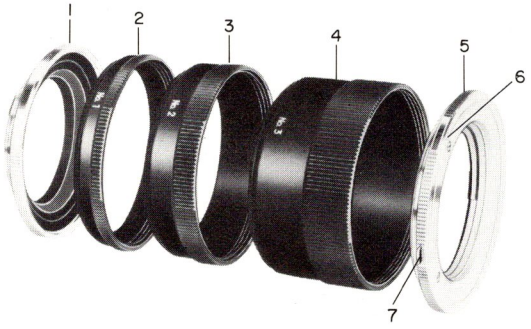
The Minolta SR Extension Tube Set II consists of a group of three tubes of different lengths and two rings. These can be arranged in eight different combinations. The magnification potential



Combination of camera extension tubes and 58mm *f*/1.4 mounted on bellows.

Minolta SR Extension Tubes II.

1. EB Ring (Extension Body Ring)
2. No. 1 Ring
3. No. 2 Ring
4. No. 3 Ring
5. EL Ring (Extension Lens Ring)
6. Red dot mark
7. Lens lock button



EXTENSION TUBES II CLOSE-UP TABLES (Meters)

f = 55 mm

Combination No.	Combination of Tubes No.	Photographic Range (mm)	Magnification Rate	Distance from Subject to Film Plane	Exposure Multiple
1	EB+1+2+3+EL	24× 36~ 22× 33	1.0~1.1	213~214	4 (2)
2	EB+2+3+EL	26× 40~ 24× 36	1/1.1~1.0	214~213	4 (2)
3	EB+1+3+EL	31× 47~ 26× 40	1/1.3~1/1.1	220~214	3(1.5)
4	EB+3+EL	38× 58~ 31× 47	1/1.6~1/1.3	225~220	3(1.5)
5	EB+1+2+EL	48× 72~ 38× 58	1/2.0~1/1.6	242~225	2 (1)
6	EB+2+EL	62× 94~ 48× 72	1/2.6~1/2.0	263~242	2 (1)
7	EB+1+EL	96×144~ 62× 94	1/4.0~1/2.6	335~263	1.8(1)
8	EB+EL	190×284~ 93×140	1/7.9~1/3.9	555~330	1.4(0.5)
		~182×274	~1/7.6	~550	

f = 58 mm

Combination No.	Combination of Tubes No.	Photographic Range (mm)	Magnification Rate	Distance from Subject to Film Plane	Exposure Multiple
1	EB+1+2+3+EL	26× 40~ 22× 33	1/1.1~1.1	231~230	4 (2)
2	EB+2+3+EL	29× 43~ 26× 40	1/1.2~1/1.1	232~231	4 (2)
3	EB+1+3+EL	34× 50~ 29× 43	1/1.4~1/1.2	236~232	3(1.5)
4	EB+3+EL	41× 61~ 34× 50	1/1.7~1/1.4	245~236	3(1.5)
5	EB+1+2+EL	50× 76~ 41× 61	1/2.1~1/1.7	256~245	2(1.0)
6	EB+2+EL	67×100~ 50× 76	1/2.8~1/2.1	302~256	2(1.0)
7	EB+1+EL	101×151~ 67×100	1/4.2~1/2.8	372~302	1.7(1.0)
8	EB+EL	204×306~101×151	1/8.5~1/4.2	620~372	1.3(0.5)
		~194×292	~1/8.1	~595	

f = 100 mm

Combination No.	Combination of Tubes No.	Photographic Range (mm)	Magnification Rate	Distance from Subject to Film Plane	Exposure Multiple
1	EB+1+2+3+EL	43× 65~ 36× 54	1/1.8~1/1.5	445~420	3(1.5)
2	EB+2+3+EL	48× 72~ 41× 61	1/1.2~1/1.7	448~428	2(1.0)
3	EB+1+3+EL	58× 86~ 46× 68	1/2.4~1/1.9	485~442	2(1.0)
4	EB+3+EL	70×104~ 53× 79	1/2.9~1/2.2	530~462	2(1.0)
5	EB+1+2+EL	86×130~ 62× 94	1/3.6~1/2.6	582~495	1.7(1.0)
6	EB+2+EL	115×173~ 79×119	1/4.8~1/3.3	600~565	1.6(1.0)
7	EB+1+EL	150×256~ 98×148	1/7.1~1/4.1	910~650	1.4(0.5)
8	EB+EL	343×515~139×209	1/14.3~1/5.8	1,600~815	1.2(0)
		~235×353	~1/9.8	~1,230	

of the entire set used as a single combination is indicated by the fact that with a 55mm Rokkor lens, life-size (1:1) image ratios can be achieved. For higher magnifications, more than one set of tubes can be combined. No compensation for close-up exposure is necessary when the extension tubes are used with a Minolta SR model having through-the-lens exposure measurement. With other camera models exposure factors have to be computed individually and translated into manual settings of the aperture.

The three tubes in the set are made of lightweight aluminum and finished in matte black. They have screw threads on their ends. The two rings equipped with bayonet mounts for attachment to the camera and lens are chrome-plated. Regardless of which combination of

EXTENSION TUBES II CLOSE-UP TABLES (Feet)

f = 55mm

Combination No.	Combination of Tubes No.	Photographic Range	Magnification Rate	Distance from Subject to Film Plane	Exposure Multiple
1	EB+1+2+3+EL	15/16"×1 7/16"~7/8"×1 5/16"	1.0~1.1	8 3/8"~8 7/16"	4(2)
2	EB+2+3+EL	1"×1 5/16"~15/16"×1 7/16"	1/11~1.0	8 7/16"~8 3/8"	4(2)
3	EB+1+3+EL	1 1/4"×1 7/8"~1"×1 5/16"	1/13~1/4.1	8 5/8"~8 7/16"	3(1.5)
4	EB+3+EL	1 1/2"×2 5/16"~1 1/4"×1 7/8"	1/16~1/4.3	8 7/8"~8 5/8"	3(1.5)
5	EB+1+2+EL	1 7/8"×2 7/8"~1 1/2"×2 5/16"	1/2.0~1/4.6	9 1/2"~8 7/8"	2(1)
6	EB+2+EL	2 7/16"×3 3/4"~1 7/8"×2 7/8"	1/2.6~1/2.0	10 3/4"~9 1/2"	2(1)
7	EB+1+EL	3 13/16"×5 11/16"~2 7/16"×3 3/4"	1/4.0~1/2.6	1'1"3/16"~10 3/4"	1.8(1)
8	EB+EL	7 1/2"×11 3/16"~3 11/16"×5 1/2" ~7 3/16"×10 3/4"	1/7.9~1/3.9 ~1/7.6	1'9 7/8"~1'1" ~1'9 11/16"	1.4(0.5)

f = 58mm

Combination No.	Combination of Tubes No.	Photographic Range	Magnification Rate	Distance from Subject to Film Plane	Exposure Multiple
1	EB+1+2+3+EL	1"×1 9/16"~1/8"×1 5/16"	1/1.1~1.1	9 1/16"~9"	4(2)
2	EB+2+3+EL	15/16"×1 11/16"~1"×1 9/16"	1/1.2~1/1.1	9 1/8"~9 1/16"	4(2)
3	EB+1+3+EL	1 3/8"×2"~15/16"×1 11/16"	1/1.4~1/1.2	9 1/4"~9 1/8"	3(2.5)
4	EB+3+EL	1 5/8"×2 3/8"~1 3/8"×2"	1/1.7~1/1.4	9 5/8"~9 1/4"	3(1.5)
5	EB+1+2+EL	2"×3"~1 5/8"×2 3/8"	1/2.1~1/1.7	10 1/16"~9 5/8"	2(1.0)
6	EB+2+EL	2 5/8"×3 15/16"~2"×3"	1/2.8~1/2.1	11 7/8"~10 1/16"	2(1.0)
7	EB+1+EL	4"×5 15/16"~2 5/8"×3 15/16"	1/4.2~1/2.8	1'2 5/8"~11 7/8"	1.7(1.0)
8	EB+EL	8"×1'1/16"~4"×5 15/16" ~7 5/8"×11 7/16"	1/8.5~1/4.2 ~1/8.1	2'1/16"~1'2 5/8" ~1'11 7/16"	1.3(0.5)

f = 100mm

Combination No.	Combination of Tubes No.	Photographic Range	Magnification Rate	Distance from Subject to Film Plane	Exposure Multiple
1	EB+1+2+3+EL	1 11/16"×2 9/16"~1 7/16"×2 1/8"	1/1.8~1/1.5	1'5 1/2"~1'4 1/2"	3(1.5)
2	EB+2+3+EL	1 3/4"×2 7/8"~1 5/8"×2 3/8"	1/1.2~1/1.7	1'5 5/8"~1'4 7/8"	2(1.0)
3	EB+1+3+EL	2 5/16"×3 3/8"~1 13/16"×2 11/16"	1/2.4~1/1.9	1'7 1/8"~1'5"	2(1.0)
4	EB+3+EL	2 3/4"×4 1/8"~2"1/8×3 1/8"	1/2.9~1/2.2	1'8 7/8"~1'6 3/16"	2(1.0)
5	EB+1+2+EL	3 3/8"×5 1/8"~2 7/16"×3 11/16"	1/3.6~1/2.6	1'10 15/16"~1'7 1/2"	1.7(1.0)
6	EB+2+EL	4 9/16"×6 13/16"~3 1/8"×4 11/16"	1/4.8~1/3.3	1'11 5/8"~2'1/4"	1.6(1.0)
7	EB+1+EL	5 7/8"×10 1/16"~3 7/8"×5 13/16"	1/7.1~1/4.1	2'11 13/16"~2'1 9/16"	1.4(0.5)
8	EB+EL	1'1 1/2"×1'8 1/4"~5 1/2"×8 3/16" ~9 1/4"×1'1 7/8"	1/14.8~1/9.8 ~1/9.8	5'3"~2'8 1/8" ~4'3 7/8"	1.2(0)

tubes and rings you select, you must always have the two-end rings and one or more of the screw-threaded extension tubes. The various combinations of rings and tubes and the resulting ranges of picture-taking area, magnification rate, and working distance, in addition to exposure factors, are given in the accompanying tables for the 55mm, 58mm, and 100mm lenses (other than the 100mm *f*/4 Bellows Rokkor).

The overall length of the entire set is

56mm. The combined extension of the EB and EL rings is 7mm. The no. 1 ring is 7mm. The no. 2 is 14mm. The no. 3 ring is 28mm.

To attach the extension tube combination to the camera, insert the ring marked "EB" into the camera mount in the same manner as you would a lens. Align the red dot on the ring with that on the camera and turn the ring clockwise until it stops with a click. (To detach the ring, push down the lens lock button, and turn the ring counterclockwise.) You may now add one or more of the no. 1, 2, and 3 tubes. The EL ring is then screwed into the front of the tube assembly. The lens is attached to the EL ring (and also removed from it) in the same way the lens is mounted on the camera body.

As a guide to selecting the combination of tubes, refer to one of the accompanying close-up tables and note either the picture-taking area or magnification rate pertinent to the situation. Then read across the table to the first column showing the combination of tubes. Note also that there is a range of working distances from subject to film plane. This will give you a preliminary indication of how far away from the subject the film plane should be. (The film plane is indicated by a mark on top of the camera body.) The last column to the right indicates the exposure factor and, in parentheses, the additional *f*/stop compensation to make. Thus, the notation "4(2)" means that you must make a compensatory exposure factor adjustment of four, which is accomplished by opening the lens two *f*/stops. The notation "3(1.5)" indicates a rounded-off exposure factor of three, achieved by opening the lens one and one-half *f*/stops.

The entire set of rings and tubes occupies very little bulk, but if you wish to confine yourself to a small extension capability that will not add very much to the bulk in your pocket or gadget bag, you should have with you at least the no. 1 or no. 2 ring in addition to the EB and EL rings. (For convenience in recall, although the "EB and "EL" notations are clearly engraved on the rings, "EB" stands for *extension-body* and "EL" stands for *extension-lens.*)

With this extension tube set all exposure settings on the camera and lens must be made manually, although the determination of these settings can be made easily through the stop-down method of exposure measurement. Meter- and diaphragm-coupled automatic extension tube sets are available as independently made accessories for use with Minolta and other makes of cameras. These may or may not work satisfactorily with your camera, depending upon the precision with which the coupling linkages are manufactured. Since each ring and tube has its own pairs of meter couplings and diaphragm couplings, there is always the possibility of cumulative shifts in timing, which could bring about a lack of full coordination between the action of the shutter and the full closing and opening and closing of the lens diaphragm. Whether or not a particular set of automatic extension tubes works for you is something you will have to determine through trial and error.

Macro Extension Tubes

Although designed primarily for use with the 50mm and 100mm Macro Rokkor lenses, the two macro extension tubes for these lenses (sometimes called *life-size adapters*) may be used with most other Minolta Rokkor lenses. The lens data sheets show the magnifications and working distances for each of these. The macro tube for the 50mm lens adds an extension of 25mm; the tube for the 100mm lens adds an extension of 50mm. With a 55mm Rokkor lens and the 50mm macro tube, the magnification range (using the additional focusing ex-

tensions of the lens) is 0.47× to 0.60×. With the 100mm macro tube, the magnification range is 0.91× to 1.04×.

In effect, you can achieve the same convenience with almost all of the Minolta Rokkor lenses in focusing and composing at maximum aperture while being assured of automatic diaphragm- and meter-coupling operation. There are, however, some reservations about this that must be noted. With the exception of the macro lenses and the Bellows Rokkor 100mm *f*/4, the regular range of wide-angle, standard, and telephoto lenses is not optically designed for best performance at the very close working distances used in close-up photography. This is true of all camera lenses, regardless of make, unless specifically designed for close-up work. At close working distances, optical aberrations are introduced; however, these can be minimized or eliminated by stopping down the lens. Whether the lens is at wide aperture or stopped down, the effects achieved should ordinarily be slightly or markedly superior to results with supplementary close-up lenses. There are no hard and fast rules to offer, for each lens has its own characteristics, which are governed by its focal length and its optical formulation.

The macro extension tube most likely to find the greatest potential use in your gadget bag for both close-up work and ordinary photography, particularly with telephoto lenses, is the 50mm macro tube, whose length is 25mm. The longer tube—the 100mm macro tube, whose length is 50mm—would have greater utility in close-up work with short focal length lenses and in general photography with longer telephoto lenses. (To avoid confusion, the designations 50mm macro tube and 100mm macro tube relate only to the lenses for which they were originally designed. As mentioned and as emphasized here, the additional extensions provided by these tubes are 25mm and 50mm, respectively.)

THE BELLOWS EXTENSION SYSTEM

A bellows extension fitted between camera and lens provides infinitely variable extensions of the lens away from the film plane, within the limits of extension, to achieve desired image reproduction. A complete bellows unit consists of (1) a single or double rail, (2) a combination of a lens mount and camera mount attached to the rail(s), (3) an accordion-pleated bellows connecting these two mounts, and (4) focusing knobs, which increase or decrease the distance between the lens and the film plane. The particular advantage of a bellows unit is convenience in adjusting the scale of image magnification and in fine focusing. In themselves, these conveniences make the bellows extension unit quite attractive to those who have a serious interest in close-up photography and its many applications. In addition, the Minolta bellows extension units are basic elements around which you can build a fairly elaborate system for photographing small objects within a wide range of magnifications. The concept of *system* is described in the section immediately following, while the features and use of the individual elements of the system are described in ensuing sections.

Bellows Systems Elements

At the heart of the system is the bellows extension unit. Currently available are the Auto Bellows I, Auto Bellows II, and Bellows III. The Bellows II is not available in the United States; its key features are embodied in a combination of the Auto Bellows I and focusing rail. Both of the auto bellows units have

auto-diaphragm coupling with its advantages in focusing and composing at full aperture and automatic stopping down of the lens aperture during exposure. The Bellows III and earlier models (Bellows I and Bellows II) are used manually. The data sheets in the lens chapter contain, for each lens in the range of 28mm through 300mm, the magnification ranges and working distance ranges for each of the currently available bellows extension units.

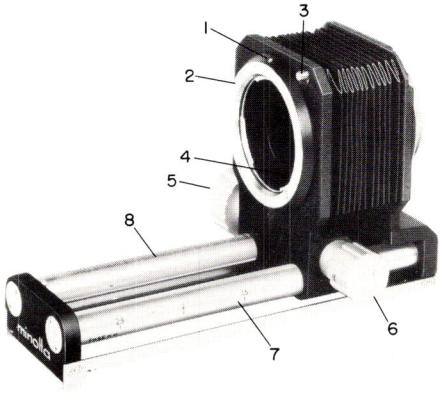
The detachable focusing rail may be used as an accessory to assist in fine focusing without altering the already fixed lens extension and the position of the tripod. This can be used with both the Auto Bellows I and Bellows III. It can also be used with the camera body alone in conjunction with its own attachment of supplementary close-up lenses, Macro Rokkor lenses, and extension tubes, as the case may be.

Slide-copier attachments are available for each of the bellows units. They hold mounted or unmounted transparencies in plane-parallel position for copying by transillumination. The Macrostand serves a similar purpose and attaches to the focusing rail, thereby permitting reproduction of small objects such as postage stamps or tiny three-dimensional objects such as insects, jewels, and small mineral samples. Any of the bellows extension units (or the camera body itself) can be mounted for convenient use in a vertical arrangement on the Minolta SR Copy Stand II. This is particularly advantageous for flat copy, but small objects can also be photographed in this manner. Again, the advantage is that parallel positions are maintained between film plane and copy.

The lenses most frequently used in general close-up work and in photomacrography with the bellows units are the Auto Bellows Rokkor, standard 55mm and 58mm lenses, Macro Rokkors 50mm and 100mm, telephoto 100mm, and 135mm and 200mm. Applications of most of these lenses in connection with the bellows units are described in the sections immediately following.

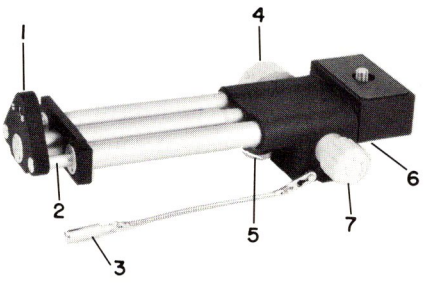
Auto Bellows I

The Auto Bellows I is available as an independent accessory or as part of a



Auto Bellow I parts identification.

1. Lens mounting indicator
2. Lens mount
3. Lens release button
4. Lens coupling pin
5. Focusing knob
6. Clamp
7. Rail with magnification scale
8. Rail with extension scale

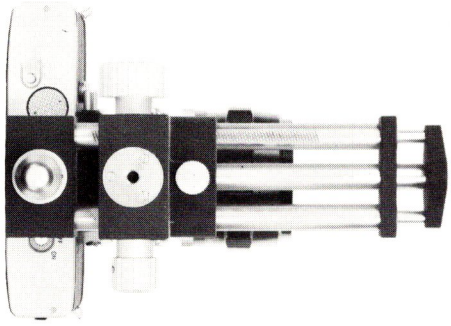


Opposite, Slide Copier
for Auto Bellows I and Bellows III.

1. Lens clamp
2. Strip film holder clamp
3. Holder lock
4. Strip film holder
5. Diffuser
6. Mounted film holder
7. Strip film tray
8. Attaching screw



Opposite, Auto Bellows I mounted on focusing rail. Bellows attaches to camera body just as lens, while any appropriate Minolta lens (standard lens used here) attaches to bellows front in same manner as to camera body.



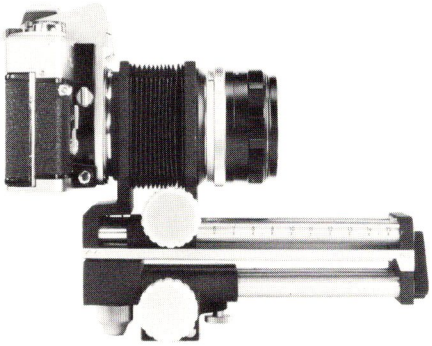
Opposite, underside of Auto Bellows I and focusing rail showing, left to right, attaching screw for mounting assembly to camera, tripod socket, and accessory holder clamp.

Opposite, Auto Bellows I
focusing rail parts identification.

1. Accessory holder
2. Accessory holder rod
3. Distance setting chain
4. Focusing knob
5. Accessory holder clamp
6. Attaching screw
7. Clamp



Opposite, Macro Stand for Auto Bellows I and Bellows III.



more complete Auto Bellows I Outfit, which includes the bellows unit, focusing rail, macrostand, a distance setting chain, slide copier, strip film holders, and a step-down adapter for use with lenses having 52mm filter-mount diameters, all contained within a handsome fitted case. The latter has room for a camera body and one lens in the standard focal length series—50mm, 55mm, or 58mm. The bellows is attached to and removed from the camera in the same manner as any lens. Lenses or other extension devices are attached to the front of the bellows as though it were the camera lens mount. Removal of the attachment from the bellows front is accomplished by pushing downward on the lens release button in the upper corner. With those lenses that have built-in preview buttons, the effects to be achieved at any given lens aperture setting can be examined before exposure merely by depressing the preview button. This is applicable, for example, in the case of the Auto Bellows Rokkor 100mm *f*/4. To make stop-down exposures with other bellows units, depress the locking preview button on the camera body; it will remain depressed without further finger pressure until pushed in once more.

The focusing rail can be used as an accessory in itself for fine focusing, but it is also a necessary adjunct for attaching either the slide copier or the Macrostand. The focusing rail is attached to the bellows rail by first slipping the lip of its own front end into the matching depression on the front end of the bellows rail. Then the attachment screw at the bottom rear of the focusing rail is screwed into the tripod socket of the bellows rail. The bellows component and the focusing rail are thereby combined into a single, rigid unit whose sliding controls can be operated independently. The entire assembly can be attached then either to a tripod or to the Copy Stand II. When you use the focusing rail on a tripod in a vertical position, you will need a ball-and-socket tripod mount, which must be of heavy, sturdy construction. Since the camera weight will be displaced to the side, the tripod must be sufficiently heavy to resist this weight displacement.

When using the 55mm lens by itself as an attachment to the bellows, the exact magnification for any bellows extension is read easily and directly from the scale on the left bellows rail. The reading should be taken from the position of the base of the bellows lens mount at its front position. When 50mm and 58mm lenses are used, the magnification scale can be used as an approximation. When the exact magnification ratio is needed with these or other lenses (other than the Bellows Rokkor 100mm *f*/4), the following formula should be used:

$$M = \frac{\text{bellows extension}}{\text{focal length of lens}}$$

The bellows extension can be read directly from the right-hand bellows rail, which is engraved in centimeters. The lower front of the lens mount support, adjacent to the focusing knob, will serve as the index line for reading bellows extension.

Exposure readings with all Rokkor lenses, whether or not meter-coupled, must be made by the stop-down method. The reading can be taken using the preview button on the lens, if available and convenient, or the preview button on the camera body. After the reading has been taken, viewing can then be done at full aperture, but only with automatic diaphragm-coupled Rokkor lenses. With lenses that have manually controlled diaphragms, the aperture must be preset to its actual picture-taking position just prior to exposure.

The distance setting chain is intended for use in positioning a small object in front of a 50mm, 55mm, or 58mm lens. The distance setting chain is first attached to the small hook on either side

AUTO BELLOWS I CLOSE-UP TABLES (Meters)

f = 55mm

Magnification Rate	Bellows Extension (mm)	Photographic Area (mm)	Distance from Subject to Film (mm)	Exposure Multiple
0.7	39	34 × 51	221	3
0.8	44	30 × 45	216	3
1.0	55	24 × 36	214	4
1.2	66	20 × 30	215	5
1.4	77	17 × 26	220	6
1.6	88	15 × 23	226	7
1.8	100	13 × 20	233	8
2.0	111	12 × 18	241	9
2.2	122	11 × 16	250	11
2.4	133	10 × 15	259	12
2.6	144	9 × 14	268	13
2.8	155	9 × 13	278	14

f = 58mm

Magnification Rate	Bellows Extension (mm)	Photographic Area (mm)	Distance from Subject to Film (mm)	Exposure Multiple
0.6	35	40 × 60	244	3
0.8	47	30 × 45	231	3
1.0	59	24 × 36	228	4
1.2	71	20 × 30	230	5
1.4	83	17 × 26	235	6
1.6	94	15 × 23	241	7
1.8	106	13 × 20	249	8
2.0	118	12 × 18	257	9
2.2	130	11 × 16	267	11
2.4	142	10 × 15	276	12
2.6	154	9 × 14	286	13

of the bellows rail adjacent to either one of its control knobs. The distance setting chain is then extended its full length with adjustments of camera stand and object until the front of the chain just reaches the object. Then you can set the desired magnification by reference to the left-hand bellows rail fairly precisely for the 55mm lens or approximately so for the 50mm and 58mm lenses. Alternatively, you can set a specifically desired extension using the scale on the right-hand bellows rail. In this case, the specific extension is relative to the specific lens being used. Lock the bellows in place with the clamping knob and then bring the image into sharp focus by moving the focusing rail forward or backward while examining the image on the viewing screen.

Exposure computation without the use of the through-the-lens metering system is described in a later section of this chapter.

Suggestions for copying both color transparencies and black-and-white neg-

AUTO BELLOWS I CLOSE-UP TABLES (Meters)

f = 100mm

Magnification Rate	Bellows Extension (mm)	Photographic Area (mm)	Distance from Subject to Film (mm)	Exposure Multiple
0.4	40	60 × 90	496	2
0.5	50	48 × 72	449	2
0.6	60	40 × 60	426	3
0.7	70	34 × 51	412	3
0.8	80	30 × 45	404	3
0.9	90	27 × 40	400	4
1.0	100	24 × 36	399	4
1.1	110	22 × 33	400	5
1.2	120	20 × 30	402	5
1.3	130	19 × 28	406	5
1.4	140	17 × 26	411	6
1.5	150	16 × 24	416	6

f = 100mm (Auto Bellows Rokkor)

Magnification Rate	Bellows Extension (mm)	Photographic Area (mm)	Distance from Subject to Film (mm)	Exposure Multiple
0.1	52	240 × 360	1,208	1.2
0.2	62	120 × 180	718	1.5
0.3	72	80 × 120	561	2
0.4	82	60 × 90	488	2
0.5	92	48 × 72	448	2
0.6	102	40 × 60	425	3
0.7	112	34 × 51	411	3
0.8	122	30 × 45	403	3
0.9	132	27 × 40	399	4
1.0	142	24 × 36	398	4
1.1	152	22 × 33	399	5

atives are offered in a succeeding section, but here we will describe the attachment of the slide copier. The slide copier is attached to the accessory holder using the thumbscrew at the base of the slide copier. The three accessory holder rods, which help assure rigidity, should be inserted all the way into the holes at the front of the focusing rail and should be locked in position by tightening the forward clamping knob underneath the focusing rail.

The rear of the slide-copier bellows is attached to the front of the lens. When using 58mm lenses or the Macro Rokkor 50mm lens, the 55mm/52mm step-down ring must be removed from inside the rear of the slide copier. Attach the rear of the slide-copier bellows to the front of the lens, locking it in place with the small thumbscrew clamp. When using 55mm lenses, the 55mm/52mm step-down adapter should be screwed into place in front of the lens, which should then be clamped to the rear of the slide copier.

AUTO BELLOWS I CLOSE-UP TABLES (Feet)

f = 58mm

Magnification Rate	Bellows Extension	Photographic Area	Distance from Subject to Film	Exposure Multiple
0.6	1 3/8"	1 9/16" × 2 3/8"	9 9/16"	3
0.8	1 7/8"	1 3/16" × 1 3/4"	9 1/16"	3
1.0	2 5/16"	15/16" × 1 3/8"	8 15/16"	4
1.2	2 13/16"	13/16" × 1 13/16"	9 1/16"	5
1.4	3 1/4"	11/16" × 1"	9 1/4"	6
1.6	3 11/16"	9/16" × 15/16"	9 1/2"	7
1.8	4 3/16"	1/2" × 13/16"	9 13/16"	8
2.0	4 5/8"	17/32" × 11/16"	10 1/16"	9
2.2	5 1/8"	7/16" × 5/8"	10 1/2"	11
2.4	5 5/8"	3/8" × 9/16"	10 7/8"	12
2.6	6 1/16"	3/8" × 9/16"	11 1/4"	13

f = 100mm (Auto Bellows Rokkor)

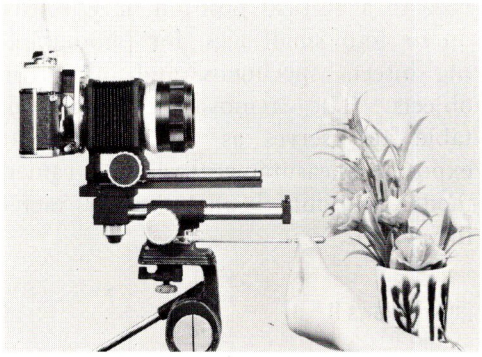
Magnification Rate	Bellows Extension	Photographic Area	Distance from Subject to Film	Exposure Multiple
0.1	2 1/16"	9 7/16" × 1'2 3/16"	3'11 9/16"	1.2
0.2	2 7/16"	4 3/4" × 7 1/16"	2' 4 1/4"	1.5
0.3	2 7/8"	3 3/16" × 4 3/4"	1'10 1/16"	2
0.4	3 1/4"	2 3/8" × 3 9/16"	1' 7 3/16"	2
0.5	3 5/8"	1 7/8" × 2 7/8"	1' 5 5/8"	2
0.6	4"	1 9/16" × 2 3/8"	1' 4 1/2"	3
0.7	4 7/16"	1 3/8" × 2"	1' 4 3/16"	3
0.8	4 13/16"	1 3/16" × 1 3/4"	1' 3 7/8"	3
0.9	5 3/16"	1 1/16" × 1 9/16"	1' 3 11/16"	4
1.0	5 5/8"	15/16" × 1 7/16"	1' 3 5/8"	4
1.1	6"	7/8" × 5/16"	1' 3 11/16"	5

f = 100mm

Magnification Rate	Bellows Extension	Photographic Area	Distance from Subject to Film	Exposure Multiple
0.4	1 9/16"	2 3/8" × 3 9/16"	1'7 1/2"	2
0.5	2"	1 7/8" × 2 7/8"	1'5 11/16"	2
0.6	2 3/8"	1 9/16" × 2 3/8"	1'4 3/4"	3
0.7	2 3/4"	1 3/8" × 2"	1'4 3/16"	3
0.8	3 3/16"	1 3/16" × 1 3/4"	1'3 7/8"	3
0.9	3 9/16"	1 1/16" × 1 9/16"	1'3 3/4"	4
1.0	3 15/16"	15/16" × 1 7/16"	1'3 11/16"	4
1.1	4 5/16"	7/8" × 5/16"	1'3 3/4"	5
1.2	4 3/4"	13/16" × 1 3/16"	1'3 13/16"	5
1.3	5 1/8"	3/4" × 1 7/8"	1'3 9/16"	5
1.4	5 1/2"	11/16" × 1"	1'4 3/16"	6
1.5	5 7/8"	5/8" × 15/16"	1'4 3/8"	6

f = 55mm

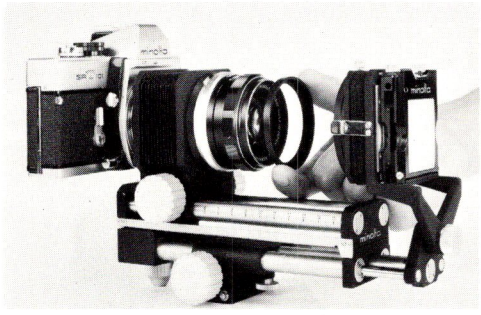
Magnification Rate	Bellows Extension	Photographic Area	Distance from Subject to Film	Exposure Multiple
0.7	1 1/8"	1 5/16" × 2"	8 11/16"	3
0.8	1 3/4"	1 3/16" × 1 3/4"	8 1/2"	3
1.0	2 3/4"	15/16" × 1 3/8"	8 3/8"	4
1.2	2 5/8"	13/16" × 1 13/16"	8 7/16"	5
1.4	3"	11/16" × 1"	7 7/8"	6
1.6	3 1/2"	9/16" × 15/16"	8 7/8"	7
1.8	3 15/16"	1/2" × 13/16"	9 1/8"	8
2.0	4 3/8"	15/32" × 11/16"	9 1/2"	9
2.2	4 13/16"	7/16" × 5/8"	9 13/16"	11
2.4	5 1/4"	3/8" × 9/16"	10 3/16"	12
2.6	5 11/16"	3/8" × 9/16"	10 5/8"	13
2.8	6 1/16"	3/8" × 11/16"	10 7/8"	14



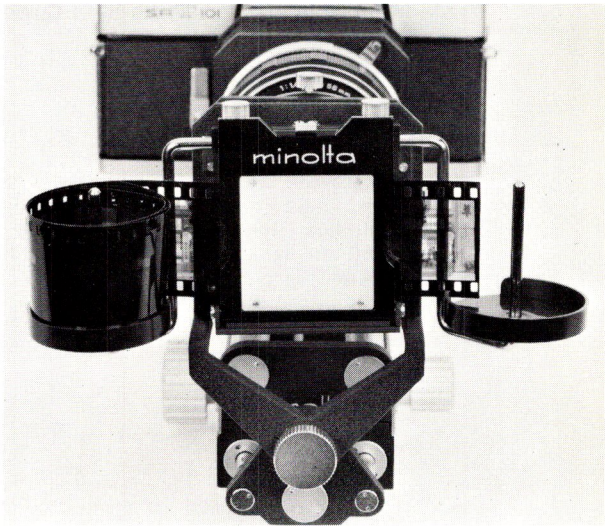
To use the distance setting chain with standard 50, 55, or 58mm lenses, place object at maximum reach of chain and then set either desired magnification or extension on bellows tracks.



Mounted slides are inserted into the slide holder (above). To insert strips of film (below), first attach the strip film trays, tightening them in position with the strip film holder clamps. In either case, the film emulsion must face the diffuser. Vertical frame adjustment is made by raising or lowering film holder. For horizontal adjustment, move the slide itself.

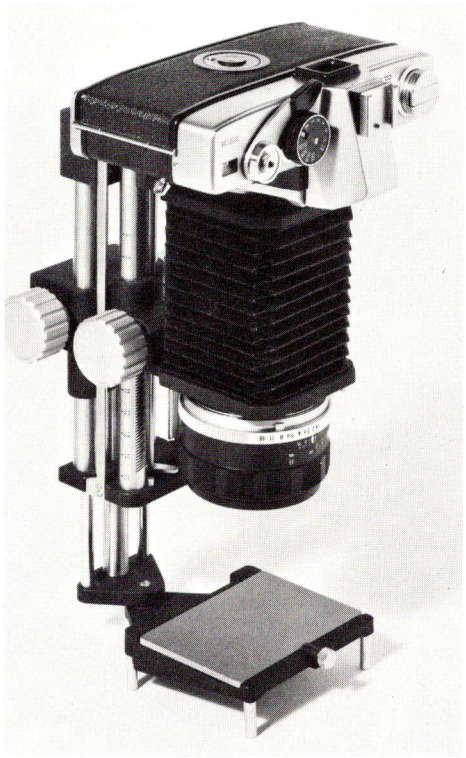


Slide Copier is attached to accessory holder of focusing rail. Accessory holder rod should be all the way into holes at front of focusing rail and tightened in place. Rear of Slide Copier bellows is attached to front of lens with lens clamp (small knurled screw at top). With 55mm f/1.7 lens, adapter ring located inside rear of Slide Copier is first screwed into that lens. When 58mm or Macro Rokkor 50mm lens is used, lens adapter ring is first removed.



To copy a mounted slide, insert it into the slide holder from either the left or right. The emulsion side of the film should face the diffuser plate. To copy unmounted transparencies as individual frames or in strips, pull the diffuser down (releasing it from the retainer spring), insert the film with the emulsion facing outward, and then return the diffuser to its upright position, where it should be held securely in place underneath the retainer spring. Long strips of film can be supported by strip-film trays attached to the sides of the diffuser. The strip-film trays are attached by loosening the thumbscrews on top of the diffuser and inserting the end of the wire support.

Additional suggestions on films, illumination, and exposure when making



The Macro Stand is attached to the focusing rail in the same manner as the Slide Copier. The Macro Stand may be used vertically for convenience in psitioning subject or it can also be used horizontally in which case some means must be found for attaching flat subject such as a postage stamp. With a 55 or 58mm lens, the accessory holder should be inserted into the focusing rail until the red line around the center rod reaches the edge of the hole near the accessory holder clamp. With a 50mm lens, the accessory holder should be all the way in. Tighten the accessory holder into position in either case.

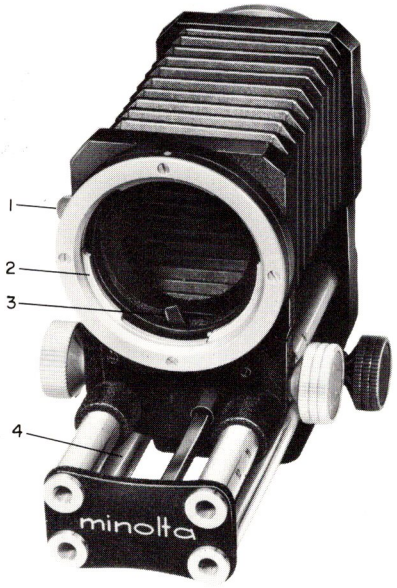
slide copies are covered in a succeeding section.

The Macrostand attaches to the focusing rail at its end in the same way as does the slide-copying attachment. It can be used in a vertical or horizontal position for photographing flat copy such as postage stamps, but it must be used in a vertical position only, resting on its four small legs, for photographing insects, specimens, and other tiny objects. The removable Macrostand table also serves as a gray scale for exposure measurement when a camera model without through-the-lens metering is used.

Auto Bellows II

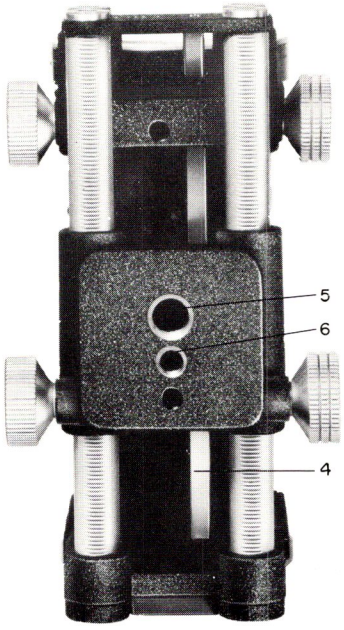
The Auto Bellows II for Minolta SR cameras is a joint product of Minolta and Novoflex manufactured in Germany. It is distributed in some countries but not in the United States where the combination of the Auto Bellows I and the detachable focusing rail are considered to accomplish the same purposes.

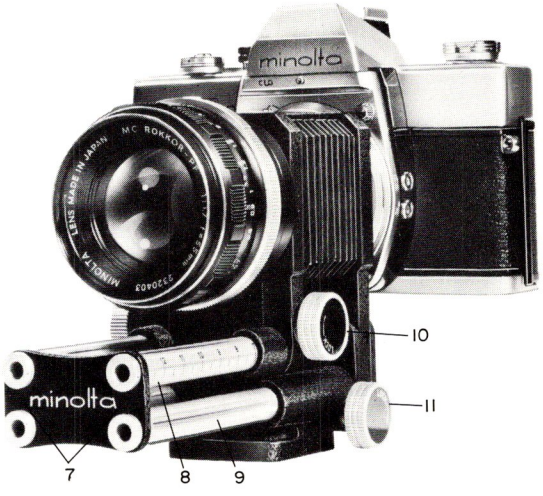
Auto Bellows II has a built-in focusing

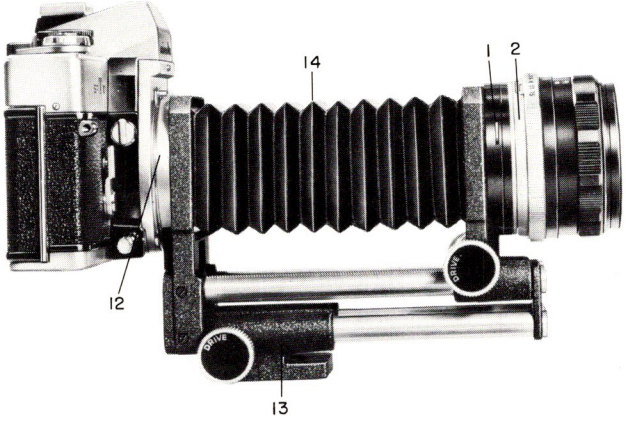


Minolta Auto Bellows II (Novoflex model distributed in Europe).

1. Lens lock release button
2. Bayonet for lens
3. Preset lever
4. Automatic diaphragm preset bar

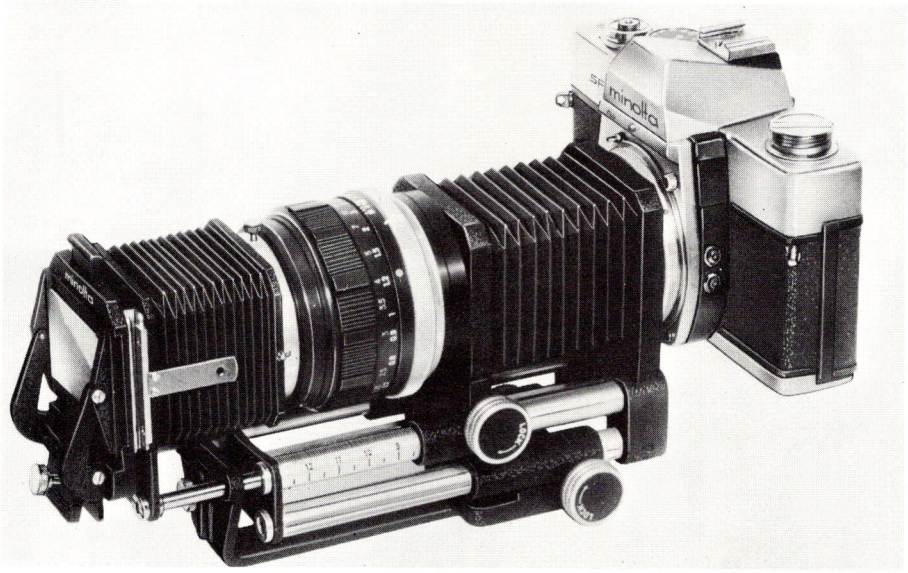




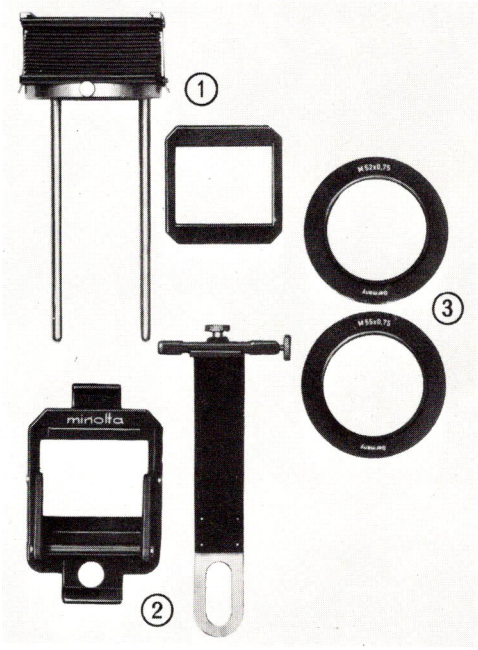


Minolta Auto Bellows II (cont'd.)

5. 3/8-inch German tripod socket
6. 1/4-inch English tripod socket
7. Slide Copier socket
8. Bellows guide rail
9. Focusing guide rail
10. Bellows extension control knob
11. Focusing control knob
12. Camera bayonet
13. Built-in focusing rail
14. Bellows



Slide copier attachment in place on Auto Bellows II.

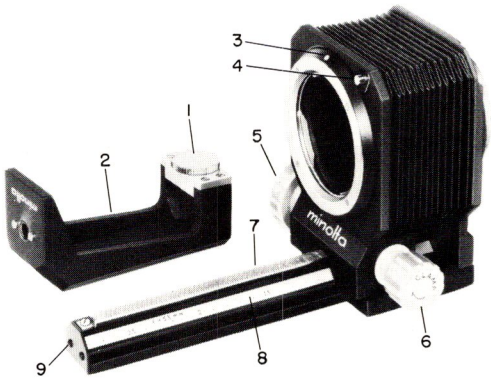


(1) Slide copying attachment for Auto Bellows II, (2) attachment rings, (3) slide holder.

rail that is not detachable. It has both German and English-type tripod sockets of 3/8 and 1/4 inches. An accessory slide-copying attachment is also available. Otherwise, its operation, including the relay of the auto-diaphragm feature of the MC Rokkor lenses, is similar to that of the Auto Bellows I.

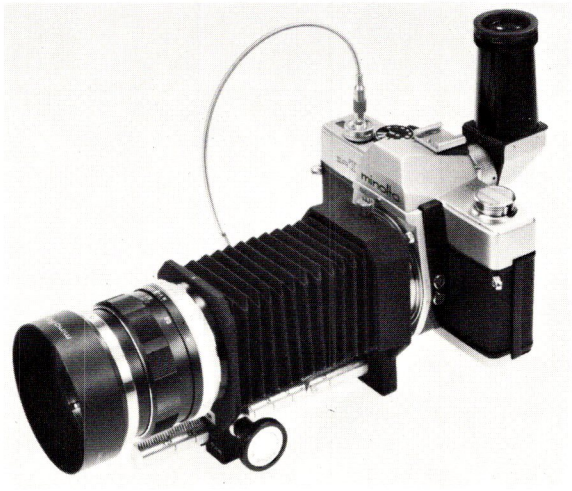
Bellows III

The Bellows III can be used to perform all of the functions of the Auto Bellows I with the exception of the relaying of the auto-diaphragm feature of the MC Rokkor lenses. The Bellows III is a single-rail extension unit. With a 55mm Rokkor lens it permits magnification up to 2.8×. Magnification and extension scales are engraved on either side of the single focusing rail and are used in the manner described above for the Auto Bellows I. Maximum bellows extension is 180mm (7-1/16 inches). Focusing is done in the same manner as with the Auto Bellows I. Exposure measurement is done through the stop-down method, also as discussed above. The full range of accessories for the Auto Bellows I can be used with the Bellows III. To attach either the slide



Minolta Bellows III parts identification.

1. Attaching screw
2. Connector (optional)
3. Lens mounting indication
4. Lens release button
5. Focusing knob
6. Clamp knob
7. Extension scale (not shown)
8. Magnification scale
9. Track



Auto Bellows I mounted together with camera and lens. Anglefinder V for convenience in viewing at low level. Cable release for jar-free exposure, especially good for slow shutter speeds.

copier or the Macrostand, you will need an additional, optional accessory called a *connector,* which slides over the bellows rail for use as an accessory shoe.

The Reverse Adapter

With the exception of the Macro Rokkor lenses, other lenses in the Rokkor series designed for use directly on the camera will yield their best overall performance when the ratio of the image size to actual size is no greater than 1:8 or 1:10. Although satisfactory results can be achieved at very close working distances, which yield higher magnifications, this ordinarily requires stopping down the lens to minimize optical aberrations. Additional sharpness is lost when the magnification begins exceeding a ratio of 1:1, for then image size on film begins to exceed object size, which is contrary to optical design expectations. With relatively short focal length

BELLOWS III CLOSE-UP TABLES

f = 50mm (Macro)

Magnification Ratio	Bellows Extension mm (inches)	Photographic Area mm (inches)	Distance from Film to Subject mm (inches)	Extra Stops to Open Aperture
0.7	36 (1 1/16)	34 × 51 (1 5/16 × 2)	210 (8 1/4)	1.5
0.8	41 (1 5/8)	30 × 45 (1 3/16 × 1 3/4)	206 (8 1/8)	2
1.0	52 (2 1/16)	24 × 36 (15/16 × 1 7/16)	203 (8)	2
1.2	62 (2 7/16)	20 × 30 (3/4 × 1 3/16)	205 (8 1/16)	2
1.4	72 (2 7/8)	17 × 26 (11/16 × 1)	210 (8 1/4)	2.5
1.6	83 (3 1/4)	15 × 23 (5/8 × 15/16)	215 (8 1/2)	3
1.8	93 (3 11/16)	13 × 20 (1/2 × 13/16)	222 (8 3/4)	3
2.0	103 (4 1/16)	12 × 18 (1/2 × 11/16)	230 (9 1/16)	3
2.2	113 (4 1/2)	11 × 16 (7/16 × 5/8)	237 (9 3/8)	3.5
2.4	124 (4 7/8)	10 × 15 (3/8 × 9/16)	245 (9 5/8)	3.5
2.6	134 (5 1/4)	9 × 14 (3/8 × 9/16)	254 (10)	3.5
2.8	144 (5 11/16)	9 × 13 (3/8 × 1/2)	262 (10 5/16)	4
3.0	157 (6 3/16)	8 × 12 (5/16 × 1/2)	274 (10 3/4)	4
3.2	165 (6 1/2)	8 × 11 (5/16 × 7/16)	282 (11 1/8)	4
3.4	175 (6 7/8)	7 × 10 (1/4 × 3/8)	286 (11 1/4)	4.5
3.5	180 (7 1/16)	7 × 10 (1/4 × 3/8)	290 (11 3/8)	4.5

lenses of asymmetrical design it is possible to obtain an image ratio greater than 1:1 by merely reversing the lens and attaching it to the camera so that its front faces the film while its back faces forward. This is accomplished through use of the reverse adapter or ring included with the Macro Rokkor 50mm *f*/3.5 lens. (If you do not have this lens and wish to obtain a reverse adapter, ask your camera dealer.)

The reverse adapter has a bayonet mount on one side that fits into the camera body in the same manner as a lens; on its other side it has a male thread of 55mm diameter, which fits into the front of the lens. Under this arrangement, of course, you lose automatic diaphragm control. You can still operate the diaphragm manually, but if you wish to focus and compose at full aperture, you must manipulate the diaphragm-control lever, which was ordinarily in back of the lens but is now at its front. Turn it gently in a clockwise motion; when you remove your finger the lever will spring back, and the diaphragm will close to the preset aperture.

When the lens is used in this way, it cannot be focused. It must be positioned at a fixed distance from the subject. The magnification factors and working distances for greater than life-size images attainable with three of the commonly used wide-angle lenses are given in the following table:

Lens	Magnification factor	Working distance
28mm *f*/3.5	2.06×	148.62mm (5.9″)
28mm *f*/2.5	2.28×	169.92mm (6.7″)
35mm *f*/1.8	1.43×	175.98mm (6.9″)

Much more flexibility and even greater magnifications can be achieved when lenses are mounted in reverse on one of the bellows extension units. The lenses appropriate for such use and the magnifications and working distances

BELLOWS III CLOSE-UP TABLES

f = 55mm

Magnification Ratio	Bellows Extension mm (inches)	Photographic Area mm (inches)	Distance from Film to Subject mm (inches)	Extra Stops to Open Aperture
0.7	39 (1 1/8)	34 × 51 (1 5/16 × 2)	221 (8 11/16)	1.5
0.8	44 (1 3/4)	30 × 45 (1 3/16 × 1 3/4)	216 (8 1/2)	1.5
1.0	55 (2 3/16)	24 × 36 (15/16 × 1 3/8)	214 (8 3/8)	2
1.2	66 (2 5/8)	20 × 30 (13/16 × 1 13/16)	215 (8 7/16)	2
1.4	77 (3)	17 × 26 (11/16 × 1)	220 (7 7/8)	2.5
1.6	88 (3 1/2)	15 × 23 (9/16 × 15/16)	226 (8 7/8)	3
1.8	99 (3 15/16)	13 × 20 (1/2 × 13/16)	233 (9 1/8)	3
2.0	111 (4 3/8)	12 × 18 (1/2 × 11/16)	241 (9 1/2)	3
2.2	122 (4 13/16)	11 × 16 (7/16 × 5/8)	250 (9 13/16)	3.5
2.4	133 (5 1/4)	10 × 15 (3/8 × 9/16)	259 (10 3/16)	3.5
2.6	144 (5 11/16)	9 × 14 (3/8 × 9/16)	268 (10 5/8)	3.5
2.8	155 (6 1/16)	9 × 13 (3/8 × 11/16)	278 (10 7/8)	4
2.9	160 (6 5/16)	8 × 12 (5/16 × 1/2)	282 (11 1/8)	4.5

f = 58mm

Magnification Ratio	Bellows Extension mm (inches)	Photographic Area mm (inches)	Distance from Film to Subject mm (inches)	Extra Stops to Open Aperture
0.6	35 (1 3/8)	40 × 60 (1 9/16 × 2 3/8)	244 (9 9/16)	1.5
0.8	47 (1 7/8)	30 × 45 (1 3/16 × 1 3/4)	231 (9 1/16)	1.5
1.0	59 (2 5/16)	24 × 36 (15/16 × 1 3/8)	228 (8 15/16)	2
1.2	71 (2 13/16)	20 × 30 (13/16 × 1 13/16)	230 (9 1/16)	2
1.4	83 (3 1/4)	17 × 26 (11/16 × 1)	235 (9 1/4)	2.5
1.6	94 (3 11/16)	15 × 23 (9/16 × 15/16)	241 (9 1/2)	3
1.8	106 (4 3/16)	13 × 20 (1/2 × 13/16)	249 (9 13/16)	3
2.0	118 (4 5/8)	12 × 18 (17/32 × 11/16)	257 (10 1/16)	3
2.2	130 (5 1/8)	11 × 16 (7/16 × 5/8)	267 (10 1/2)	3.5
2.4	142 (5 5/8)	10 × 15 (3/8 × 9/16)	276 (10 7/8)	3.5
2.6	154 (6 1/16)	9 × 14 (3/8 × 9/16)	286 (11 1/4)	3.5
2.7	159 (6 1/4)	9 × 13 (3/8 × 1/2)	292 (11 1/2)	4

BELLOWS III CLOSE-UP TABLES

f = 100mm

Magnification Ratio	Bellows Extension mm (inches)	Photographic Area mm (inches)	Distance from Film to Subject mm (inches)	Extra Stops to Open Aperture
0.4	40 (1 9/16)	60 × 90 (2 3/8 × 3 9/16)	496 (19 1/2)	1
0.5	50 (2)	48 × 72 (1 7/8 × 2 7/8)	449 (17 11/16)	1
0.6	60 (2 3/8)	40 × 60 (1 9/16 × 2 3/8)	426 (16 3/4)	1.5
0.7	70 (2 3/4)	34 × 51 (1 3/8 × 2)	412 (16 3/16)	1.5
0.8	80 (3 3/16)	30 × 45 (1 3/16 × 1 3/4)	404 (15 7/8)	1.5
0.9	90 (3 9/16)	27 × 40 (1 1/16 × 1 9/16)	400 (15 3/4)	2
1.0	100 (3 15/16)	24 × 36 (15/16 × 1 7/16)	399 (15 11/16)	2
1.1	110 (4 5/16)	22 × 33 (7/8 × 5/16)	400 (15 3/4)	2
1.2	120 (4 3/4)	20 × 30 (13/16 × 1 3/16)	402 (15 13/16)	2
1.3	130 (5 1/8)	19 × 28 (3/4 × 1 7/8)	406 (15 9/16)	2
1.4	140 (5 1/2)	17 × 26 (11/16 × 1)	411 (16 3/16)	2.5
1.5	150 (5 7/8)	16 × 24 (5/8 × 15/16)	416 (16 3/8)	2.5

f = 100mm (Auto Bellows Rokkor)

Magnification Ratio	Bellows Extension mm (inches)	Photographic Area mm (inches)	Distance from Film to Subject mm (inches)	Extra Stops to Open Aperture
0.1	52 (2 1/16)	240 × 360 (9 7/16 × 14 3/16)	1208 (47 9/16)	0.5
0.2	62 (2 7/16)	120 × 180 (4 3/4 × 7 1/16)	718 (28 1/4)	0.5
0.3	72 (2 7/8)	80 × 120 (3 3/16 × 4 3/4)	561 (22 1/16)	1
0.4	82 (3 1/4)	60 × 90 (2 3/8 × 3 9/16)	488 (19 3/16)	1
0.5	92 (3 5/8)	48 × 72 (1 7/8 × 2 7/8)	448 (17 5/8)	1
0.6	102 (4)	40 × 60 (1 9/16 × 2 3/8)	425 (16 1/2)	1.5
0.7	112 (4 7/16)	34 × 51 (1 3/8 × 2)	411 (16 3/16)	1.5
0.8	122 (4 13/16)	30 × 45 (1 3/16 × 1 3/4)	403 (15 7/8)	1.5
0.9	132 (5 3/16)	27 × 40 (1 1/16 × 1 9/16)	399 (15 11/16)	2
1.0	142 (5 5/8)	24 × 36 (15/16 × 1 7/16)	398 (15 5/8)	2
1.1	152 (6)	22 × 33 (7/8 × 5/16)	399 (15 11/16)	2

appropriate to them are noted on the lens data sheets in the chapter on lenses. In general, you can expect that when a lens is of asymmetrical design, reversing the lens will yield greater magnification. If the lens is nearly symmetrical, you will not increase magnification, but in some cases you might achieve greater sharpness, depending upon the design of the particular lens. In the case of the Macro Rokkor 50mm *f*/3.5, one advantage of reversing the lens is that it enables you to get closer to photomacrographic subjects. When used in its normal mode with the front of the lens facing forward, the deeply recessed lens within the built-in lens hood configuration puts a physical limit on closeness; reversing the lens overcomes this difficulty. Since the Macro Rokkor 50mm lens is nearly symmetrical, reversal does not affect image size particularly. When the Macro Rokkor 50mm lens is mounted in reverse position on the bellows extension, magnification as great as 5× can be obtained.

Exposure is most easily computed automatically through use of the behind-the-lens exposure-measuring system. Alternatively, you can use the methods described in the next section.

Exposure by the Numbers

As mentioned above, the rated apertures, as engraved on the lens mount, are correct only when the lens is focused at infinity. With any closer subject, which calls for extension of the lens away from the film plane in order to achieve a sharp focus, less light will reach the film. This is because of the greater distance the light must travel, which causes it to diverge over a wider area with less brilliance at any given point in the same plane. As a practical matter, the decrease in illumination is not particularly noticeable up to image ratios of 1:8, but beyond this, greater extensions of the lens from the film plane require that an adjustment be made in exposure. The amount of adjustment is referred to as the *exposure factor* or the *exposure multiple.* This is the factor by which the amount of light striking the film must be increased to achieve a correct, compensatory exposure. This factor can be computed using the following formula when built-in automatic exposure measurement is not available.

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

In this formula, *EF* stands for exposure factor.

If we know the magnification ratio, it is possible to calculate the exposure factor using an even easier formula:

$$\text{EF} = (\text{magnification ratio} + 1)^2$$

For example, if we know that the magnification ratio is 1:2 (or one-half life-size), we can figure:

$$\text{EF} = (\tfrac{1}{2} + 1)^2$$
$$\text{EF} = (1\tfrac{1}{2})^2$$
$$\text{EF} = 2\tfrac{1}{4}$$

This means exposure must be increased 2¼ times over whatever exposure reading we have obtained from a light meter. If the exposure factor was four, exposure would have to be increased four times and so on.

Using the exposure factor, we can now derive the proper *f*/stop for macrophotography. Exposure always doubles for each change downward in *f*/stop. Thus, *f*/8 is twice as large as *f*/11, *f*/11 is twice as large as *f*/16, and so on.

With an exposure factor of four and a light meter reading of *f*/8, the adjusted aperture for macrophotography would be *f*/4 (or two stops down from *f*/8). With an exposure factor of four and a light meter reading of *f*/11, the adjusted aperture for macrophotography would be *f*/5.6 (or two stops down from *f*/11).

When the exposure factor is a fraction, adjusted aperture for macro-

photography is calculated by using the following formula in which *EA* stands for effective aperture:

$$EA = \sqrt{\frac{f \times f}{EF}}$$

Thus, if *EF* equals 2¼ (2.25), as in the above example, and the *f*/stop is 8:

$$EA = \sqrt{\frac{8 \times 8}{2.25}}$$

$$EA = \sqrt{\frac{64}{2.25}}$$

$$EA = \sqrt{28.4}$$

EA = 5.3 or, for practical purposes, *f*/5.6

GENERAL CLOSE-UP TECHNIQUE

Most of the foregoing has related to the selection and use of lenses and close-up accessories to achieve desired magnifications. When you get behind the camera and begin exploring the world of the small made large through the optical system, you become aware of a variety of problems whose mastery becomes a fascinating challenge in itself. You discover that every problem met in ordinary photography is also magnified, including control over depth of field, perspective, camera movement, subject movement, lighting, and background control. The approaches to handling these problems are in essence those encountered in the ordinary variety of photographic situations, but the measures to be taken or the procedures to be followed must in each case be much more precise.

Reference should be made to the chapter on image management, for its general treatment of problems of depth of field and perspective are relevant here; also refer to the chapters on exposure and lighting.

Perspective: Control of Relative Size

When photographing three-dimensional objects with the aim of achieving high magnifications, which include 1:1 image ratios, your camera setup tends to exaggerate the size of the physical surface or object closest to the camera relative to things or surfaces further away. The finished picture may then look odd or unnatural. This is partly because the camera lens is brought much closer to the subject than unaided eye can ever be. Also, when you look at the real subject you can shift your view to see it in depth from different angles, and you can also make psychological accommodations to perceive physical relationships as you expect them to be in a normal sense.

The first solution is to use a lens whose focal length is appropriate to the subject matter. In a general way, you can correlate physical depth of the subject with selection of longer focal length lenses for best perspective control. At one extreme, when photographing single-plane objects you are not concerned at all with perspective control. The matter of lens selection is solely one of determining how important it is to have edge-to-edge sharpness. Ordinarily, you would not use a wide-angle lens, but if you are photographing documents in tight quarters, and if you are concerned solely with reasonable legibility rather than knife-edge sharpness up to the very edge, a wide-angle lens would be acceptable. Ideally, you would use one of the Macro Rokkor lenses or the Auto Bellows Rokkor, since these lenses have been designed specifically for working at close distances. You must, however, work with what is available to you under the existing conditions.

With three-dimensional objects you would tend to use lenses of longer focal



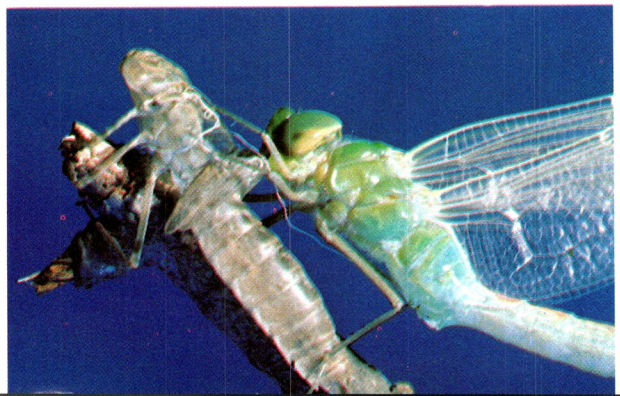
A frontlighted flower usually shows up best in contrast with a dark background. Tore Håkannson used a 58mm f/1.4 lens with an extension tube, Kodachrome II. The droplets of water, which you can spray on, pick up sky reflections.



Small, three-dimensional objects are best photographed with lens of about 100mm in order to have more working room for lights and to control perspective. Robert Dehesdin used a combination of bellows and Bellows Rokkor 100mm lens with bounce flash, Ektachrome-X.



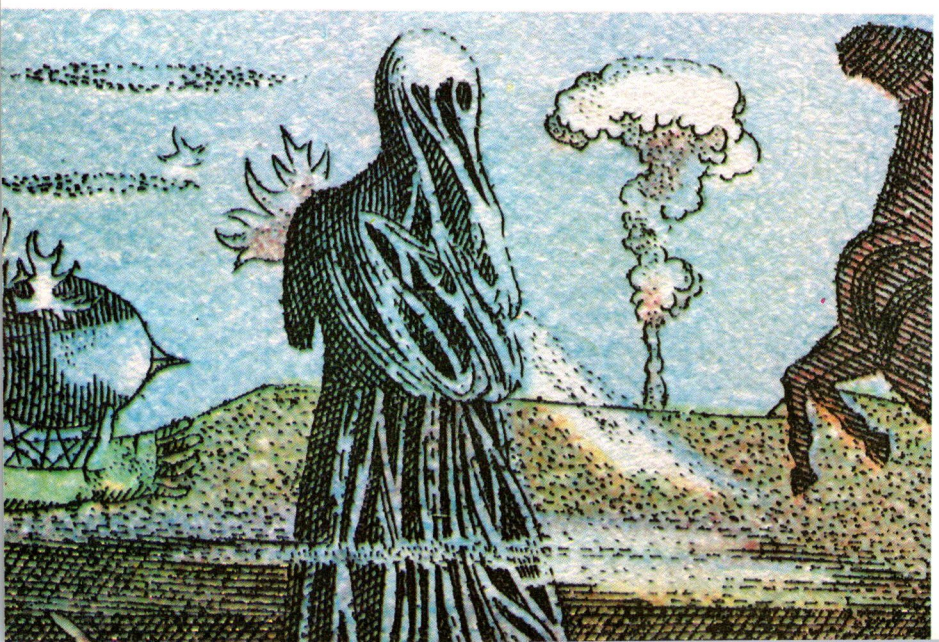
The honeybee was photographed with the diaphragm-coupled combination of the Auto Bellows I and the Auto Bellows Rokkor 100mm lens, natural light, Ektachrome-X, f/5.6 at 1/60 sec. Photo from Minolta Camera Company, Ltd.



Birth of large dragonfly photographed with electronic flash, Ektachrome-X, Macro Rokkor 50mm, f/8 at 1/60 sec. The brilliance of flash permits sky to show up darker. Photo from Minolta Camera Company, Ltd.



These two copies of a Czechoslovakian stamp were made with the Macro Rokkor 50mm *f*/3.5 lens using sunlight with the stamp so positioned that the sun's rays were directed at an oblique angle. Sidelighting is important in bringing out the engraved lines clearly. The entire stamp was copied with the lens in normal position. The section of the stamp was copied with the lens reversed, mounted on the Auto Bellows 1, for greater than 1:1 magnification. Kodachrome II. Joseph D. Cooper.



length, ideally the Macro Rokkor 100mm $f/3.5$ lens, but you could also use any other of the telephoto lenses in the range of 85mm through 200mm. In some cases, you might also achieve very interesting effects through use of the 300mm $f/4.5$ lens, extended with one of the macro extension tubes or a combination of tubes from the Minolta Extension Tube Set II. When photographing small objects you are ordinarily not so concerned with edge-to-edge sharpness, inasmuch as the object is rarely photographed up to the very edge; rather, it is usually framed by some empty space. When, however, you are to photograph a small section of a larger area in order to bring out detail or texture, you would be concerned with overall sharpness, keeping in mind that the viewer would be examining the picture from edge to edge. In such a case you would have great flexibility because the detailed or textured surface would not be so deep as to represent a perspective problem. Accordingly, you could use any standard lens, stopped down suitably, or one of the Macro Rokkor lenses.

Furthermore, whenever possible or appropriate, you should position the object or the camera or both so that as much as possible of the subject is ordered into a plane parallel with the film.

Depth of Field

Depth of field, as pointed out in an earlier chapter, is really depth of a zone of sharpness extending in front of and behind the point of critical focus. For any given lens at a given aperture, depth of field will diminish as you get closer to the subject. This is because working closer gives you a higher magnification. Hence, regardless of the lens you use, if you achieve the same magnification within the film area, you will have the same depth of field. The only thing that will change is the perspective effect. Depth of field can be increased only by using smaller lens apertures.

Now we are in the business of making trade-offs. Smaller lens apertures call for longer exposures. In order to use shorter exposure settings on the camera you would use more brilliant lighting, if available and appropriate to the subject, and faster films. The latter may be quite appropriate for many subjects, but not when fine-line rendition is important or essential.

You can increase depth of field somewhat, but not substantially, by using the smallest lens apertures. With some lenses you might be tempted to use $f/22$ or $f/32$, but at these smallest apertures there are risks of impairing image quality through the *diffraction effect*, explained in the chapter on lenses. In brief, at very small lens apertures you may get some softening of image contours. One non-optical correction for this is to use strong side-directional lighting to create light-and-shade effects, which enhance the impression of sharpness.

Control of Movement

The movement problem is exacerbated by the interplay of several factors. To increase depth of field you use smaller lens apertures, which must then be compensated by longer exposures. High magnifications do not in themselves constitute a source of difficulty. Rather, they bring out existing movement, which is not discernible in small-scale reproduction. When photographing flowers or insects outdoors in nature, you become acutely aware of environmental problems. The slightest breeze will cause a displacement of the subject. If the weight of the camera and bellows extension unit is not balanced on a tripod, you may get image displacement on film after you have completed your composing and framing due solely to a shift in camera position caused by

its being off balance; moreover, the slightest touch on the camera controls may throw the image off center. When lighting conditions change, calling for adjustments in shutter speeds on manually controlled cameras, you risk causing additional image displacement.

The corrective measures described here pertain mainly to control of camera movement and shutter speed, although limiting movement of the subject is also desirable insofar as it is feasible.

For flat copy and smaller objects one solution is to integrate the subject support with the camera support. You can accomplish this by using the Macrostand, for example, or by using the Minolta Copy Stand II. In both cases, the hazard of independent movement of one or the other is minimized, but the hazard of vibration of the whole setup from environmental causes is not eliminated. It must be noted, moreover, that the higher the position of the camera on the copy stand in a vertical position, the more it alone is subject to vibration or other movement caused by environmental force.

The environmental problem is felt uniquely in older buildings, which may have a certain "looseness" about them, making them subject to external force caused by people walking, engaging in physical work, starting and stopping motors, opening and shutting doors, and so on. The rumbling of a truck or bus in front of a building can also set off vibrations that are scarcely noticeable in ordinary photography but which are given effect in prolonged exposure under high magnification.

Hence, the first rule is that you must make sure that your equipment is supported tightly and rigidly. A tripod or other support should be sturdy. The center of gravity of the combined camera and support should be as low as possible, consistent with picture-taking conditions. Some photographers tape their tripod to the floor or to the table, if small camera supports are used. The table or the tripod or both might have rubber shock absorbers under their feet.

Camera movement or vibration during actual exposure must also be minimized. This is most likely to occur during moderately long exposures. This is a relative expression, for what might be a safe hand-held exposure of 1/60 sec. under ordinary conditions might be unsafe when making close-ups. Ideally, you should have the shortest possible, vibration-free exposure, but under some conditions a somewhat longer exposure might be safer than a shorter one.

Let us break down the possible sources of movement during exposure. First, there is the impact of external force on the shutter release itself. Second, there is the mechanical response of the camera in flipping the mirror out of the way, releasing the shutter, and closing the shutter—all of which can introduce movement. Third, there is environmental shock transmitted to camera or subject or both. Movement caused by activating the shutter can be minimized, with regular camera models, by using a self timer or a cable release. The self timer releases the shutter automatically after enough time has elapsed to allow the camera to stop vibrating after the timer has been released. The mirror lock-up device can be used to eliminate the hazard of mirror movement. A cable release can be used to absorb hand and finger pressure while activating the shutter-button release. The use of a remote control with a motorized camera model further removes the hazard of force exerted by the human operator.

Ideally, when making close-ups you should have shutter speeds of 1/125 sec. or less. A shutter speed of 1/60 sec. is risky. When taking pictures indoors, the camera should be used with electronic flash ("X" sync), for with this lighting source, exposure duration is usually about 1/1000 sec., which overcomes the

movement problem. When other lighting sources are used, and if you can minimize all other sources of environmental force, you might experiment with moderately short exposures or with somewhat longer ones that give you the advantage of smaller *f*/stops. The longer exposure might absorb the initial shock of the shutter release, which is of fixed duration. That is, the longer the time during which the shutter is completely open, the more it will register a subject clearly and sharply without movement, thereby subordinating some or most of the possible softness caused by shutter movement at the beginning.

Another technique sometimes used is to cover the lens with a black card (or turn off the light), release the shutter at the "B" setting, hold the shutter open with a locking cable release, remove the card (turn on the light) for the desired length of time, restore the card (or turn off the light), and close the shutter. A variation of this technique is to use existing light or additional pictorial lighting sources that will afford an exposure of at least a few seconds for purposes of control. In this case the same procedure is repeated, except that the card is simply held away from the front of the lens for a predetermined duration and then returned to the lens, after which the shutter is closed.

Lighting of Small Objects

The general guidelines on artificial lighting discussed in the earlier chapter also apply to close-up photography, except that everything must be reduced in scale. Lamps and reflectors suitable for portrait photography are generally not suitable, because they spill too much light on and around the subject. The same has been true of flash sources, although with the smaller units some greater control can be exercised. Really what matters is the angle of coverage of the lamp reflector. The high output of the lighting source is in itself advantageous when working with high magnifications or image ratios in order to make up for the loss of light intensity within the camera.

Ring flash units are often used in close-up work, but they are limited to special applications because of the flatness of lighting effect. Appropriate uses are in medical and dental photography and in the illumination of small, flat objects.

Another disadvantage in using conventional continuous-lighting sources close to the subject is that they throw off a great deal of heat, causing discomfort to the photographer and subjecting heat-sensitive subjects to possible damage. This is particularly true of botanical and biological specimens. One way out of this, if necessary, is to use a stand-in subject while setting up the lighting and then substitute a fresh, undamaged subject for the brief moments of actual exposure.

Ideal sources for small to very tiny objects produce concentrated beams of light. A slide projector without any slides in it is quite suitable. Spotlights and flashlights can be used provided they give even illumination. Flashlights sometimes project uneven patterns of lighting. The commonly available high-intensity lamps are well adapted to photography, for they emit concentrated and brilliant light beams. Your two basic lights are a main source and a fill-in source, as described in the chapter on lighting. If background shadows are a problem, you might need an additional light to burn out the shadow pattern behind the subject.

Reflectors are convenient sources of indirect lighting. They bounce back onto the subject for fill-in purposes some of the light emitted by main and secondary lamps. Again, your reflectors must be proportionately smaller than those used in photography of larger objects. Have on hand a variety of flat

and curved cards with different reflective surfaces, including some covered with crumpled aluminum foil. Also, have a variety of mirrors to throw light into inaccessible areas or to provide highlights, rim lights, and backlighting effects.

You will need small stands or supports to hold your reflector cards and mirrors. These can be ordinary office, laboratory, or household items, such as spring clips, merchandise price-card holders, laboratory clamps, or table-top tripods.

Reflections from nonmetallic objects can be controlled either by putting polarizing screens over the light sources or through use of a Minolta polarizing filter over the lens or both. The combination is more effective than either by itself. Use of a polarizing filter does not assure that you will eliminate all reflections, since the filter works more effectively at some angles than others. Bright metallic surfaces can be dampened if necessary. With care, using putty or plasticine, you can pat the surface until it becomes shiny-dull. If this is not enough, you can blow some powder onto the object; it will adhere to the slightly oily surface. Commercial dulling sprays intended for cutting down on high gloss can be obtained from professional photo supply houses or from artists' supply houses.

Outdoor lighting has the advantages and disadvantages of a single source. Reflectors or fill-in flash (not quite convenient at close working distances) are essential for opening up shadows.

SLIDE AND FILM-COPYING

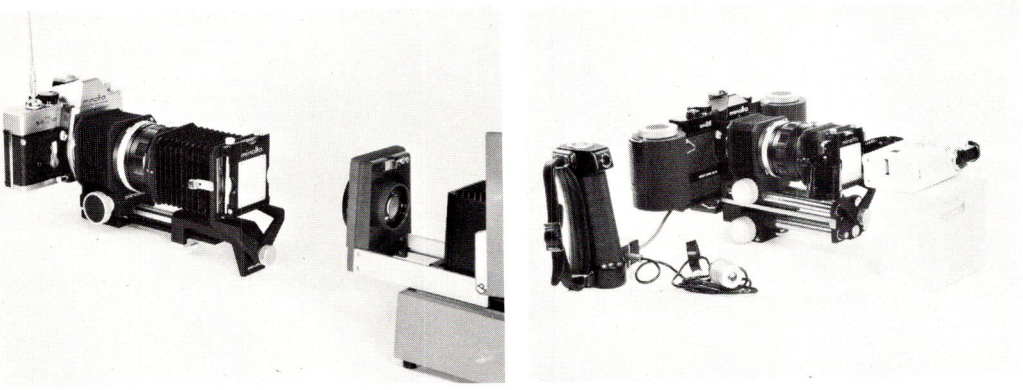
The slide-copier attachments for the Minolta bellows extension units make it convenient for anyone with or without a darkroom to produce the following: slide duplicates; size and color variations of original slides; positive projection slides from color negatives; color or black-and-white negatives from positive transparencies for use in print-making; and black-and-white slides from black-and-white film negatives. Density and tonal variations can be made to improve upon originals. The creative photographer can go beyond these techniques into the area of special effects through double exposure, montages, and composites.

The slide-copier attachment is the key piece of hardware that puts all of this within relatively easy reach for any amateur or professional. It accepts either slide mounts or unmounted film and holds either one in a flat plane, parallel to the film in the camera. This eliminates exacting and tedious procedures for verifying the alignment of the two planes from corner to corner. Since the light-sensitive film is safely enclosed in the camera, all of the procedures can be carried out conveniently in ordinary room-light conditions. (An optional exception to this is in the "flashing" of the film for contrast control, as explained below.)

One of the more important uses of the slide-copying procedures is the making of simple duplicates of your more important slides. You can use these duplicates for occasional slide projection or for lending to others. Thus, the prize original is kept safely filed while only a duplicate is subject to damage.

Color Slide Reproduction

The procedures for focusing and for obtaining desired magnifications were discussed in the earlier sections on use of the bellows units. It is important to mention again that if you wish to make a 1:1 reproduction using all of the original transparency, you must strip it from its mount and insert it in the outer channel directly in front of the diffuser glass. If you use a slide in its mount and wish to fill the full frame of the film in



Two of the various means of illuminating slides through diffuser. Left, the Minolta Slide Projector. Right, electronic flash in conjunction with motor-driven SR-M and 250-exposure film back.

the camera, you will need slightly higher magnification to compensate for the loss of some film area due to masking by the slide mount.

Aside from correctly matching the film to its light source, as described in the chapter on exposure, the two technical problems to be overcome are the attainment of color fidelity and the control of image contrast. As to color fidelity, it should be understood that it is practically impossible to absolutely reproduce all of the color in the original exactly as it appears there. For one thing, color film usually varies from batch to batch, and there are also variations, however minute, in processing. For another, it is one thing to make an original exposure on film from the world about you; it is another matter to make a copy of an image on film. Much of the subtlety of tonal gradation in the world about you is lost when reproduced on film because of its inherently narrower contrast range. Your problem in making a copy of a film is that each reproduction builds up additional contrast while dropping out subtle tonal gradations. The ordinary rule is that if you wish to duplicate the original contrast range, you use a special duplicating film, which is specially designed for such purposes in that it is inherently softer or flatter in its tonal range.

You can also use regular color film, provided the subjects to be copied are a little flat or lacking in contrast. To reproduce what you consider to be a good transparency with a reasonably long tonal scale using ordinary color films, you would have to resort to the flashing technique, described below.

It is important also to make sure, if you are using a continuous light source, that there are no fluctuations in voltage, which can cause shifts in color balance. If you wish to achieve critically fine results, you should obtain a voltage regulator through your photo dealer. This is not a problem with flash illumination, where the only requirement is that you be assured that the individual flash charge is fully built up before each exposure.

A detailed procedure for making duplicates and for using a filter pack to control the color balance of the duplicate transparency is summarized briefly here. The starting point is to select a well-exposed transparency that you regard as typical of one of your average subjects. You might have several "typical" subjects that differ in their characteristics depending upon your photographic interests, so for each you might have to follow the same procedure. This procedure is applicable either to the use of a continuous light

source or to flash exposure. If you are using continuous lighting, exposure control is achieved by varying the shutter speed while holding the *f*/stop constant. With flash, you have a choice of holding the shutter speed constant and varying the *f*/stop or holding both of these constant and varying the distance of the flash from the diffuser plate.

Using a continuous light source with the lens set at *f*/11, you would make a series of test exposures beginning with one-half second and continuing through half-second increments up to four seconds. In making these test exposures you could use a filter pack to observe changes in color balance with each of the filters selected. More information on this will be given below. When you have the processed film in hand, compare the exposures with the original transparency in order to identify the particular frame that most closely resembles the color *density* of the original. At this stage do not be too concerned about whether all of the color balance has been achieved. The selected frame will indicate what should be your standard exposure for the shutter speed and *f*/stop combination used to produce that frame under identical conditions (lighting source, image ratio, filter pack, and duplicating film). Because of shifts from batch to batch of duplicating film, it is well to procure either a 100-foot roll and load your own film as needed or to purchase professional packages of 36-exposure magazines when available, such as Anscochrome Duplicating Film Type 5470, which is sold in packages of 25. Film should be stored in a refrigerator when not in use.

Once you have a standard duplicate for reference, place over it one or two filters from a color balancing set as indicated in the accompanying color correction table. When you have achieved a close match with the original, you can predict fairly well that with the same slide-duplicating setup, which must include all the variables listed above, you will be able to duplicate comparable transparencies.

You can also make up for differences in exposure density—overexposure and underexposure—in originals if you make up a master set of five duplicate transparencies. Assume that the balanced master slide was shot at one second at *f*/11. Make two additional exposures, successively, at half-stop intervals from *f*/8 to *f*/11. These will give you two reference slides to indicate compensation needed for half-stop and one-stop overexposure. If the slide to be copied compares with either of these two overexposure references, you would compensate when copying them by *decreasing* exposure by one-half stop and one stop respectively. To have reference slides for slight underexposure within a one-stop range (where the original slides are somewhat dense), you would make two successive exposures at a half stop less between *f*/11 and *f*/16 and at *f*/16. An original that compares with either of these would be given one-half stop or one stop of *additional* exposure.

If all other factors remain constant and you wish to increase or decrease the image ratio of the slide duplicate, this can be done without much difficulty, provided critically correct results are not desired or important, by reference to the table of exposure factors in this chapter.

When using continuous light sources, you have the advantage of through-the-lens exposure metering, which should be used only as a point of departure, however. Bear in mind, also, that when using exposures longer than 1/10 sec. (unless otherwise indicated by the film manufacturer) you should compensate for reciprocity effects, as discussed in the chapter on exposure.

When using a flash source, the only control on exposure after the distance between the flash and the diffuser glass is established, is through *f*/stop manipulation. As a point of departure for

determining an approximate exposure above and below which to make additional exposures, divide the distance of the flash from the diffuser glass into the flash guide number for the particular film being used. You must then add a compensatory factor for light loss through the diffuser glass. As a point of departure, since you will be making additional tests anyway, you can set this at two stops, and open the lens accordingly. If you want to be more exact about it, you could substitute a tungsten light source at the same distance and make two exposure meter readings: one pointing at the light source and the other pointing at the diffuser plate, which is held between the meter and the light source. The second reading should be taken with the meter and the light source in their same relative positions a few feet apart. The difference in *f*/stop readings between the two will indicate how much compensation to make for the diffuser glass.

With ordinary non-duplicating-type (reversal) color films, as well as with the duplicating types when they need contrast reduction, you can use a preflashing technique to minimize or reduce contrast. Basically, the aim is to subject the film on which the transparencies are to be copied to a very low level of uniform light before or after the copy exposures are to be made. The effect is to lower maximum density and contrast between shadows and highlights.

One flashing technique, with film in camera, is to make double exposures using the same light source under identical conditions. In the absence of a camera mechanism for making double exposures, you accomplish this by making the desired exposure and following it with a flashing exposure on the same frame. Both exposures must be made with the room light lowered to a level that will not have any effect on the film, because the entire operation must be performed with the shutter held open at "B." After making the slide exposure by either turning your light source on and off or using flash, maintain the shutter in an open position through the locking cable release and remove the slide. Then attach a neutral density 2.0 filter over the lens and make a second exposure by flash or by again turning on the continuous lighting source for the same duration. Obviously, flash would be more convenient in this case.

An entire strip of film can be flashed at once. While this requires the use of a darkroom, it simplifies the making of individual exposures in the camera. One means of doing this is to modify a Kodak Darkroom Lamp as shown in the accompanying illustration. The important thing is that the light source must be far enough away—about six feet—to be uniform over the entire film area. At a distance of 6 feet, a strip of film about 22 inches long can be flashed. The color quality of the light must be identical to that used for copying. Hence, unless you employ filtering, you cannot mix a flood or tungsten light source with a flash source. You should also use a neutral density filter 2.70 to reduce light output. Your experience might also tell you that you should use a color compensating filter to achieve a neutral, maximum density in the flashed film. The film speed will be a factor in determining the duration of flashing. Make a series of tests starting with about a 20-sec. exposure. After you have standardized on the flashing equipment and distance arrangements, you can thereafter flash the film either before or after exposure in the camera.

Under the best procedures, you cannot hope to achieve an identical match for reasons given above and for reasons of your own operating procedure. You should minimize quality loss by using lenses under ideal conditions. The best lens for slide-copying is the Macro Rokkor. Avoid the use of supplementary close-up lenses, because they can intro-

duce minor edge distortions, although you might want to experiment with these at different aperture settings. When using regular camera lenses you ordinarily work at *f*/11.

Meticulous care must be taken of the original transparencies to assure that they do not become soiled, scratched, or dusty. During handling, some dust is always likely to accumulate on the slide. Remove it with a blower or brush or both, used gently.

Making Color Negatives

The standard procedure in making color prints is first to make an internegative from the color original. This is what is done by photo finishers. If you do your own printing, you can do the same, although it is also possible for you to order an internegative from the Eastman Kodak Company or from a photo finisher.

The slide-copier setup is used exactly as in making color duplicates. The chief difference is that instead of using a positive or reversal color film you use an internegative material available from professional photo supply houses. Examples of internegative materials are listed in the accompanying film chart. The lighting source must match that of the internegative material. Since you will have additional opportunities for control during printing on paper, precise color balance is not as important as when making positives.

Making Color Slides from Negatives

Another procedure you might try is to make color slides from negatives. In this case, you need a special positive film material such as Ektacolor Slide Film Type 5028. A good lighting source is a 500-watt projection lamp whose output passes through heat-absorbing glass.



This common iguana was photographed in the Copenhagen Zoo by John Callisen, whose zoo photographs have been used as illustrations in two books. He has been in photography since 1950 and currently has his own advertising agency in Stockholm.



This boa constrictor at the zoo was made with the 135mm lens. It is a good distance lens for this type of subject. John Otto Callisen.

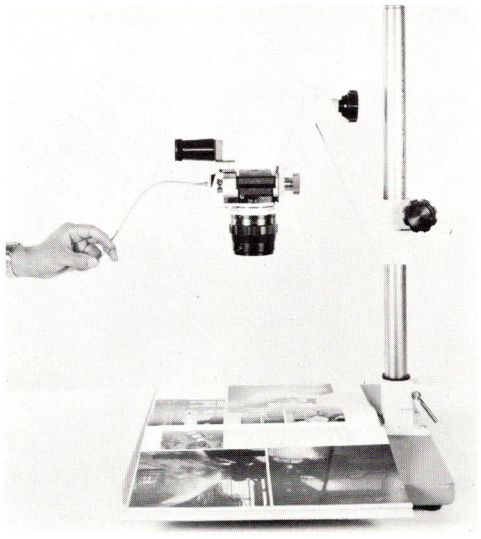
As with the slide-duplicating procedure, you will have to do some experimenting to find the right combination of conditions.

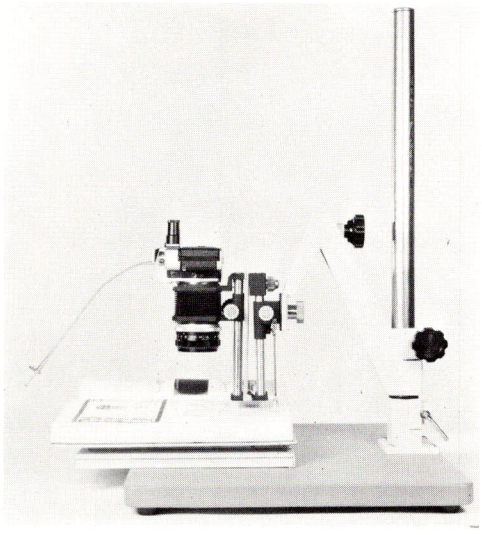
Black-and-White Reproductions

To make black-and-white prints from a color transparency, you must first have a negative. You can produce this in the darkroom by projection of the color transparency onto black-and-white sheet film, but a simpler procedure is to use the slide copier. The mounted or unmounted transparency is inserted into the slide copier in the conventional manner. You can use just about any light source, since you are not concerned with color fidelity, although you might still observe differences between high-color-temperature and low-color-temperature sources. Electronic flash is perhaps your best lighting source.

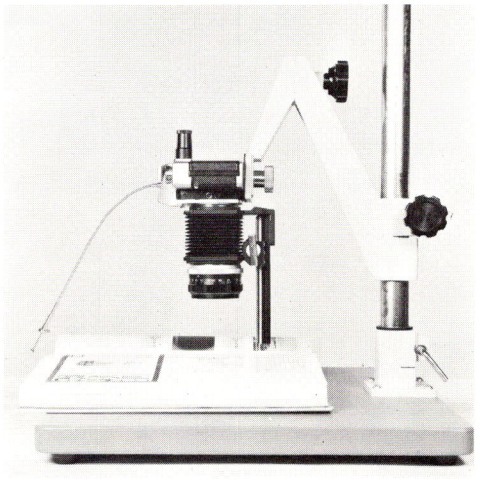
The film should be a relatively slow one, such as Kodak Panatomic-X. Since you have the same problem of contrast build-up as with color film reproductions, you can reduce contrast by overexposure and underdevelopment, as described in the chapter on exposure.

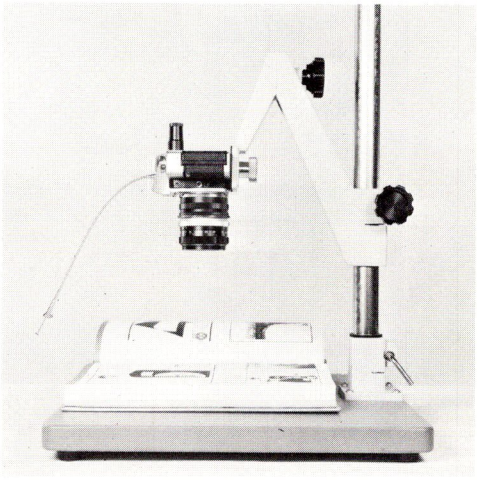
Filters may be used to change color balances in any way desired. The black-and-white filter chart in the exposure chapter lists the effects achieved with objects of different color characteristics. You can darken or lighten the sky and so on. You do not need to worry about eliminating ultraviolet in the sky: Now you need be concerned only with actual colors, as projected by your own light source. Use the appropriate exposure factors with the filters you select, unless you use the through-the-lens metering system.





Some of the various arrangements of use of Minolta Copy Stand.





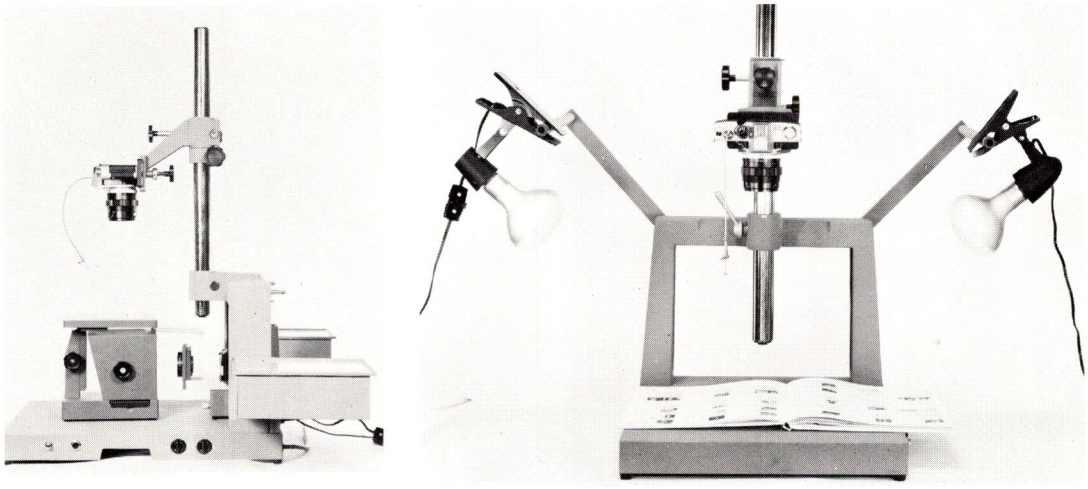
DOCUMENT COPYING

The main problems in copying books, papers, and other documents are: positioning the original so that it is plane-parallel with the film in the camera; attainment of uniform light distribution over the subject; and control of surface reflections.

Films for Copying

Suitable black-and-white films for reproduction of printed or line matter are Kodak High-Contrast Copy Film and, when developed for high contrast, Kodak Panatomic-X. For reproduction of continuous tones, Kodak Panatomic-X and Ilford Pan-F may be used, although they tend to be contrasty and should be developed accordingly. Alternatives are Kodak Plus-X Pan and Ilford FP-4.

A color film for line copying of both black-and-white as well as color is Kodachrome II, Daylight or Type A. For continuous-tone color copying, you can



Minolta Photomicrography System II stand can be used in general copy work.

choose between Kodak Ektachrome-X for average, well-balanced results or Kodachrome II for more vivid effects.

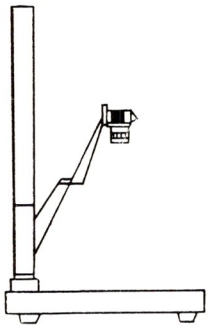
When working on location and you wish to obtain document reproductions without regard to the finest quality, you can use a fast film such as Kodak Tri-X.

Infrared films are often used in investigative work, which can include photographing altered paintings, burnt or charred documents, overprinted documents, and so on. An infrared filter must be used, and adjustments must be made in lens settings as explained in the chapter on creative variations.

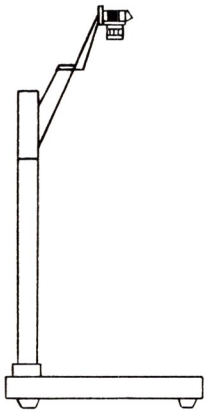
The Copying Setup

The most convenient arrangement in the copying of originals is to use a copy stand, which can be adapted from your enlarger; it would be more convenient, however, to use the Minolta SR Copy Stand II, which assures proper alignment of camera and copy and makes the positioning of copy easier. The camera should be positioned, ordinarily, so that the viewing head is at about eye level. For convenience in composing and focusing you would want to use the angle, or waist-level, finder.

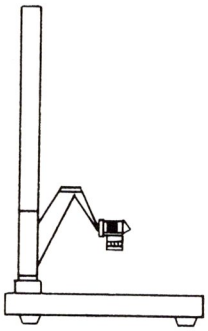
Various ways of positioning the Macro Rokkor 50mm *f*/3.5 lens on the Minolta Copy Stand II (cont'd. on next page).



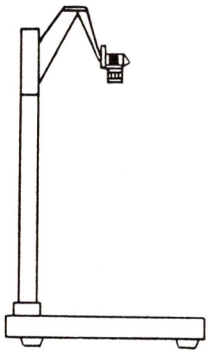
Magnification 1/6.4.



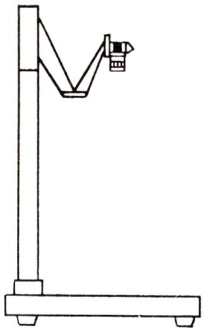
Magnification 1/13.



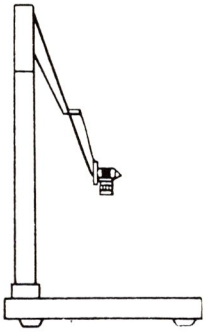
Magnification 1/2.



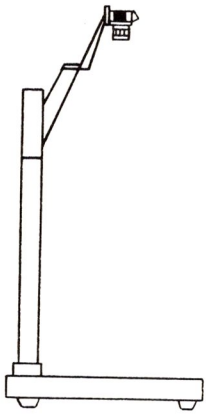
Magnification 1/8.3.



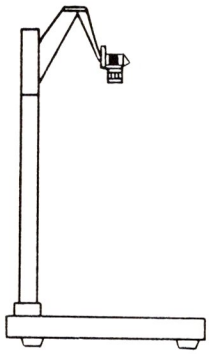
Magnification 1/8.3x.



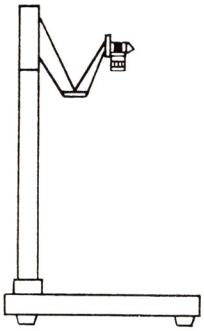
Magnification 1/3.4.



Magnification 1/12.7.



Magnification 1/8.



Magnification 1/8.

Illumination must be balanced with either two or four lamps on either side of the easel or baseboard at 45° angles to it. To check on the evenness of light distribution, put a pencil directly under the lens. If it casts a shadow on one side or the other (or in any direction), you know that the lights are not equally balanced. Suitable adjustments can then be made until you achieve balance. Another way of checking on even distribution *to the corners* is to use the incident-light meter head of the Minolta Auto Meter Professional in all four corners and in the center. Variations in the positioning of the lamps can then be made until you have identical readings from all points.

When copying a magazine you may

have difficulty in obtaining absolute flatness for both sides. You can put a supporting object under either or both sides when the magazine does not lie flat. With a book, you might have to build up one side or the other with another book or with a pile of papers until you have equal height in order to maintain equivalent sharpness. You can also lay a clean glass plate over the top, but it must be in a plane-parallel position so the lens does not pick up reflections.

Contrast and Reflection Control

When line matter, printed or drawn, is found on both sides of white paper, the underside is likely to show up in the reproduction. This can be avoided or eliminated by inserting a sheet of black paper behind the surface of the original. When there is line material on one side of white paper, put an additional white sheet or card underneath the original to strengthen the contrast. When typewritten originals are to be photographed, the typist should put a sheet of carbon paper underneath the original as it is being typed, so there will be an identical image on both sides of the sheet of paper.

When printed or line material is on colored paper, you can eliminate the color in black-and-white reproduction by using a filter of the same color. If there is printing on both sides, put a sheet of black paper under the original.

The area around the copy-stand baseboard should be neutral. All reflective surfaces should be withdrawn or covered; otherwise they will contaminate or interfere with uniformity of light distribution. Check also to see whether there are any reflections or hot spots from other light sources or bright, reflective surfaces that need to be brought under control.

If these precautions are observed, you should have little or no trouble with smooth paper originals, but you may encounter trouble with textured surfaces, which inevitably reflect their own tiny catchlights. You can minimize this effect, but probably not eliminate it entirely, by using polarizing filters over light source and lens.

For further information on copying techniques obtain a copy of Kodak Professional Data Book M-1, *Copying*.

PHOTOGRAPHIC AREAS AND MAGNIFICATIONS WITH MINOLTA COPY STAND II

Lens	Photographic Area	Magnification	Distance from Object to Film Plane
55mm Standard	330×495~192×288mm (1'-1"×1'-7½"~7⁹⁄₁₆"×11⅜")	1/13.8~⅛	855~550mm 2'-9⅝"~1'-9⅝"
58mm Standard	300×445~196×295mm (11¹³⁄₁₆"×1'-5½"~7¾"×11⅝")	1/25.8~⅛	855~600mm 2'-9⅝"~1'11⅝"
50mm F/3.5 Macro	350×525~48×72mm (1'-1¾"×1'-8¹¹⁄₁₆"~1⅞"×2¹³⁄₁₆")	1/14.6~½	855~230mm 2' 9⅝"~9¹⁄₁₆"
Macro with Life Size Adapter	48×72~24×36mm (1⅞"×2¹³⁄₁₆"~¹⁵⁄₁₆"×1⁷⁄₁₆")	½ ~1/1	230~203mm 9¹⁄₁₆"~8"

CHAPTER VIII

Motorized Camera Operations

The motorized camera accomplishes three things that make it adaptable for a wide variety of uses: (1) It takes over the manual operation of using a film-advance lever to transport film after an exposure and recock the shutter; (2) it is capable of being operated by remote control without loss of the automatic resetting feature; and (3) it can function as a sequence recording camera either through its own continuous recycling rate or through use of an intervalometer, or time-lapse instrument.

The following material expands upon the uses of motorized cameras, the operation of existing Minolta motor cameras, the use of the 250-exposure accessory back, and the use of remote firing and timing controls.

APPLICATIONS OF MOTORIZED PHOTOGRAPHY

The key elements described above that give a unique place to motorized camera operation are in themselves brief descriptions of the many areas of application. The following are just a few of its uses: instant-ready operation for split-second timing; rapid-sequence photography for capturing action sequences; time-lapse photography, through which progressive events are recorded for analytical and other purposes; remote control photography, which enables you to observe a photographic situation and to take pictures without putting your hands to the camera; surveillance photography under conditions that cause an intruder to trigger a record of his presence; and identical exposure-making of a single subject under identical light conditions.

The Instant-Ready Camera

The simple elimination of the need to rewind the film after each exposure makes it possible to have the camera instantly available for taking pictures at the critical moment of action. This is certainly a great advantage when you are taking pictures in rapid sequence, for the automatic film advance shortens the minimum time interval between

exposures. Under these circumstances, then, you need only concentrate on keeping the subject in view, and perhaps slightly adjusting the focus.

For many photographers, however, including photojournalists, sports photographers, nature photographers, and others, sequence photography may be less important than having an instantly ready camera, one that is always ready for the picture to be taken without their having to remember whether or not they advanced the film after the last picture or, worse, discovering at an irretrievable moment that they had actually failed to advance the film. Actually, one of the more important advantages for such photographers is that the motorized camera can be used as a semi-sequence camera. In some situations, for example, you might want to take a few or many pictures in rapid sequence when an advantageous moment presents itself, and the camera is ready for exposure with only the slightest touch of the finger. In short, the instant-ready camera enables the photographer to concentrate on subject matter, viewpoint, and critical timing.

This feature is highly important, because the photographer does not have to divert part of his time and attention from a subject that must be watched closely to fiddle with camera controls. This may be a critical factor when a special-purpose lens is being used that requires attention in itself or when some special technique introduces an additional control factor. For example, if you are working with a zoom lens and are preoccupied with the manipulation of image size in the viewfinder, it is an advantage to be relieved of activating the film-advance lever. This is also true when you are working with a long focal length lens, which gives you a shallow depth of field, or when you are taking pictures close up and are controlling sharpness either by rocking back and forth or by manually focusing the lens. The less you need to concentrate on the mechanical controls, the more you are able to concentrate on creative aspects of picture-taking, even in such situations as making informal portraits or following the romping antics of children at play. With the motor-controlled shutter action, you can more confidently release the shutter just before the critical moment, for you know that if you do so a bit too soon, you have an opportunity to run off another shot either in automatic motor sequence or selectively.

Rapid-Sequence Photography

With the motor control set for continuous shooting you will get a given number of frames exposed per second as long as you hold the motor switch depressed at the camera or through remote control. This enables you to record successive stages of a continuous movement or action. It is ideally suited for sports photography, public events, following the movement of objects from one point to another, and so on. It does not necessarily assure you, however, that you will be able to catch the peak of an action. For example, if you are firing at the rate of three frames per second and each of them takes an exposure of 1/500 sec., you will be recording only 3/500 of all the action taking place within the span of a second. Obviously, within the remaining 497/500 sec. you could lose a lot of peak action! Hence, sequence shooting should be regarded as the taking of slices of time out of a continuity of action within a given span. If you rely entirely on sequence shooting to catch peak action, you might succeed, but the odds are against it. The better compromise is that described above: Try to catch the peak by firing off the critical shot a split moment beforehand and, as insurance, follow through with a burst of one or two additional shots.

Sequence shooting at maximum motor-controlled speed has applications in

motion or task analysis. Minute variations, displacements, and increments of activity can be recorded for subsequent analysis.

You must keep in mind that you can consume a great deal of film in a very short time if you keep your finger on the motor-release button. At the rate of about three frames per second you would go through a 36-exposure film cartridge in 12 or 13 seconds. Hence, the ordinary technique with that size film load is to take pictures in short bursts of two or three exposures and sometimes four. For most analytical purposes and for any prolonged sequence shooting, the 250-exposure filmback for the motorized camera is recommended.

Time-Lapse Photography

Time-lapse photography is the periodic recording of a progressively developing situation through use of a controlled timing device known as an *intervalometer*. The currently available Minolta intervalometers, for use with Minolta motorized cameras, are capable of being set for fixed intervals ranging from ½ sec. to as much as one minute or ten minutes. One independent make, designed specifically for photographic applications, gives intervals of 1½ sec. up to 45 hours. The intervalometers are used both for the activation of lighting systems and the synchronous triggering of camera exposures. Fields of application include the analysis of work, surveys of traffic, blooming of flowers, and movement of clouds. Laboratory scientists use time-lapse photography, in conjunction with photomicrographic and macrophotographic equipment, for recording chemical and physical reactions, cell division and multiplication, and various kinds of biological growth, response, and change.

An advantage of intervalometric control of the camera and lighting is that picture-taking can go on while other work is being done and without the presence of a human operator, within the limits of a 250-exposure film load. Of course, the 36-exposure loads can also be used, but their relatively short lengths impose limitations for any serious studies.

Surveillance Photography

The special application of motorized cameras to surveillance activity is that they can be set up to record the presence of intruders at any time without human observers having to be present. When a beam of light is intercepted or some other triggering mechanism is activated, one or more pictures may be taken of the intruder. Optionally, the same triggering action can be used to set off an alarm or to flood the area with lights. A non-motorized camera can be used in the same manner with such triggering arrangements, but picture-taking would necessarily be limited to a single exposure.

This type of surveillance photography is applicable in much the same manner to wildlife picture-taking. An animal or bird entering a controlled field could cause one or more pictures to be taken of itself. During the day the operation can be set up without the need for artificial lighting, but for night sequences of human or animal subjects, rapid-recycling flash units can be used. If human intruders are to be photographed without their knowledge, invisible infrared illumination can be used in conjunction with infrared films. For a repeating flash sequence the lamp would have to be covered with a deep red infrared filter. The camera should be in a sound-baffled enclosure in order to make the shutter action inaudible.

Remote-Control Photography

Remote control of the camera involves the determination of the precise moment of exposure by the photographer without his presence at the camera position.

A simple application of remote control is the use of either a short or long cord to activate the motor-control button of the camera.

In portraiture, for example, the camera could be mounted on a tripod while the photographer moves around in an effort to evoke different poses or expressions from his subject. Without returning to the camera, the photographer can release the shutter by touching the button at the end of the control cord in his hand. The separation between camera and photographer tends to make the subject less conscious of the camera.

Innumerable other situations can be imagined in which one or more cameras can be placed beforehand at predetermined distances with predetermined areas of coverage for particular lenses and suitable exposure settings with or without auxiliary lighting. Pictures can thus be taken at will by the photographer without his having to draw attention to himself. In place of a remote-control cord he can use a wireless transmitter and receiver for use under conditions that require the photographer-observer to work at a considerable distance from his subject.

The remote-control technique is especially applicable to surveillance photography, surgical procedures, and sports events.

Identical Color Reproductions

When you wish to make a quantity of color slides, all identically reproduced, it is best to do this on one continuous length of film in order to minimize processing variations. The advantage of the motorized exposures is that, once you have made the desired camera settings for the particular subject and light conditions, you can make all of the remaining exposures quickly and easily. This would not be too important for anyone who makes occasional slide duplicates, but the reduction in operating time would be important for professional photographers and for laboratory personnel who must be conscious of the cost factor and use of time.

When making slide duplicates, following the procedures given in the chapter on close-up photography, you can provide illumination either by a quick-recycling flash source or by a suitable continuous-lighting source.

THE MINOLTA SR-M

This section covers procedures for the operation of the motorized Minolta SR-M. Succeeding sections describe the use of the 250-exposure filmback and bulk film loader, intervalometers, and other optional accessories.

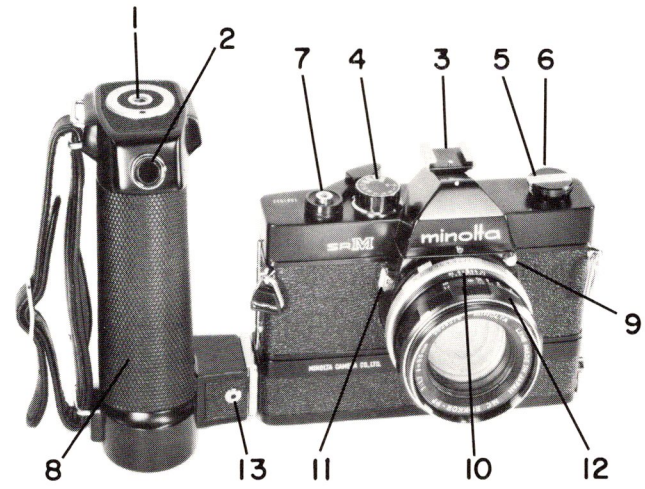
Minolta SR-M Specifications

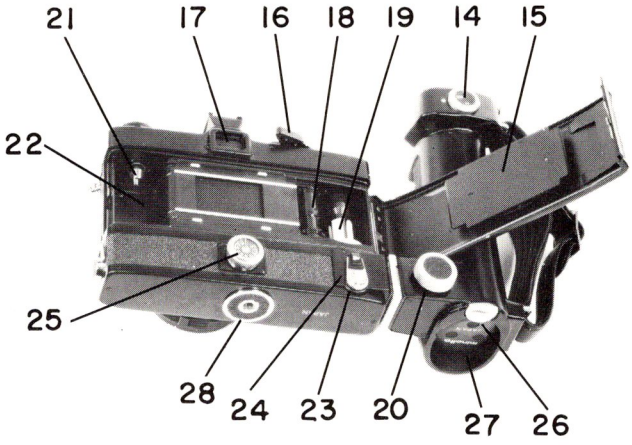
All procedures applicable to the Minolta SR-T 101, with the exception of exposure-metering, are applicable to the Minolta SR-M. The model SR-M accepts all Rokkor lenses for manual or automatic diaphragm control. Lenses in the MC Rokkor series can be used with the Minolta SR-M in the automatic-diaphragm mode, but their meter-coupled feature will be inoperable.

Although the SR-M is intended for motor-drive operation, it can also be used for manual operation optionally or in case of mechanical or electrical failure, including the exhaustion of the battery power source. In manual mode, film loading, advancing, shutter releasing, and film rewinding procedures are identical to those for the SR-T 101.

Other identical features, not related to the motor drive, are shutter speeds, fixed eye-level pentaprism focusing and viewing, built-in accessory shoe, and built-in mirror lock.

Unique features of the SR-M are: the





Parts of the Minolta SR-M.

1. Connector socket
2. Motor-drive switch
3. Accessory shoe
4. Shutter-speed dial
5. Film-rewind crank
6. Back cover open knob
7. Shutter-release button
8. Battery grip
9. Lens-release button
10. Diaphragm ring
11. Mirror lock-up control
12. Focusing ring
13. Accessory jack
14. S.C. selector/battery switch
15. Film pressure plate
16. Film-advance lever
17. Finder eyepiece
18. Sprocket
19. Film take-up spool
20. Battery grip lock
21. Rewind shaft
22. Film chamber
23. Power rewind switch
24. Manual rewind lever
25. Frame counter
26. Battery container lock
27. Battery container
28. Tripod/connector socket

motorized film advance, which operates at a maximum of three frames per second; the frame counter on the back of the camera, which cuts off the motor when exposures are completed; and the motorized rewind, which takes about 13 seconds to re-spool and stops at the original starting end of the film with a portion still protruding from the film cartridge.

The power source consists of eight 1.5v penlight batteries, size AA (12v in all). A battery grip holding the eight batteries in their own container attaches to the camera through a cordless contact. A dial on the battery grip has continuous position ("C"), single-exposure operation ("S"), and "OFF" positions. An accessory jack at the base of the battery grip is for use with remote-control cords, intervalometers, and wireless remote-control receivers.

An a.c. power supply cord is also available to replace the battery container in the battery grip. This cord is used with a d.c. rectifier.

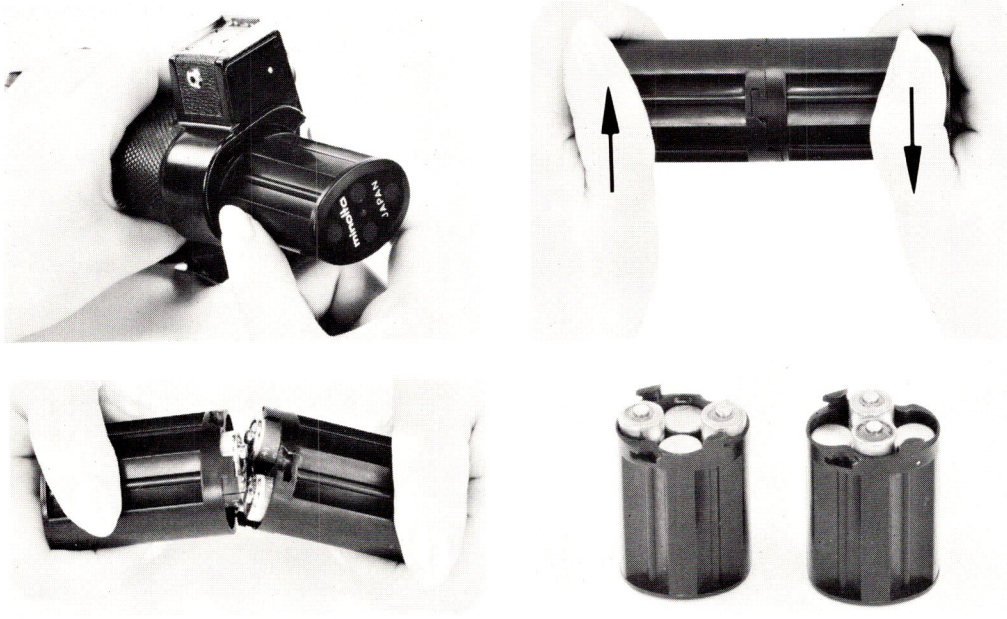
The Minolta SR-M is finished in black only. It weighs 1560g (55 oz) with the 55mm *f*/1.7 lens without batteries.

The Battery Grip

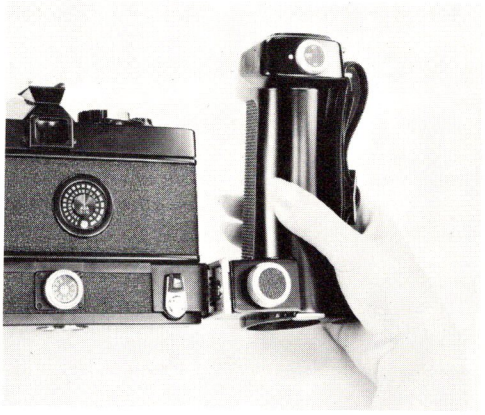
To install or replace the batteries, turn the battery-container lock at the bottom of the battery grip in either direction. The battery container will slide out into your hand. Hold both ends of the battery container in your two hands and twist the container, as shown in the illustration, to take it apart in the middle.

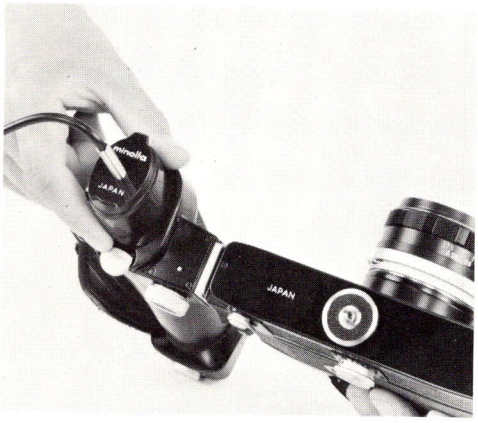
Install the eight batteries in alternate "+" and "−" positions as indicated inside the battery-container halves. Bring the battery units together and twist them to form a single container. Reinstall the container in the battery grip so that the words "Minolta Japan" face you. Turn the container lock at the bottom of the battery grip.

To attach the battery grip to the camera body, slide the battery contact



Top left, position for removal or insertion of battery container. Top right, twisting battery container by exerting force in opposing directions will cause it to open at middle. Lower left, two halves come apart and are also brought together in same manner for locking as single unit. Lower right, batteries are installed alternately in + and − positions as indicated inside battery container halves.





Left, attach battery grip to camera body by sliding shoe over contact bracket on camera. Then turn knurled knob to tighten. Right, an a.c. power supply cord fits into the battery grip in place of the battery container. It is used with a d.c. rectifier.

shoe over the contact bracket on the side of the camera. Tighten the battery grip in place by turning the knurled knob at the base of the battery grip.

Set the "S-C" selector dial on top of the battery grip to either the "S" or the "C" position, and with the frame counter positioned at the start of its counting cycle, test the motor operation by pressing the motor-drive switch on front of the battery grip near the top.

When working indoors, especially with the 250-exposure filmback, the a.c. power source may be substituted for the battery container. Usually this will be under conditions in which the power supply cord connected to the house (or main) outlet will not interfere with ease of operation.

The battery checker is an optional accessory that is really an indispensable traveling companion. It slides into the shoe of the battery grip and tests the power reserve of the batteries. If the test lamp lights up, this indicates that the batteries are still capable of driving the motor at a rate of at least 2.5 frames per second. If the test lamp does not light up, replace the batteries with fresh ones.

To use the battery checker you must first detach the battery grip by turning the knurled knob counterclockwise. The battery grip can then be slid off the mounting bracket toward the rear. The "S-C" selector *must not* be in the "OFF" position.

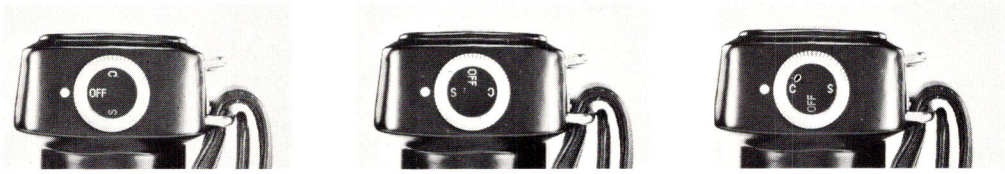
The battery checker should be held firmly in place so that the terminals make good contact. As soon as a battery check has been made, remove the battery checker: If it is in position longer than five continuous seconds, this will weaken the batteries. Do not touch the terminals.



Battery test lamp.

Shutter Speeds

The "T-B" setting on the shutter dial corresponds in manual use to the ordinary "B" setting. In manual use at this setting the Minolta SR-M shutter will remain open while the shutter-release button is depressed and will close as soon as pressure on the button is with-

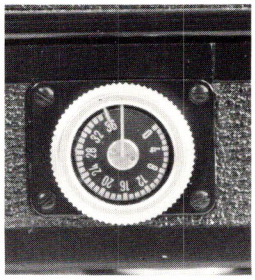


When not in use, selector switch should be set at "OFF," left. For most ordinary uses, switch will be set at "S" for single exposures, middle, while for continuous or sequence exposures, setting is "C," right.

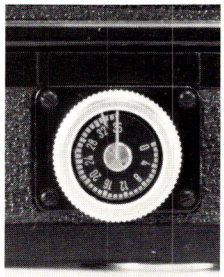
drawn. When the camera is motor-driven, the "T" setting can be used only when the "S-C" selector dial of the battery grip is turned to the "S" position. When the switch is activated, with the shutter dial set at "T," the shutter will remain open until the shutter dial is turned manually toward the numerical shutter speeds, beginning with one second, at which point the shutter will close immediately.

At the "S" (single exposure) setting of the "S-C" selector dial, any shutter speed can be on the camera.

At the "C" (continuous or sequence) setting, any shutter speed in the range of 1/30 sec. through 1/1000 sec. can be used. Slower shutter speeds should not be set on the camera.



After film has been loaded, set frame counter by pulling outer ring and turning to bring short red line indicator to the number of exposures for that film, above. Advance three frames. Long red line indicator will then correspond with number of exposures of film in camera, below.

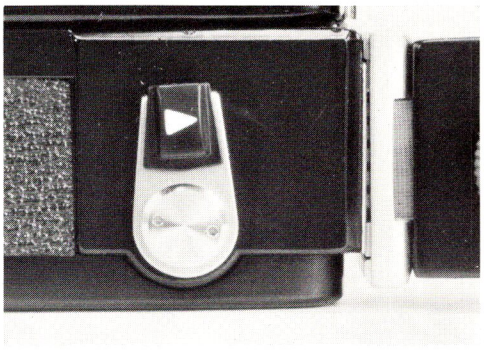


Film Loading and Unloading

The initial steps in loading film—opening the back, placing the film magazine into the film chamber, and inserting the film leader into one of the slits on the take-up spool—are the same as those for the SR-T 101, which are described in the chapter on basic camera operations.

After inserting the film leader into one of the take-up slits, close the camera back. Then set the frame counter to the number—usually "36" or "20"—that corresponds to the number of exposures on your film. To do this, lift up the outer ring so that it turns freely and bring the short red-line indicator opposite the number "36" or "20." Advance the film three frames either manually or with the motor film advance. The long red indicator should then be positioned over "36" or "20." Thereafter, to find out how many unexposed frames remain on the film read the number directly under the long red-line indicator.

You can also use shorter lengths of film—less than 36 or less than 20—but the actual number of exposures ought to correspond to the initial frame-counter settings. If the number of exposures available is less than what you set on the frame counter, it will stop operating before reaching "0" on the frame-counter dial, and the motor will make a "whir-r-r" sound. This is a signal



To unload film manually or by motor rewinding, push power film-rewind switch to right as indicated by white arrow.

to rewind the film. Accordingly, when using film you have loaded into a magazine yourself, be sure you have allowed enough leader to accommodate both loading the film in the camera and advancing it three frames in addition to the number you wish to expose. Unless you have a particular reason for using shorter lengths of film, it would be safer to standardize on 36 exposures; they will tend to be used up rather quickly in any event. If you use shorter lengths, these, too, ought to be standardized to avoid possible confusion in setting the frame counter.

You must fasten the end of the film securely to the spool of the film magazine, for otherwise it may be ripped loose by the motor. If this should occur, the film would have to be removed in a photographic darkroom or in a changing bag.

When the film has been fully used, or when you wish to remove it from the camera beforehand, regardless of the position of the frame counter, you simply push the power film-rewind switch to the right as indicated by its white arrow. The film will rewind automatically, stopping when the counter reaches the number originally set when loading the film, usually 36 or 20. You must not change the frame counter from its original position. If you do so, the film will not be completely rewound automatically. Rewinding will then have to be completed manually.

For manual rewind, which is necessary if you have allowed the batteries to become exhausted, set the "S-C" selector dial at "OFF" and turn the film rewind crank clockwise.

The SR-M in Use

With the battery grip attached, the camera is most conveniently used in its horizontal format. It can also be used vertically, but each person must then find the most convenient camera-holding position for himself. When used with the 250-exposure filmback as described below, the battery grip attaches to the base of the camera at the mid-position.

Using the battery grip you can hold the camera in your hand in a state of readiness with your finger close to the motor-drive switch. Holding the camera vertically in your hand, you can do repetitive blind shooting of subjects who otherwise might become self-conscious when they see you lift a camera to your eye. You may also use the camera in this manner suspended from your shoulder or from your neck by the camera strap.

Without the battery grip attached, the Minolta SR-M can be used as a regular camera.

The mirror lock is used selectively for special purposes such as macrophotography, photomicrography, and slide duplicating. After the subject has been brought into critical focus, the mirror is locked up out of the way by turning the mirror-lock button clockwise until it stops. You return the mirror to normal position by turning the same button counterclockwise. The mirror lock operates independently of the shutter-release and film-advance mechanisms and can be activated at any time without the loss of film frames.

For flash photography with motor operation you would ordinarily use the "S" setting. The "C" setting on the

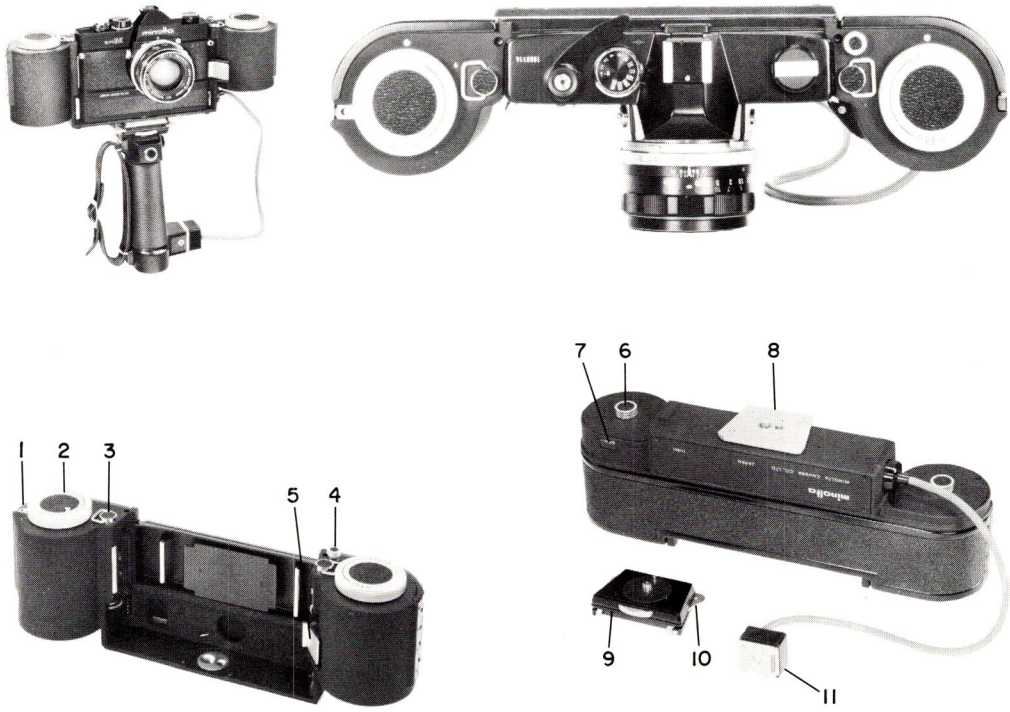
battery grip would only be used in conjunction with special-purpose, fast-recycling flash units suitable for high-speed sequencing.

250-EXPOSURE FILMBACK

The 250-exposure filmback is an optional accessory for use with Minolta motorized SR cameras. Two special film magazines are used, one for supply and one for take-up, each capable of holding the maximum loadable length of ten meters (33 feet) of film. The 250-exposure filmback replaces the regular camera filmback.

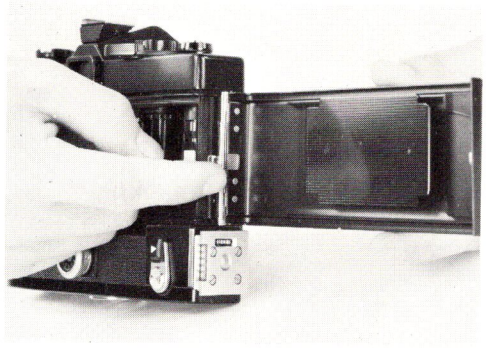
The film is ordinarily advanced by the motor drive, but the manual film advance can also be used. The exposed film advances progressively after each exposure into the take-up magazine, which is removed for subsequent development. The film is *not* rewound into the original film-supply magazine. If only part of the film is exposed, it can be sliced off with the built-in film cutter for immediate development. The film counter shows remaining exposures available; it automatically stops when exposures are completed. When another film load is inserted, the frame counter must be reset manually.

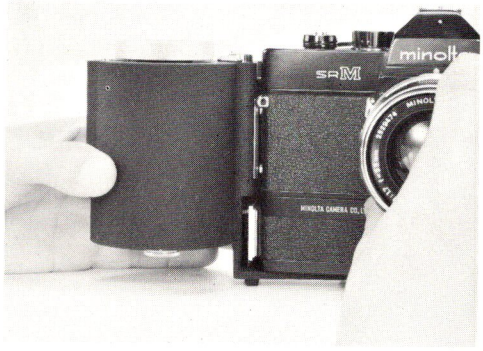
The battery grip is attachable for

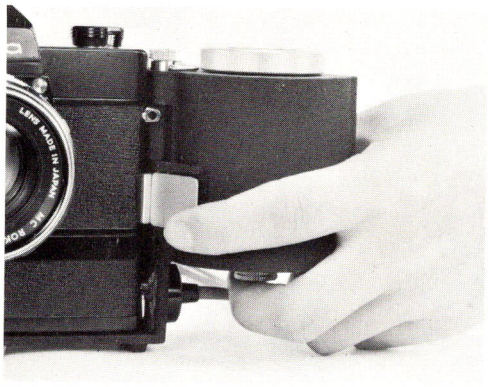


Above, the Minolta SR-M with the 250-Exposure Film Back. Below, parts of the 250-Exposure Film Back.

1. Cover release
2. Cartridge-control dial
3. Strap-attaching link
4. Film cutter
5. Safety lock
6. Cartridge-release knob
7. Frame counter
8. Foot plate
9. Attaching bracket
10. Retaining-finger release
11. Contact bracket







Attaching 250-Exposure Back to camera. To remove regular camera back, push up on release lever, above left. Camera is dropped into film back (rather than vice versa). First, drop side of camera with film-advance lever into 250-Exposure Back to engage camera's locking pins with holding plate of camera back, above right. Then push other side of camera in gently until it locks into position. Finally, secure camera with safety lock, opposite.

hand-held operation; the camera can also be mounted on a tripod or some other secure support for remote operation. Built-in tripod sockets are U3/8 and U1/4.

The total weight is 1310g (46.2 oz) distributed as follows: body—950g (33.5 oz); two cartridges—260g (9.2 oz); grip-attaching bracket—100g (3.5 oz).

Attaching the Filmback

Open the regular camera filmback and push up on the release lever on the hinged side. The regular filmback can then be removed.

The 250-exposure filmback is engaged one side at a time. The procedure is to hook up the camera body to the filmback. First, the side of the camera that has the film-advance lever is dropped into place so that it engages its locking pins with the camera-holding plate of the filmback. Then the other side of the camera (the film-rewind side) is pushed into place with gentle pressure until it is locked in securely. The camera is then secured with the safety lock.

Attaching Battery Grip

The battery grip is mounted on the bottom of the camera with a special bracket. This bracket is first seated by aligning its protruding pin with a small hole near the connector socket on the battery grip. Then the bracket is screwed securely into the battery-grip socket by turning the protruding knurled disk of the bracket.

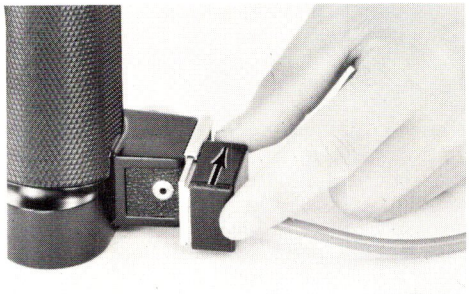
When the bracket is mounted on top of the battery grip, the assembly is slid over the foot plate from the front of the camera, until it locks securely onto the filmback.

Electrical contact is made between the battery grip and the filmback by a contact bracket on the end of the filmback cord. Push this bracket all the way back into the grip contact shoe, and hold it there while tightening the grooved knob.

To remove the attaching bracket from







Attaching battery grip to camera base. Mount the intermediate attaching bracket by aligning pin with small hole near connector socket on battery grip, above left. Turn protruding narrow disk to tighten. Slide bracket shoe over camera foot plate from front until they lock securely, above right. Complete electrical hook-up by pushing contact bracket on cord all the way into grip contact shoe and tightening it with grooved knob, opposite.

the filmback foot plate, depress the two grooved retaining-finger releases simultaneously and slide the bracket mounting shoe off the foot plate, toward the front of the camera. The retaining-finger releases are located on both sides of the narrower end of the attaching bracket.

The camera is now set up for motor-drive operation.

Film Loading and Unloading

The filmback should be taken off before removing and replacing the film cartridges. Turn both cartridge-control dials on the filmback so that the word "OPEN" on each is aligned with the indicator dot. Then pull up the back lock lever. This will let you open and move the back cover completely.

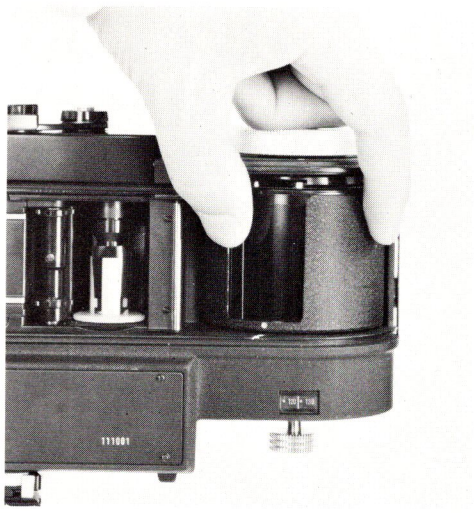
For removal of the film cartridge, the cartridge control dial must be set to "OPEN." Pull out the cartridge-release knob at the base of the cartridge chamber and, tipping the camera backward while shaking it slightly, remove the cartridge as it slides out.

To remove the film spool from the cartridge, press the rounded button on top of the cartridge and turn the inner shell in either direction. The two will be separated when the opening of the inner shell and the remaining projection on the rim of the outer shell are aligned.

Next, load the spool with up to two-hundred-and-fifty 24 × 36mm frames, using either the bulk film loader or doing it manually. This operation is performed in total darkness. (Instructions on using the bulk loader are given below.) When the spool has been loaded, it is inserted into the inner shell of the cartridge, which in turn is introduced into the outer shell. This is then turned for a lighttight position. The film gate will be closed and locked, but a short leader of film will be projecting.

To insert the loaded film cartridge into the left-hand feed or supply cham-







Removing film cartridge. Turn both cartridge control dials on the film back so that "OPEN" at each end is aligned with indicator dot, top left. Pull up back lock lever to open and remove cover completely. Pull out cartridge-release knob; tip back toward rear until cartridge slides out; shake slightly if necessary, top right. Removal of film spool is done in darkroom only. Press rounded button on top of cartridge and turn inner shells in either direction until its opening at edge is aligned with retaining projection on rim of outer shell. The two parts of spool will then separate, opposite.

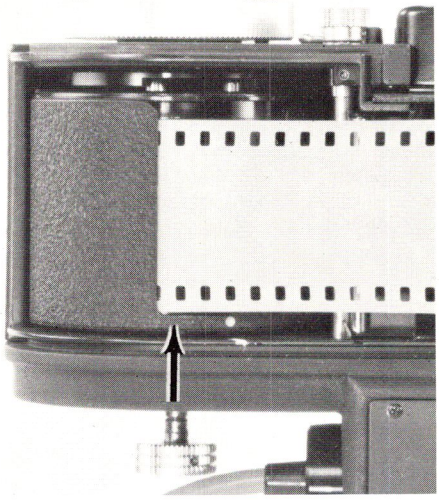
ber (as viewed from the rear), you must first make sure that the cartridge-control dial is set at "OPEN" and that the cartridge-release knob is pulled out. Insert the cartridge so that the dot centered at the edge of the film gate on the lower rim of the cartridge will be aligned with the line on the inside of the chamber bottom. Then push in the cartridge-release knob.

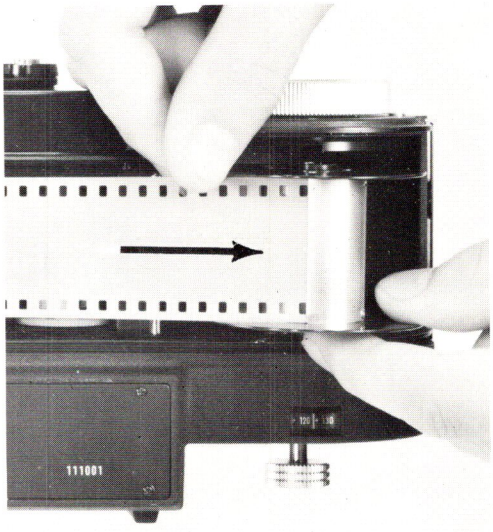
Draw the leader, emulsion side down, across the back of the camera and insert the end of the leader under the metal retaining clip of the empty take-up cartridge spool. Wind a few turns of the film onto the spool. Place the spool in the cartridge *outer shell* with the leader projecting through the open gate. Align the gate opening of the inner shell with those of the outer shell, and insert the *inner shell*. Turn the latter counterclockwise to close the film gate and lock the cartridge, which will be indicated by a click.

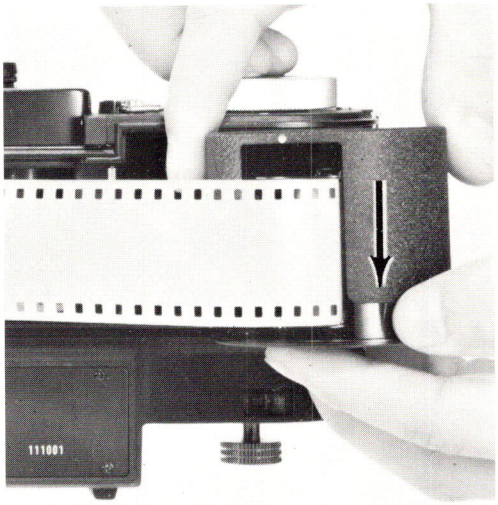
Insert the take-up (right-hand) film cartridge in the same manner as the feed or supply cartridge. Be sure to push in the cartridge-release knob.

The *left-hand* cartridge-release knob should now be turned counterclockwise until the film is under slight tension. Be careful not to force the tension or you will disengage the film from the take-up spool.

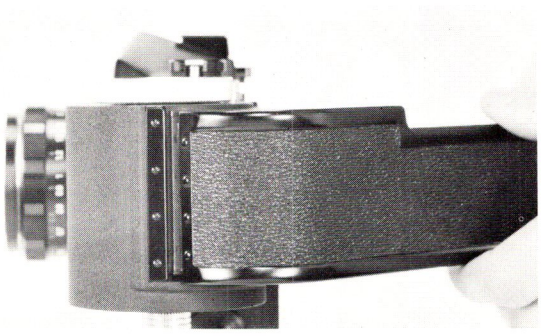
The camera back cover may now be restored. The back cover is grasped with

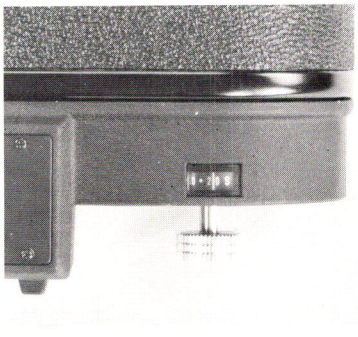




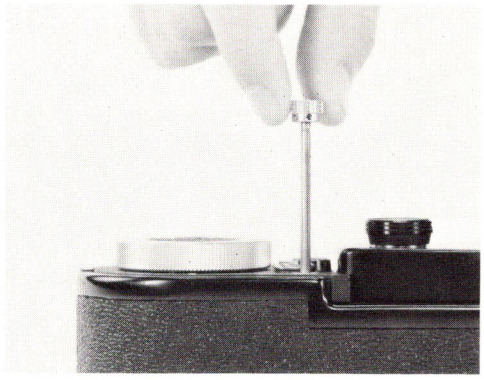


To insert loaded cartridge into film back, you must have cartridge control dial set at "OPEN" and cartridge release knob pulled down. Insert cartridge into left-hand chamber, aligning dot at edge of film gate on lower rim of cartridge with line inside camera film chamber, above left. Then push in cartridge release knob. Insert end of film leader (emulsion side down) under take-up spool retaining clip (above right) and wind a few turns. Place spool in cartridge outer shell with leader projecting through open gate, opposite. Align inner and outer gate openings, insert inner shell, and turn counterclockwise to lock cartridge with a click.





To attach back cover hold at an angle approximately 90° to film plane, left. Insert tongue on lefthand end all the way into groove of opening. While aligning top and bottom film-back rails with channels around edges of back cover, gently close cover until righthand end engages securely. Turn both cartridge-control dials to align "CLOSE" with indicator dots. Pull out cartridge-release knob under frame counter window (right), and turn clockwise to set required exposure number to red indicator. Push knob back in. Camera may now be operated.



To cut film at any intermediate point, first close film gate of feed cartridge (lefthand side); align "OPEN" with indicator dot. Then grasp knurled knob and pull up firmly and steadily a full stroke.



To release film back from camera, disengage safety lock, and pull up release knob.

its indented edge facing upward. The cover should be held so that it is at an angle of approximately 90°, with the strip of film stretched across the focal plane. The two sides of this angle will come together at the left-hand end of the camera. Insert the tongue of the back cover into the groove at the left side of the feed-chamber opening. Then, making sure that both top and bottom guide rails of the filmback opening are aligned to fit into the channels around the edges of the cover, push the cover gently into position at the right end until the catches engage securely in the back-cover lock.

If the back cover should fail to move smoothly and easily into position, do not force it as this may seriously damage the hinge tongue. In case of such failure, remove the cover completely and start all over again until the cover falls into place properly.

Turn both cartridge-control dials to align the word "CLOSE" with the indicator dot at both ends.

To save some film, all of the preceding operations can be done in darkness. When you load in light, you can advance the film manually five or six times to wind the light-struck film onto the take-up spool.

Set the frame counter by pulling out the cartridge-release knob under the frame-counter window, and turn it clockwise until the required or maximum exposure number appears under the red indicator. Push the knob back in. The camera is now fully ready for use.

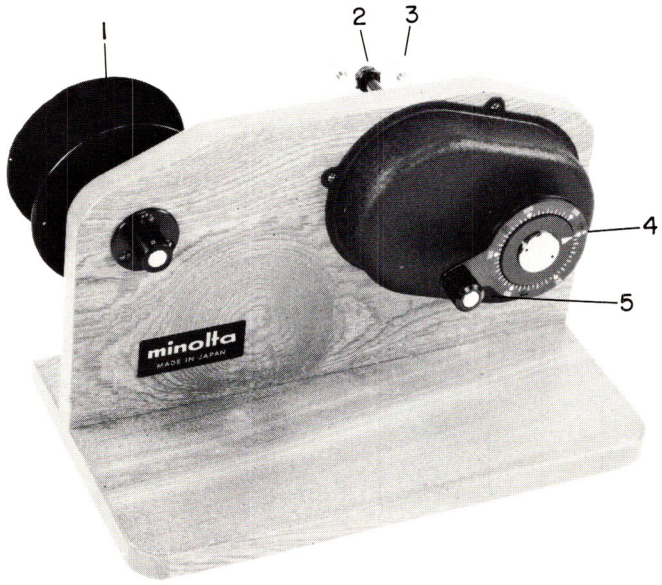
When the frame counter reaches "0," the motorized film advance will automatically stop. At that point advance the film several times manually before opening the back cover to protect the last few frames from light.

The precautions relating to the frame

counter and short lengths of film, as covered in connection with the operation of the model SR-M, should be referred to.

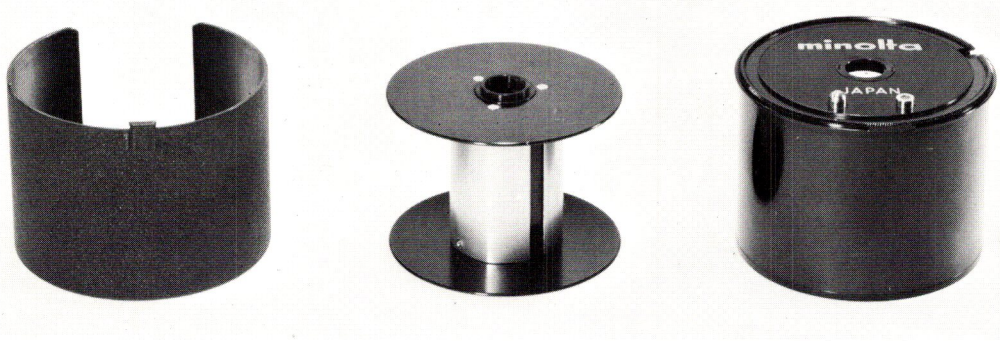
The film may be cut at any intermediate point if you need to have the exposed portion developed immediately. First, close the film gate of the feed cartridge by turning the cartridge-control dial until it aligns the "OPEN" with the indicator dot. Then grasp the knurled knob next to the cartridge-control dial and pull it all the way up; this will cut the film. Advance the film several times to move the exposed film completely into the take-up cartridge. Turn the cartridge-control dial on the right-hand take-up side to align the "OPEN" with the dot and open the back cover.

To release the 250-exposure filmback from the camera, disengage the safety



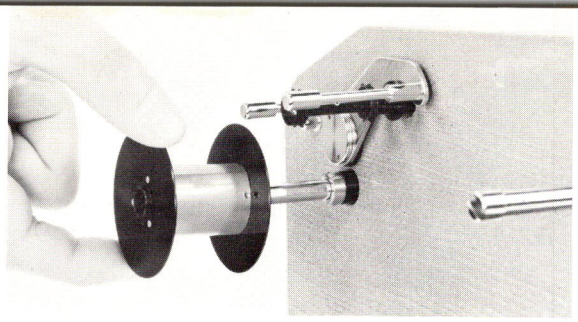
Film loader for 250-exposure film cartridges. Up to two-hundred-and-fifty 24 × 36mm frames can be loaded into special film cartridges for 250-Exposure Film Back from 100-ft. rolls of bulk 35mm film.

1. Supply reel
2. Take-up spindle
3. Retaining arms
4. Counter dial
5. Counter crank

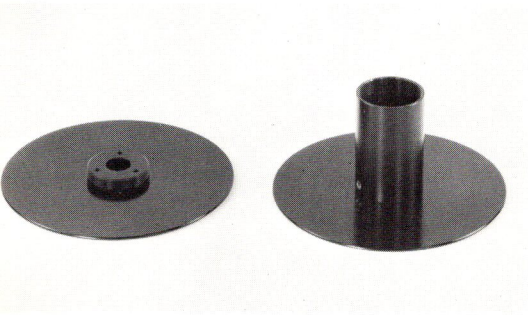


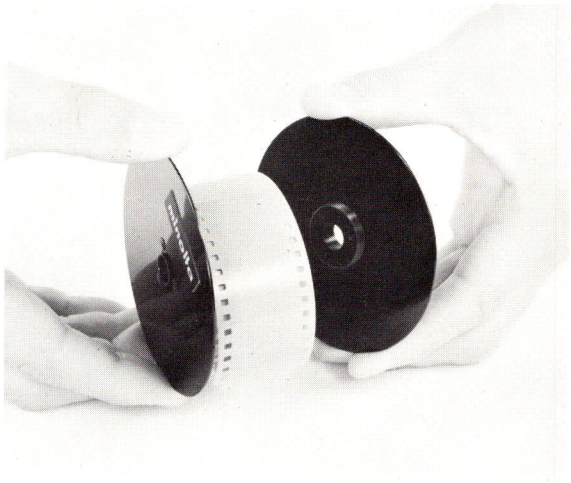
Outer shell, film spool, and inner shell.



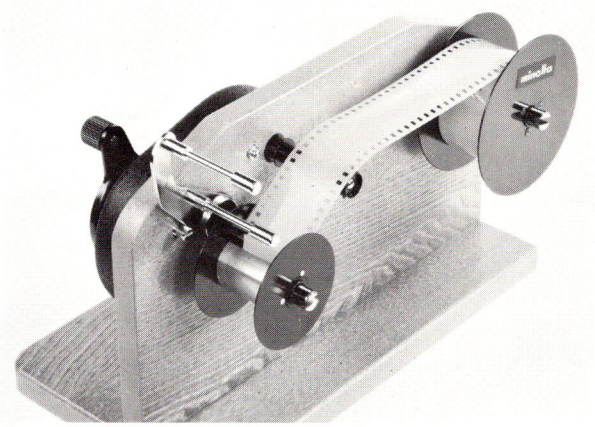


Left, before loading film supply, pull dial all the way out, and turn in either direction to set pointer to number of frames to be spooled. Right, remove film spool from cartridge and place on take-up spindle of loader. To remove film spool from cartridge, press rounded button on top and turn inner shell in either direction until its edge opening and projection on rim of outer shell are aligned.

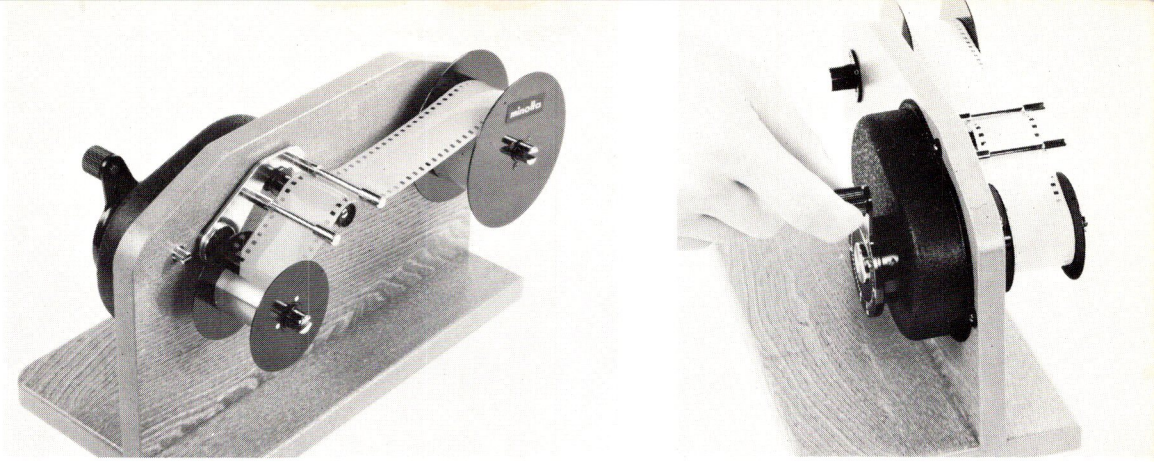




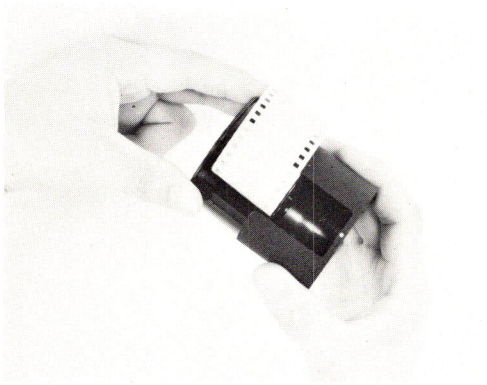
Left, unscrew and separate parts of bulk supply reel. Right, in darkness, load up to 100 ft. of bulk film on supply reel, screw on disk component of reel, and place loaded reel on supply spindle of bulk loader. Film is loaded correctly if emulsion faces spindle and if end of film leads off top of reel toward sprocket.



Lift film retaining arms upward and out of the way. Insert end of film under metal retaining clip of cartridge film spool.



Left, engage film perforations with sprocket teeth and snap film retaining arms back into position. Right, turn counter crank clockwise until it stops. Cut film at supply reel. Lift film retaining arms and remove loaded spool.



Opposite, put loaded spool back into cartridge leaving short length of film protruding. Turn inner shell of cartridge clockwise to close film gate and lock cartridge with a snap. As a further check on proper loading, when brand name "Minolta" of cartridge is facing up, film leader should be projecting from left side of film gate with emulsion side facing cartridge.

lock and pull up the camera-body release knob (the one that has the built-in rewind crank).

Bulk Film Winder

The Minolta bulk film winder for the 250-exposure film cartridge can be preset for any number of frames up to 250. When that number is reached, the winding will stop automatically. The procedures that follow are carried out in the darkroom.

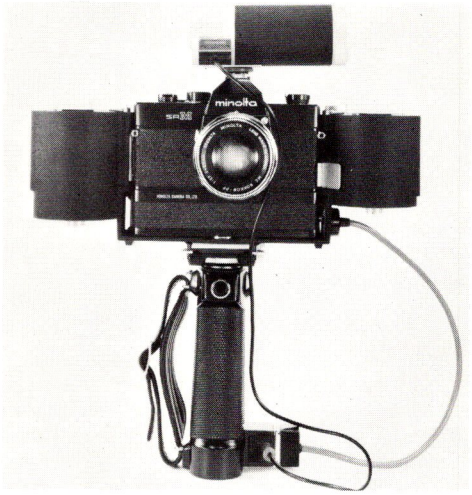
The supply of bulk film is loaded onto the film spindle of the film loader. The spool from the 250-exposure film cartridge is placed in position on the spindle of the cartridge spool spindle and the film engaged with the spindle slot. The end of the film is cut into the shape of a leader about 2cm wide at its end and about 3cm long. This leader is inserted into the spool, which is then wound about one-half turn. The film perforations next to the side of the film loader must be engaged with the sprocket wheel of the film loader.

The film-pressure lever is now turned carefully until the pressure shaft just touches the film surface near the sprocket wheel. The film-pressure lever will click into position at that time.

Pull out the frame dial and rotate it clockwise to set the desired number of exposures. The index mark and the frame-counting figures at the positions of 0, 50, 100, 150, 200, and 250 are painted fluorescent for darkroom visibility. Turn the winding handle steadily until it comes to an automatic stop, and the required length of film will have been wound onto the spool.



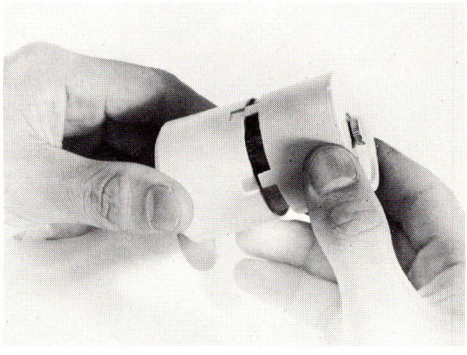
Intervalometer-PM mounting and connector-cord arrangements for Minolta SR-M with regular and 250-exposure backs.





Selector dial with on–off switch and time intervals.





To install or replace batteries, first remove cover of Intervalometer-PM by unscrewing. Separate plastic battery case by turning central screw on end of one part counterclockwise. Battery case comes apart as shown. Insert five AA-size 1.5v dry battery cells with + and − ends up or down according to markings in battery case.

Now cut the film midway between the supply of film and the take-up spool. Remove the film-cartridge spool and insert it into the outer and inner shells of the film cartridge, as described above. If a reserve supply of film cartridges is loaded they should be kept in their storage cases away from dust.

INTERVALOMETERS AND REMOTE CONTROL

This section covers the use of intervalometers and remote control aids. They are both devices for operating the motorized cameras through external means. Some of the uses of this type of equipment were described earlier in the chapter.

Minolta Intervalometer-PM

The Intervalometer-PM enables you to take pictures at predetermined intervals of from 0.5 to 60 sec. At a time setting of 0.5 sec., any shutter speed may be used from 1/1000 through 1/15 sec.; at a time setting of one second, the slowest shutter speed that can be used is 1/8 sec.; at a time setting of two seconds or more, the slowest shutter-speed setting on the camera is one full second.

The Intervalometer-PM consists of a timing device, a power supply housed in a plastic battery case, and a connecting cord that goes from the intervalometer to the battery grip. The accompanying illustrations show how the batteries are inserted and how the intervalometer is connected to the camera for use. The intervalometer is attached to the camera accessory shoe.

The selector dial at the end of the intervalometer should be set to the desired interval. The "S-C" selector of the battery grip should be set to either the "S" or "C" position. When you are ready to put the intervalometer to use, simply switch it on. It will keep running until you switch it off.

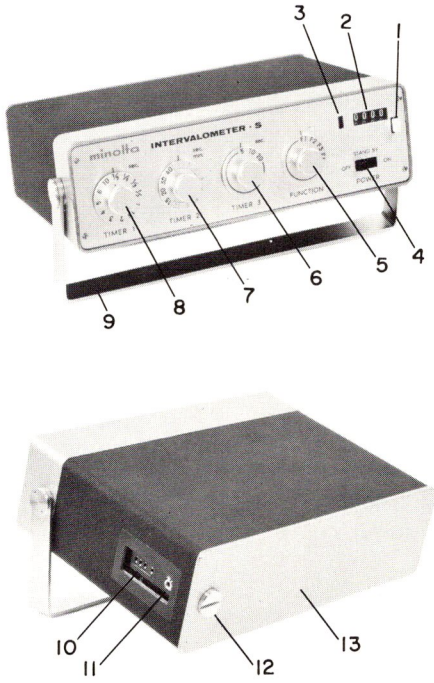
Minolta Intervalometer-S

A more versatile unit than the Intervalometer-PM is the Intervalometer-S, which is intended for use with both Minolta SR motorized cameras and the Minolta Autopak-8 D series of 8mm motion picture cameras. It has a timing interval range from 0.2 sec. through 10 sec., although for use with the Minolta SR, intervals shorter than 0.5 sec. should not be used. Timing intervals are controlled by three solid-state timers, a function selector, and a counting device that permits single-frame exposures, single-frame sequences, and continuous-run sequences of varying duration at adjustable intervals. This unit has a built-in battery checker. It has a counter that records the number of frames exposed or the number of continuous-run sequences triggered. The counter is reset to "0" by a simple touch of the reset button. As with the Intervalometer-PM, there is a choice of two connector cords —connecting cord S, which is 50cm (20 inches) long and connecting cord L, which is 250cm (100 inches) long.

Remote Control Cords

The remote control cords are designed to operate the camera from a distance. Remote control cord S is 100cm (40 inches) long; remote control cord L is 500cm (16 feet 6 inches) long.

Either the "S" or "C" positions on the selector dial can be set for use with the remote control cord. Both the con-



Parts of the Minolta Intervalometer-S.

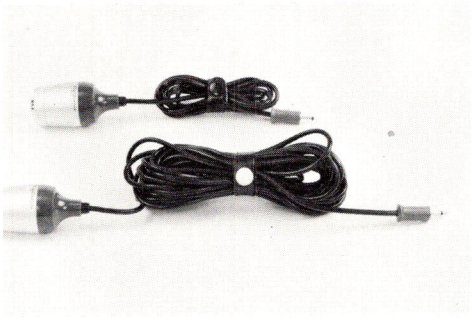
1. Counter reset button
2. Counter
3. Battery check indicator
4. Power switch
5. Function selector dial
6. Timer 3 selector dial
7. Timer 2 selector dial
8. Timer 1 selector dial
9. Handgrip/stand
10. Camera cord socket
11. Cycle-start signal lamp cord jack
12. Battery compartment cover screw
13. Battery compartment cover

INTERVALOMETER-S FUNCTION CHART

FUNCTION		TIMER (S) AND SETTING DIAL USED	PROFILE
F1	TIME-LAPSE MEMOMOTION	T1	T1: 1/5 to 10 sec. intervals COUNTER ACTUATION
F2	TIME-LAPSE MEMOMOTION	T2	T2: 15 sec. to 10 min. intervals COUNTER ACTUATION
F3	WORK SAMPLING	T2 T3	T2: 15 sec. to 10 min. intervals T3: 5, 10, 20 sec. sequences COUNTER ACTUATION
F4	INDENT WORK SAMPLING	T1 T2 T3	T1: 1/5 to 10 sec. intervals T2: 15 sec. to 10 min. intervals T3: 5, 10, 20 sec. sequences COUNTER ACTUATION

nection of the cord and its use are quite simple. Insert the plug of the cord into the accessory jack on the front of the battery grip near the camera-attachment shoe. In use, you push the release button on the end of the remote control cord to actuate the shutter and film transport.

Even though you have the remote control cord attached, you can still operate the camera with the release button on the battery grip or with the shutter-release button on the camera itself.



Remote control cords S (above) and L (below).





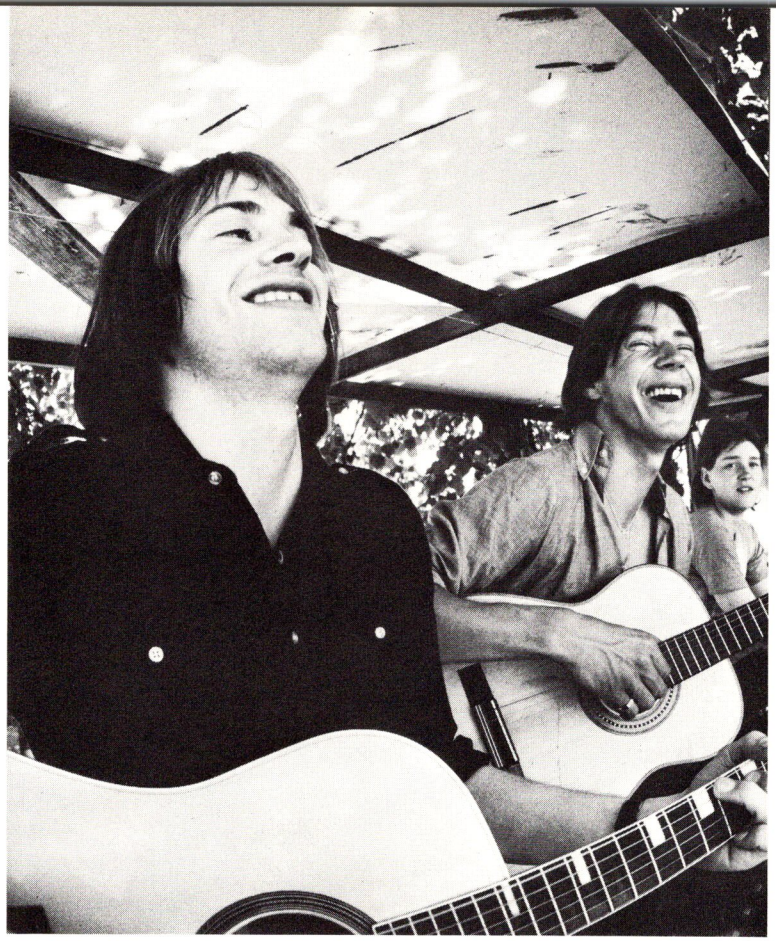
Left, connector-cord hookup of Intervalometer-S to socket of battery grip. Right, Intervalometer-S, powered by six C-sized batteries. To install or replace, unscrew battery compartment cover. Insert batteries as indicated by diagrams in compartment. Remove batteries when unit is not to be used for more than a month. To check battery power for use of the intervalometer, move power switch to "STAND-BY" position. Needle of battery check indicator to left of counter should be within white zone if battery power is sufficient. If needle goes into red zone, replace *all* batteries. Switch must be in "OFF" position when unit is not in use.

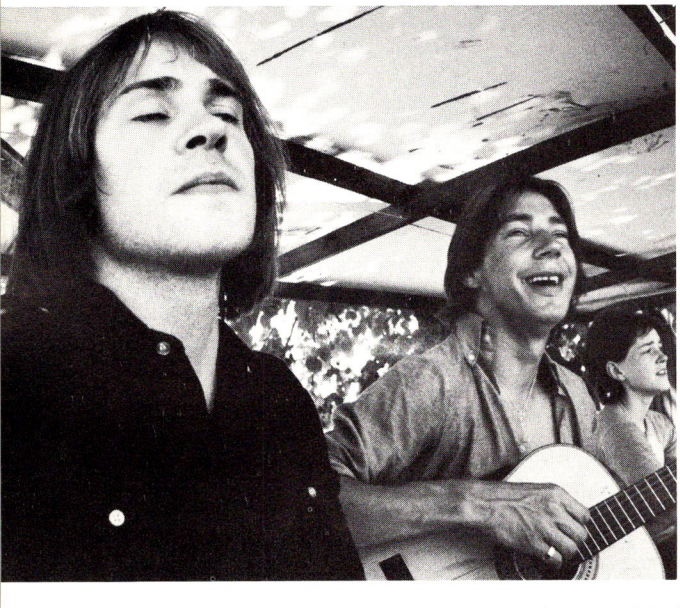
The function selector dial must be turned to obtain the correct interval series or continuous-run sequences as follows:

Time-lapse (memo motion: single-frame exposure actuation at fixed intervals). With power switch in "OFF" or preferably "STAND-BY" position, set either Timer 1 or Timer 2 dial to desired interval *between exposures* and, correspondingly, set function dial to F1 or F2. To operate, move power switch to "ON" position. CAUTION: the 1/5, 1/4, and 1/3 sec. settings of T1 dial must not be used with SR-M since its maximum interval rate is approximately three exposures per second.

Work sampling: continuous-run sequences for a desired duration at fixed intervals. Set function selector to F3; power switch "OFF" or preferably "STAND-BY." Set cycle-start interval on T2 dial. Set filming sequence time within each continuous run (5, 10, or 20 sec.) on T3 dial. Set function dial on SR-M battery grip to C-setting. *Be sure to select cycle-start intervals longer than filming time.*

Work sampling: time-lapse or memo motion single-frame exposures filmed for desired duration at regular intervals. Set the F4 position on the function selector dial. Cycle-start interval (15 sec. to 10 min.) on T2 dial. Length of time during which exposures are to be made (5, 10, or 20 sec.) on T3 dial. Interval between individual exposures (1/5 to 10 sec.) on T1 dial. Use S-setting on SR-M battery grip. Be sure T2 dial is set at longest time and that T3 is set to time longer than T1. NOTE: Remainders of all intervals are canceled when switch is moved from "ON" to "STAND-BY" and/or "OFF" and all intervals start anew when switch moved to "ON."







The motorized camera is commonly associated with sequence photography. This is an important application, but in general photography a more important use is in having the camera instantly ready for the next picture without having to lose time to advance the film manually. Each of the pictures in this series was a separate exposure, not in sequence, taken at the peak of expression of the singers. The 16mm fisheye was used to achieve some exaggeration of effect. Note the rapid falloff in relative size of head even at very close distances. Exposure was for shade inasmuch as both subjects were under a canopy in Scandia, a Stockholm park. Ilford FP4. Joseph D. Cooper.

During a heated argument in the Stockholm public square the subject was caught first in attentive readiness and then, almost as though electrically charged, leaping into action with his fierce invective. Black-and-white prints from High-Speed Ektachrome originals. Joseph D. Cooper.





CHAPTER IX

Technical Effects Photography

Of course, any picture-taking done with your Minolta SR camera produces a technical effect in that an image is recorded on film; however, the technical effects covered in this chapter are those achieved through the use of auxiliary optical devices and special mechanical aids to picture-taking. In this chapter we cover briefly panoramic photography, made possible through the use of the Minolta Panorama Head; stereoscopic photography, made possibe through the use of independently manufactured devices; astrophotography, which involves the coupling of the Minolta SR camera body to telescopes; oscilloscopic photography, utilizing the Minolta Photo Oscilloscope Unit-2; and photomicrography, which involves the simple coupling of the camera body to a microscope or the use of the more sophisticated Minolta Microscope Photomicrography System II.

PANORAMIC PHOTOGRAPHY

The information in this section should enable you to do your own panoramic picture-taking without reference to other informational sources. The only special equipment needed is the Minolta Panorama Head, which fits between the camera and a tripod head and allows you to turn the camera in a 360° circle at marked intervals of 12°. You can shoot all or part of the 360° panorama view in overlapping sections with the same angle of coverage and without fear that there will be gaps in coverage as the camera is rotated. This technique can be used with any kind of film, although it is used most conveniently with black-and-white films, which can be manipulated more easily in the darkroom for matching purposes, as explained below.

Lens Suitability

The lenses most suitable for panoramic picture-taking are in the range of 35mm through 135mm. As might be expected, the wider angle lenses, up to 55mm and 58mm, will show more coverage, thereby calling for fewer exposures than are required when you use



Minolta Panorama Head, with built-in spirit level, permits camera to be rotated to record precise overlapping sections of the horizon.

lenses from 85mm through 135mm. The longer lenses will, however, bring in details at greater magnifications. Lenses wider than 35mm are not recommended, since the unavoidable edge distortion makes it difficult to match prints without substantial cropping, thereby negating the advantage of the wider angles of coverage.

Procedure for Taking Panoramic Pictures

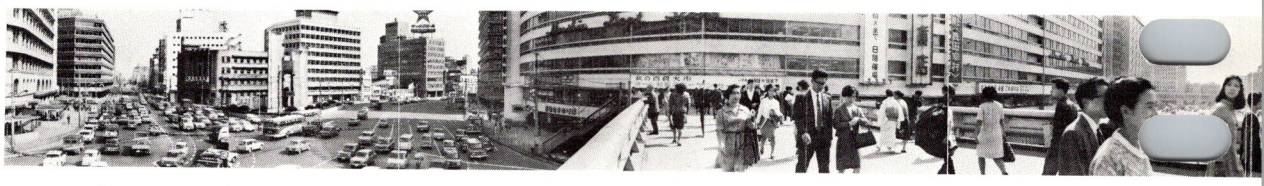
Attach the panorama head to the tripod and then attach the camera to the panorama head. Adjust the tripod legs so that the bubble in the spirit level is centered. Check this by rotating the panorama head throughout the 360° swing of the horizon.

Refer to the accompanying chart, which shows the interval settings required for the particular lens you will be using. After making each exposure, advance to the next interval marked on the panorama head and continue until you have completed either the entire cycle or as much of it as you want to record.

As you turn the panorama head with the camera on top of it, keep checking the spirit level to make sure there has

TABLE OF PANORAMA SETTINGS

Lens used	Picture angle against the long side	Graduation panorama head	Number of times required to photograph 360°	Overlap yield
				About
35 mm	45°26′	3 graduations (36°)	10	34%
55 mm	36°14′	2 graduations (24°)	15	33%
58 mm	33°24′	2 graduations (24°)	15	28%
100 mm	20°24′	1 graduation (12°)	30	40%
135 mm	15°10′	1 graduation (12°)	30	20%



Panorama shot covering horizon through 360° sweep with 58mm f/1.4 lens with camera mounted on Minolta Panorama Head. The built-in spirit level aids in assuring that the horizon is maintained at level throughout the sequence. To get a full appreciation of a

been no slippage. The bubble must always be centered if you are going to match the individual pictures into a total panoramic view.

The only important problem you will encounter is evenness of exposure. Theoretically, this is easily accomplished through the built-in exposure-metering facilities of the Minolta SR cameras, but since these are based on programmed formulas, they will not necessarily make total accommodation for extreme variations in lighting, which you are bound to encounter as you make the swing around the horizon. On sunlit days you might have problems with light striking the surface of the camera lens. If a lens hood does not shield the lens adequately, hold a cardboard or other light block to prevent the sun's rays from striking the lens. For excessively bright segments you might allow a little additional exposure, and for excessively dark areas you might make adjustment for a little less exposure than indicated by the exposure-metering system.

A minimum of exposure adjustment will be required when the sun is fairly high, whereas a maximum will be needed when the sun is at a sharp angle.

The best subject for panoramic photography has high and low points at random, distributed throughout the 360° sweep of the horizon. Ideally, if there are clouds, you should have a calm day; otherwise the same clouds might show up in different segments of the picture. The same problem pertains to moving objects. Imagine a train recorded in segment one that turns up again in segment two and then again in segment three.

Print-Matching and Mounting

The first requirement is that the print segments be of equivalent densities. This is a darkroom problem. You might have to make more than one print of the same segment.

Before mounting, lay the prints out loosely in a long strip. Check to see that they match correctly. When overlapped, the adjacent pictorial segments must blend into each other. Then the edges of the prints should be sanded slightly where they will be butted together. This eliminates the feeling of jointed edges when the matched segments are cemented to the supporting material.

When trimming matching segments, the same amount of trim should be taken from each. The adjacent segments should be mounted so that one will overlap the other slightly. The ordinary technique is to use a sharp razor blade to slice through the center of the overlap. The excess material is removed so that, when the edges are butted together, they will match precisely.

STEREOSCOPIC PHOTOGRAPHY

Stereoscopic photography is three-dimensional photography, which originates in two images taken simultaneously with a displacement between them of about 2½ inches from center to center. This corresponds to the distance between the



panoramic shot, you would have to mount it in circular format and stand inside the circle. Courtesy Minolta Camera Company, Ltd.

centers of human eyes. Long ago, in the good old days before the automobile, the stereopticon was a favorite source of home entertainment. At one end was a holder for two pictures that were viewed through two lenses at the other end, an arrangement that gave the viewer a sense of objects in depth.

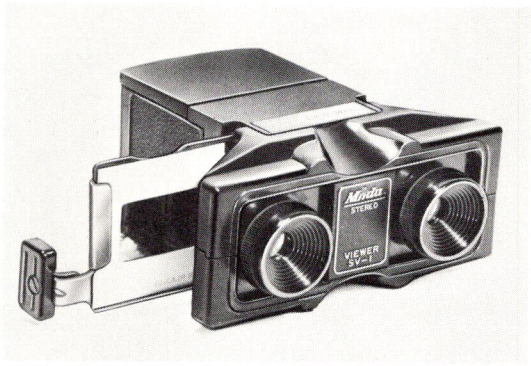
Through the years many stereoscopic cameras have come and gone for one reason or another. The original Rolleiflex was an adaptation of a twin-lens stereo camera of the day. Numerous 35mm models moved on and off the stage, because no one had ever developed a convenient, inexpensive stereo projection system. There have even been several attempts at marketing 16mm ultra-miniature-style stereo cameras, but they too foundered. One relatively inexpensive device, which retained popularity for some years, was the Stereotach. This device, attached to the front of the camera lens, used two parallel sets of mirrors with a 65mm center-to-center separation to split the image so that two nearly identical images appeared side by side on the film frame within the normal rectangle of approximately 24 × 36mm. Over the years such stereoscopic attachments have been available as accessories for various 35mm cameras. One such system, which uses the stereo attachment for both picture-taking and slide projection, is the Miida Stereo System, which is available through camera dealers.

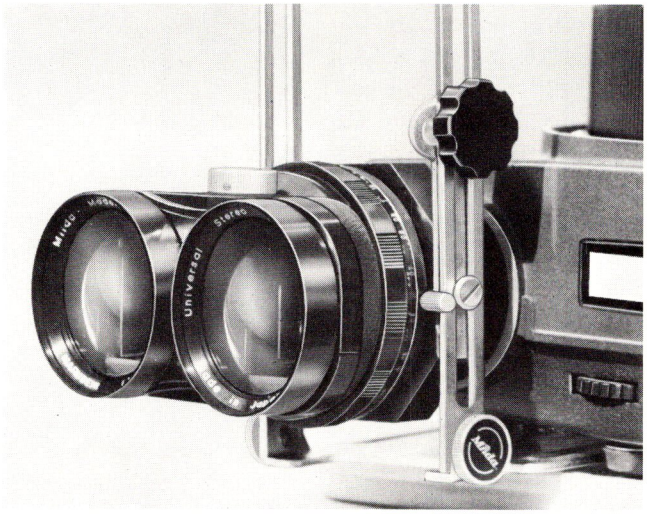
The Miida stereo adapter can be used with any of the Minolta Rokkor lenses in the 50mm through 300mm range. The stereo adapter is attached to the front of the lens with an adapter ring, which screws into the filter mount of the lens. For most of the Minolta Rokkor lenses, you will need either a 55mm or 52mm adapter ring, but for the 200mm *f*/3.5 and the 300mm *f*/4.5, the rings must be 62mm and 72mm in diameter, respectively.

The stereo adapter is used only in the horizontal position. It creates two vertical images with one single exposure. Focusing is done in the normal manner, as is exposure measurement, although you may find it necessary to compensate one *f*/stop for light loss owing to the use of the divided-mirror image system. While looking through the camera viewfinder, you must rotate the distance ring of the stereo adapter until you see each of the two separate images centered and aligned in its own half of the image area.

The best subjects for stereoscopic photography are those at moderate distances from the camera. Beyond about 200 feet the three-dimensional effect is lost; moreover, if you cover too much from foreground to background, you will tire the viewer's eyes, which will be roaming to and from foreground and background searching out details. If depth of field is limited to a narrow range, sharp details should be most prominent in foreground objects. Blurred or out-of-focus objects should be toward the background. Blur associated with object movement is acceptable, although stationary objects in the same image plane should be rendered sharply. The camera







The Miida Stereo system enables you to convert a camera to stereoscopic use by simple attachment to the front of the lens. Above left, stereo lens attachment; above right, hand viewer; below, lens attachment fixed to a projector lens.

should be held level at all times and should not be tilted upward or downward.

The viewing and projection accessories are important components of the Miida stereo system. A battery-illuminated viewer, which holds two slides at a time, is available. It can also be used as an editing device before inserting slides in a projector. If you prefer to have your slides made up as paper prints in stereo pairs, you can obtain a special hand-viewer for prints. The most dramatic effects are achieved when the slides are projected. Use any slide projector and position the stereo adapter in front of the projector lens using the Miida stereo projection stand. The optional features of projectors such as auto focus, zoom lenses, and remote control can be utilized in the normal manner. It is necessary, however, to attach polarizers (furnished with the equipment) over the front of the stereo adapter. Viewing is done through polarizing spectacles, which are available in two models: spectacles for people with normal vision and spectacles with attachments for people who wear eyeglasses. People who wear contact lenses would use the first type—just as if they did not normally wear eyeglasses.

ASTROPHOTOGRAPHY

A substantial amount of celestial photography can be done with the Minolta SR camera and the long focus Rokkor lenses. Photographs of star-filled skies can be made with lenses in the normal range and longer, since stars are recorded as points of light rather than as round bodies. To photograph the moon and the planets, the starting point in lens selection is 200mm. For planetary photography the camera should be mounted to a telescope, which in turn should be supported on a clock-driven equatorial mount.

A free pamphlet that includes references to more literature on the subject is *Astrophotography with Your Camera,* Kodak Pamphlet No. C-20, available from the Consumer Market Division, Eastman Kodak Company, Rochester, N.Y. 14650. The best periodical on astrophotography is *Sky and Telescope,* which will introduce you to the experiences of people who actually do astrophotography and who describe their techniques with numerous examples of their results. The publisher is Sky Publishing Corporation, Harvard College Observatory, Cambridge, Mass. 02138. Copies are available in most public libraries with large periodical collections. You will also find many advertisements by manufacturers and distributors of telescopes, equatorial mounts, and clock drives, as well as adapters for telescopes connecting to the camera body. Edmund Scientific Company, referenced in the chapter on creative variations, is one such source.

A very important warning is that *you must never, under any circumstances, look at the sun through a telescopic device except through the medium of neutral density filters.* You should never photograph the sun except through neutral density filters.

Telescopic Adaptations

To use a telescope with your camera, remove the camera lens and substitute a connector tube, or sleeve, that will attach to the telescopic eyepiece. You may also need to attach a supporting bracket to a reflector-type telescope to hold the camera rigidly. Such adapters are available from amateur and professional telescopic supply houses. You may be able to fashion a connector sleeve, or tube, by starting with an interchangeable lens adapter ordinarily used in connecting independent makes of lenses to the Minolta camera body. You can then have a step-down tube made by a machine shop to connect the lens adapter with the telescopic eyepiece. In this arrangement, the combination of telescopic objective and eyepiece serves as the camera lens. The objective (front) lens of the telescope determines light-gathering capability and optical quality.

The most satisfactory telescope, from the standpoint of achieving the best photographic results, is the reflector telescope, which can be either a simple type or a more advanced catadioptric type that combines both a mirror reflector and a refracting lens in the same telescope. The catadioptric design of such telescopes is basically similar to that of the Rokkor mirror reflex lenses, whose optical and mechanical schematics are shown in the chapter on lenses. The chief photographic advantage of both types of reflector telescope is that they have exceptionally fine ability to bring all colors into a common plane of focus on the film. This is made possible through the use of a front-surfaced mirror, which functions as the principal optical component of the telescope. By comparison, the refractor telescope,

which uses a large glass objective through which light passes, is unable to bring all colors into focus at the same image plane; hence, refractor telescopes may cause some loss of image sharpness.

Each type of telescope has its own advantages. The great advantage of the refractor telescope is that the observer can seat himself comfortably and look through the normal camera eyepiece. It is also easier to mount and adjust a camera fixed to the eyepiece of a refractor. With reflector telescopes, since the eyepiece at the end of the telescope tube is mounted at right angles to the tube, you must sometimes stand on a ladder or chair to look into the camera eyepiece.

In any case, you might find it convenient to attach the Minolta eyepiece magnifier or angle finder to the camera viewfinder, either to enlarge the image for focusing or to find a more convenient angle for viewing.

There are some other photographic pros and cons for both types of telescope. Dollar for dollar, you can generally get a much larger objective—the main light-gathering lens, whether of glass or of mirror design—in a reflector telescope than in a refractor type. On the other hand, the image produced with the refractor telescope is larger owing to the combination of greater focal length and eyepiece magnification. The reflector image is affected by metal vanes, which, because they cross the path of light to support a secondary mirror, may show up on bright stars as diffraction spikes. The refractor needs less, or very little, optical servicing, whereas the mirror of the reflector telescope needs occasional resurfacing and subsequent realignment. Another disadvantage of the reflector is that on hot nights turbulent air currents form in the long, open tube.

The best of two worlds is offered by catadioptric telescope designs with their mixed lens-and-mirror systems, sometimes called *folded optics.* In addition to being shorter because of this design feature, the catadioptric telescope (including the Rokkor mirror reflex lenses) overcomes the problem of color correction through elimination of chromatic aberrations, which create the spurious color that surrounds bright objects like a halo; moreover, no special setting needs to be made for infrared work when such telescopes are used in terrestrial photography. With this type of telescope, the camera can be mounted directly to the eyepiece of the telescope at its lower end. Use of the Minolta angle finder will aid in providing viewing comfort.

The mirror reflex, or catadioptric, telescope also overcomes the problem of diffraction spikes when you photograph stars or small planets, since the design eliminates the vanes used in the simple reflector telescope. Because it is completely closed, it eliminates the problem of hot air turbulence inside the telescope tube. Of course, these advantages may be offset for the amateur in that they require a greater investment; therefore, the catadioptric design is recommended for the serious amateur or professional.

Whichever telescope you select, bear in mind that its ability to resolve an image is one of its important characteristics. This is a function both of the diameter of the lens or mirror and their optical surfacing. The wider the diameter, the finer will be the image resolution: A perfectly resolved star should show up as a single point without diffraction rings around it.

Small refracting telescopes, commonly called *spotting scopes,* may also be attached directly to the lens mount of the Minolta SR camera body. These are small prism telescopes whose configuration, while longer, resembles that of a monocular. These spotting scopes have the general attributes of refractor telescopes; they are not designed specifically for photographic use, although they can serve that purpose quite well. Adapters

are available from several sources, as mentioned above, for coupling the telescope with its eyepiece to the camera and its lens. In the typical arrangement, the spotting scope is laid into the cradle of a supporting bracket to which the telescope has been attached by a band-clamping device. This bracket is attached at its base to a rail, at the other end of which is a camera-support platform. When the camera is mounted on the platform and the appropriate locking levers and sliding arms adjusted, the telescope eyepiece and the camera lens are centered on each other. Then the camera-and-lens assembly is pushed forward against a rubber shield on the telescope eyepiece to eliminate stray light. You can actually do without the rubber shield if you are sure that no direct sunlight or other source of light will reach the surface of the camera lens. You must check the camera viewing screen for vignetting (blocking out) of image corners. This is a means of making sure that the camera lens and telescope are on the same optical axis. If they are not, you might need to experiment by repositioning the lens and eyepiece, or perhaps by removing the rubber shield from in front of the eyepiece.

Another method of coupling permits you to remove the camera lens entirely and use the telescope and eyepiece combination as the sole optical source for projection of an image onto the film. For such a fixed projection, influenced only by eyepiece magnification, you need a device to couple the camera body to the eyepiece of the spotting scope. Consult a telescope supply source or, if you should start with a lens adapter made for the Minolta camera mount, have a machine shop adapt it with a clamp or screw connection to the spotting scope. A variation is a draw-tube arrangement, which consists of an inner and outer sleeve together with a clamping or locking knob. Viewed under this arrangement, the size of the image is magnified when you lengthen the draw-tube extension and diminished when you shorten the extension.

Astrophotographic Technique

Conventional astronomical telescopes have such a narrow field of view that it is difficult to center the celestial object within the image area. Consequently, such telescopes are equipped with low-powered telescopic finders. The finder scope has a set of cross-hairs that help you center the image, by making it easier to locate your subject within the field of view of the main telescope.

When you photograph stars and render them as individual points of light, the use of a telescope is of no particular advantage, since it serves only to limit the field of view and widen the spaces between the stars without increasing their individual size. They are still rendered as points of light; thus, any good lens can be used to make photographs of stars. Objects that have discernible characteristics can be photographed either with long focal length lenses or with telescopes. Obviously telescopes will provide more detail than ordinary camera lenses. Small, extended objects—the moon, planets, comets, certain nebulae, clusters, man-made satellites—are best photographed with telescopes.

The accompanying tables show the image sizes in millimeters of the moon and other planets photographed with lenses of 200mm and longer, the magnifications required for astronomical objects, the exposure recommendations for amateur astrophotography, and a check list of considerations involved in computing exposure.

For all astronomical objects, other than the sun and moon, films with high exposure indexes, both color and black-and-white, should be used. Relatively slow films can be used to record the sun and

Image Sizes In Millimeters of the Moon and Other Planets

Lens	Moon	Mercury	Venus	Mars	Jupiter	Saturn
50mm	0.50	—	—	—	—	—
105mm	1.05	—	—	—	—	—
200mm	2.0	.010	.058	.018	.044	.018
500mm	5.0	.025	.145	.045	.111	.045
800mm	8.0	.040	.232	.072	.177	.072
1000mm	10.0	.050	.290	.090	.222	.090
1200mm	12.0	.060	.350	.110	.260	.110

Moon Eclipse Exposure Table

% Eclipse	Exposure Factor	Increase in lens stop
40	2	1
60	4	2
70	8	3
80	20	4 1/3
90	50	5 1/2
100	200	7 2/3

GENERAL EXPOSURE RECOMMENDATIONS FOR AMATEUR ASTROPHOTOGRAPHY

SUBJECT	CAMERA & TELESCOPE NEEDS	f NUMBER	FILMS	EXPOSURE (depending on conditions and brilliance)
Star Trails	Rigid support	Wide open	Fast, B&W and color	Up to 30 min or more
Meteors	Rigid support	f/6.3 or better	Fast	10-30 min
Aurorae	Rigid support	f/4.5 or better	Fast, B&W and color	1 sec to 5 min
Moon	Fixed or equatorial with or without drive	About f/11	Slow	1/100 sec to 10 sec
Stars and Comets	Equatorial with guiding sights	f/6.3 or better	Fast, B&W and color	10 min to 1 hr
Clusters and Nebulae Constellations	Equatorial with sights and drive	About f/6.3	Fast, B&W and color	10 min to 1 hr
Planets	Equatorial, preferably with drive	Use what you have	Fast, B&W and color	½ to 15 sec
Sun* (Never look at the sun with any optical device!)	Rigid or equatorial with or without drive	f/32—f/64	Slow	1/1000-1/25 sec with Neutral Density Filters 4.00-6.00 over main optical objective (not the eyepiece!)
Man-Made Satellites	Rigid support	f/4.5	Fast	Hold shutter open for duration of pass

Adapted from a table of the Eastman Kodak Co.

moon. For any long exposure you need a clock-driven equatorial mount to compensate for the earth's rotation. Most auroras and stars visible to the naked eye can be captured with ten-second exposures without discernible image displacement. The clock-driven mount should be used for longer exposures.

Photography of star trails, which in itself indicates movement, requires exposures of ten minutes or more. Naturally, a tripod or other solid support is required. The distance setting of the lens should be at infinity and the diaphragm should be set for the widest aperture. The aim is to achieve maximum con-

MAGNIFICATIONS REQUIRED FOR ASTRONOMICAL OBJECTS

PLANET

Merucury ..... 30×
Venus ..... 30×
Mars ..... 60×
Jupiter ..... 60×
Uranus ..... 30×
Neptune ..... 30×
Saturn ..... 60×

SATELLITES

Titan of Saturn ..... 30×, 60×
Moon ..... 20×, 30×, 60×
I, II, III and IV of Jupiter (Io, Europa, Ganymede and Gallisto) ..... 30×

DOUBLE STARS

Alcor and Mizar in Ursa Major ..... 30×
The Trapezium in Orion ..... 30×, 60×
Albireo in Cygnus ..... 30×, 60×
Porrima in Virgo ..... 30×, 60×
The Double-Double in Lyra ..... 30×, 60×
Asteroids 30×
Comets 15×, 20×
The Milky Way 15×, 20×

NAKED-EYE CLUSTERS

The Pleiades ..... 15×
The Hyades ..... 15×

STAR CLOUDS

In Scutum ..... 15×

M OR MESSIER OBJECTS

Andromeda Galaxy M 31 ..... 15×
Praesape Star Cluster (Beehive) ..... 20×
Hercules Cluster M 31 ..... 60×
Orion Nebula M 42 ..... 20×
Cluster M 35 near n Geminorum ..... 20×
Dumbbell Nebula M 27 in Volpecula ..... 15×, 20×
Double Cluster in Perseus M 15 ..... 15×

M OR MESSIER OBJECTS IN THE SAGITTARIUS-SCORPIUS REGION

M 4 ..... 30×, 60×
M 5 ..... 30×, 60×
M 6 ..... 30×
M 7 ..... 30×
M 8 ..... 20×
M 11 ..... 20×, 30×
M 16 ..... 30×
M 17 ..... 20×
M 19 ..... 30×, 60×
M 20 ..... 20×
M 22 ..... 20×, 30×
M 23 ..... 30×
M 53 ..... 30×, 60×
M 80 ..... 30×, 60×

M OR MESSIER OBJECTS IN OPHIUCHUS

M 10 and 12 ..... 30×

Courtesy, Bausch and Lomb Co.

trast between the sky, which should be rendered black, and the star trails, which should be rendered white in a positive print or transparency. In this case, there is some advantage to using the slower, more contrasty films. On moonlit nights in the country or in brightly-lit metropolitan areas, it is difficult to retain the blackness of the sky. In these situations try a short exposure in order to keep recording the background to a minimum. Image displacement of a star trail may be calculated beforehand as a 1° movement for each four minutes of exposure. You need to find an exposure that takes into account degrees of image displacement and background illumination of the sky.

EXPOSURE TABLE FOR AMATEUR ASTROPHOTOGRAPHY THROUGH TELESCOPES

Subject	Film	Exposure Time
Stars and comets	Kodak Plus-X, Tri-X, Royal-X, Ansco Super Hypan	10 min. to 3 hours depending on set-up and brilliance
Clusters and Nebulae	Same	10 min. to 1 hour
Planets	Same	1/2 sec. to 15 sec.
Moon	Kodak Panatomic-X	1/100 sec. to 10 sec.
Sun*	Kodak Panatomic-X, Kodak Microfile	1/25 sec. to 1/1000 sec. with neutral density filters 4.00 to 6.00 over telescopic objective

***Warning: Never look at the sun through a telescopic or optical device! Serious damage to the eyes will result.**

A CHECK LIST OF CONSIDERATIONS INVOLVED IN EXPOSURE DETERMINATION

1. Subject Brightness—Each Hipparchus brightness difference of 1.0 denotes an exposure difference of 2.5.

CHOOSE ONE

2. Objective Diameter—For point objects (stars), the exposure time will be inversely proportional to the square of the diameter.
3. Equivalent f/number—For extended objects (moon, planets, comets, certain nebulae, clusters, etc.), the exposure time will be proportional to the square of the f/number.
4. Relative Film Sensitivities—Use the ratios as a guide.
5. Filters—Use filter factors.
6. Light Transmission and Indeterminables — Modify calculations by multiplying by 1/4, 1, 4, and 16 for trial exposures.

Courtesy Eastman Kodak Co.

PHOTOMICROGRAPHY

The process of taking photographs through a microscope is called *photomicrography*. The microscope acts as a high-powered optical system which is used in place of the camera lens. The camera is attached to the eyepiece of the microscope.

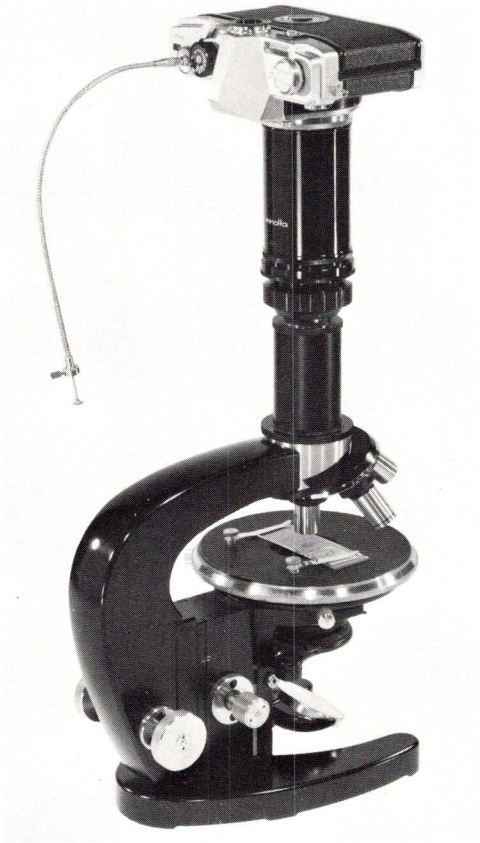
Photomicrography and microphotography are two different processes. The latter pertains to the reduction of large objects to very small images. It has come to be associated with the storage of vast amounts of information within very small film areas for use in information-retrieval systems. In this section, however, we are concerned only with photomicrography.

Minolta offers two means of making

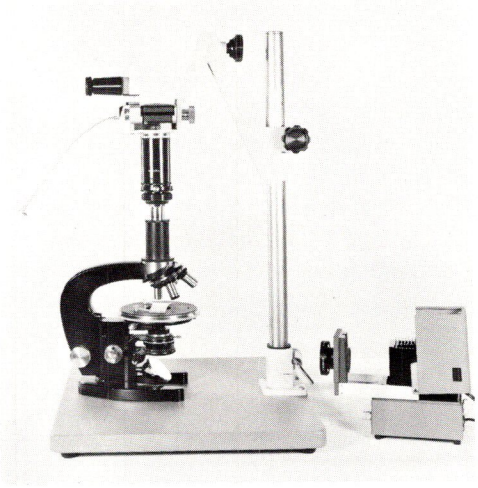
photomicrographs. For the occasional photograph taken through any compound microscope, a simple microscope adapter is available to connect the camera body to the eyepiece. Successful photomicrography can be performed using this adapter, although it cannot be done as conveniently or as efficiently as is possible with more sophisticated equipment, which permits the photographer to control and measure the volume of light converted into image form. For professional laboratory use and for the serious photomicrography hobbyist, Minolta has developed the Photomicrography System II. This system is intended for use with virtually any microscope currently available that has a built-in light source, although microscopes can also be used which require outside lighting sources. Special features include, among others, completely vibration-free operation, a sophisticated focusing system through either an aerial image or a coincidence-type rangefinder, a highly sensitive through-the-lens meter of semi-spot design, and a built-in color temperature meter integrated with a voltage regulator.

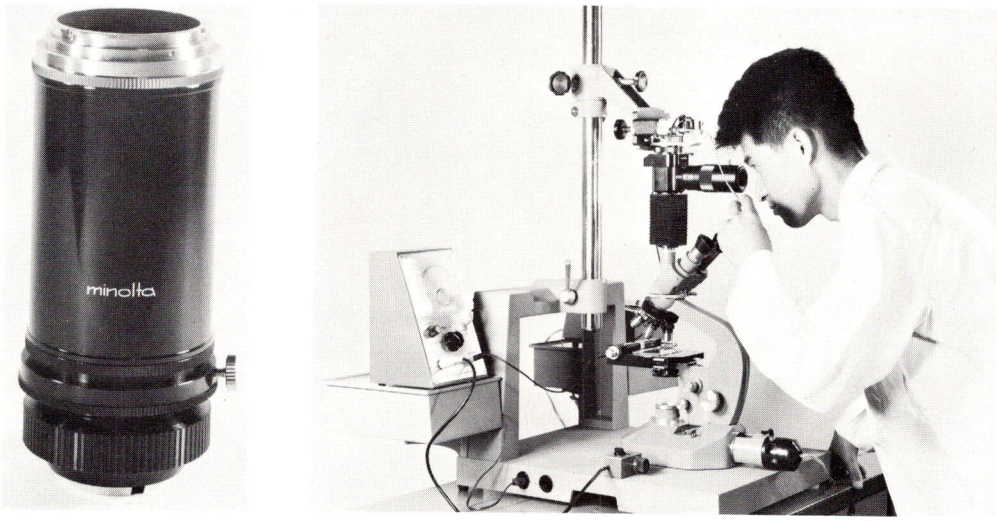
The Minolta SR camera body can also be used with a wide array of other photomicrographic equipment systems. The function of the camera body in connection with any of these systems is to serve as a film storage and transport mechanism and as a shutter mechanism for making exposures. When the simple Microscope Adapter is used, the viewing system of the camera is also an important element.

More comprehensive coverage of photomicrographic methods and materials, going beyond this brief introduction, is available in Kodak Publication No. P-2, *Photography Through the Microscope*, Eastman Kodak Company, Rochester, N.Y. 14650, $2.50, available from many photo dealers. This publication includes a bibliography of related materials.



Left, Minolta SR camera mounted on microscope with Minolta Microscope Adapter. Below, unit on Minolta Copy Stand II, with Anglefinder V and a projector as source of illumination.





Left, Minolta Microscope Adapter. Right, Minolta Photomicrography System II in use.

The Microscope in General

Photomicrography consists of the recording of a relayed series of images. The first image is produced by the objective, which is the lens in direct proximity to the subject. The objective has a magnifying power expressed in diameters from 5× through 100×. The primary image formed by the objective is projected through the body tube of the microscope up to a fixed point where it is further enlarged by the eyepiece, or ocular, of the microscope, which has its own magnifying power that may be in the range of 5× through 25×. The combined enlarging power of these two lenses yields the total magnification of the image. The degree of magnification can be altered by interchanging objectives and eyepieces. Thus, if the objective chosen has a magnifying power of 25× and the eyepiece a magnifying power of 20×, the combined magnification will be 500×.

For visual purposes, the image is viewed at the point where the light rays emerge from the eyepiece and come together in a tiny circle, called the *eyepoint*. If you wish to record this image on film, you must mount the camera with an intervening extension at a distance of about ten inches (250mm) from the eyepoint.

The objective is the more important of the two microscope lenses, for it produces the primary image, which must be composed of finely resolved details, optically flat, and suitably color-corrected. Lenses used as microscope objectives are generally of the achromatic or apochromatic type. Apochromatic lenses are corrected for chromatic aberration for three colors (wavelengths) of light and for spherical aberration for two colors.

Apochromats generally image all colors at the same plane, but the sizes of images of different colors vary because of slight differences in magnification—a phenomenon called *lateral color*. It is thus recommended that this type of objective be used in combination with an eyepiece of the "Kompensation" type described below. Apochromatic lenses are suitable for photography with all colors, particularly red and blue.

Despite the greater correction of apochromats, lenses of the achromatic

type are most popular for use as microscope objectives. Achromats are corrected for both spherical and chromatic aberration for only two colors of light. Since images of all colors are therefore not imaged at exactly the same plane, the image will have a greenish cast when a Huygens-type eyepiece is used or when the light source is not properly centered.

Because achromats are corrected well for chromatic aberration for green light when used with a green filter and black-and-white film, they can yield as good photographic results as apochromats. Generally, the apochromats are better for color photography, whereas achromats are adequate for black-and-white or for color photography at low magnification rates.

The following eyepiece types are well known and identifiable as indicated:

1. *Huygens.* Only the magnification rate is engraved on the lens, *e.g.*, 50×.

2. *Kompensation.* The letter "K" is engraved before the magnification-rate figure, *e.g.*, K50×.

3. *Periplan.* The letter "P" is engraved before the magnification-rate figure, *e.g.*, P50×.

The Huygens type, the most popular, can produce a satisfactory image when used at low magnifications. However, this type of eyepiece should not be used at high magnifications since chromatic aberration at the green wavelength becomes too pronounced for good photographic results.

Kompensation-type eyepieces are designed to compensate for such shortcomings of achromatic objectives as lateral color and green-wavelength chromatic aberration. Though even apochromatic objectives are not completely free of such aberrations at high magnifications, you can expect satisfactory photographs if they are used with a Kompensation eyepiece.

Eyepieces of the Periplan type are excellent for black-and-white photography, particularly with filtered light. They can be used for photomicrography to improve corner-to-corner sharpness throughout the field of view.

Among other kinds of eyepiece are the wide-angle type, and the orthoscope and homal types, which are used to bring the center of the field of view and its surroundings to the same focus.

The two image-projecting lenses—objective and eyepiece—should ordinarily be matched by the same manufacturing source and should be optically in balance with the condenser. This sub-stage lens concentrates the lighting source into a conical beam of light that passes through the microslide in order to make it visible either for visual or photographic observation and recording. Many microscopes today have built-in illumination sources. If you use a microscope without its own light source, you will need an appropriate narrow-beam light source or projector to direct toward a mirror, which in turn will reflect the light through the sub-stage condenser.

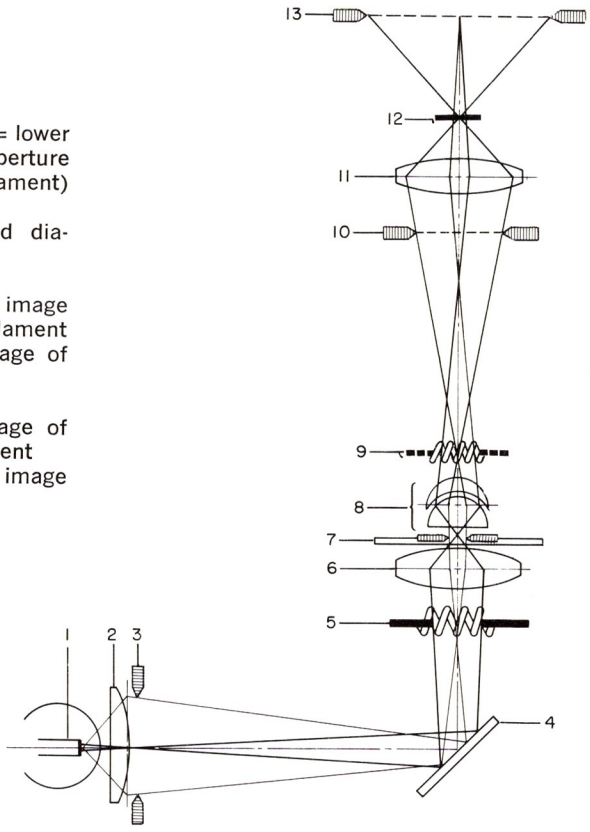
The Kohler method, shown in the diagram, is typical of lighting for photomicrography. This method is considered most suitable for photomicrography with penetrating light—that located opposite the microscope lens, behind the slide, which shines through the specimen rather than being reflected by it. It minimizes flare and provides good contrast between light and shade. The image of the light source filament is focused at the position of the diaphragm attached to the sub-stage condenser. Though it may not be necessary with microscopes having built-in light sources, going through the following procedure is advisable with both built-in and separate sources:

1. Focus the specimen sharply using an objective lens of 10× or lower.

2. Close the condenser aperture and the light source aperture (if any) all the way down; adjust the condenser up and down until the image of the light source aperture can be seen clearly.

Köhler's illumination principle.

1. Lamp filament
2. Collector
3. Field diaphragm
4. Mirror
5. Entrance pupil of microscrope (= lower focal plane of condenser with aperture diaphragm and image of lamp filament)
6. Condenser
7. Object plane with image of field diaphragm
8. Objective
9. Rear focal plane of objective with image of aperture diaphragm and lamp filament
10. Intermediate image plane and image of field diaphragm
11. Eyepiece
12. Exit pupil of microscope with image of aperture diaphragm and lamp filament
13. Projection plane (film plane) with image of specimen and field diaphragm



3. Sighting through the finder, use the sub-stage condenser centering-ring adjusting screw to center the image formed by the lamp filament and diaphragm opening.

4. Gradually open the condenser diaphragm up to its widest opening while looking through the virtual-image finder.

5. Adjust the filament image to the center or to fill evenly the entire circular field of view by means of the two knobs on the lamp socket.

Since too much illumination produces an unclear image, condenser apertures must be adjusted to suit the area of the slide to be lighted. If this illuminated area is too large, the image will become soft; if it is too small, the area away from the center of the field of view will become dark. It is generally considered best to set the condenser aperture to about 60 per cent of the angle of view covered by the lens.

The Minolta Photomicrography System II is a convenient configuration consisting of a camera-holding stand, a finder for observation and focusing, a sensitive through-the-lens exposure meter, and a color-temperature control and metering source. Designed to be used with almost any microscope with its own lighting source, it simplifies the various operating steps necessary for precise photomicrography.

Basic Photographic Procedures

Films ordinarily used in general color or black-and-white photography can also be used to obtain the same characteristic effects—contrast, image resolution, graininess, and tonal range—in photomicrography. Color films are usually the first choice. As a guide to their selection, Kodak stated: "Kodachrome-X and Ektachrome-X probably exhibit the most

contrast of the available Kodak films, although their contrasts are only slightly higher than other reversal color film. Kodachrome II Films have the finest granularity of all the color films. Others are fairly equal in this respect."

Whatever film you select, you are not likely to be able to reproduce all the colors of the specimen with equal fidelity. This problem goes back to the sensitivity of the various layers of color film to the spectral characteristics of the subject matter. You may thus have to experiment to achieve desired results through the selection of different films, filters, and staining media, and through alterations in color temperature. The general guidelines pertaining to filter selection and color temperature in the chapter on exposure apply here as well. Control of color temperature is more precise if you use the Minolta Photomicrography System II, as explained in the instruction booklet that accompanies this equipment.

The *f*/stop of the camera lens is one of the two key elements of exposure control in ordinary photography. When a microscope is used, another procedure is necessary, since the optical system of the microscope replaces the camera optics. The starting point in exposure calculation is the numerical aperture of the objective, commonly referred to as the *N.A.* The N.A. is imprinted on the mount of the microscope objective. For a 10× objective of achromat design, the N.A. is 0.25; for a 20× achromat, the N.A. is 0.50. For apochromats, higher N.A.'s are indicated. These values are commonly associated with lenses used in dry air; higher numerical apertures for use with oil-immersion objectives range from 1.00 to 1.40. Additional reference to the N.A. will be found in the following discussion of exposure calculation.

When the Minolta Microscope Adapter is used, one section of this two-piece device bayonets into the camera body in place of the lens and the other end fits into the ocular tube section of the microscope. This adapter fits ocular tubes from 23mm to 29mm in diameter.

An important technical detail to consider in setting up a microscope for use with a simple adapter is the elimination of vibration. The tripod supporting the camera should rest on shock-absorbent material. Although the camera can rest on top of the microscope, this raises the center of gravity, which makes the whole assembly sensitive to the slightest vibration, and any vibration is magnified as much as the image itself. To further stabilize the entire setup, an auxiliary support for the camera, attached to its tripod socket, is helpful. This could be the enlarger stand used upright, a copy stand used upright, or a special support —a feature of the Minolta Photomicrography System II.

Focusing, when using the simple microscope adapter arrangement, is done by viewing the image through the camera eyepiece while adjusting the focusing knob on the microscope. If the microscope is on a low table, you might want to use the Minolta Magnifier V, which further magnifies the image for critical focusing. If the microscope is at a higher position and the camera approximately at eye level, the most convenient arrangement would be to use the Minolta Anglefinder V, which enables you to view and focus while looking straight ahead.

One of the problems of focusing through the camera, rather than through a finder device available in more sophisticated equipment, is that the regular groundglass screen is ordinarily much too coarse to render fine details clearly and sharply. If you have no other alternative, simply do your best to work around this problem, making several exposures with slight adjustments in focus if you have any doubts as to accuracy. Ideally, you would substitute a fine groundglass or clear focusing screen.

An additional disadvantage to focus-

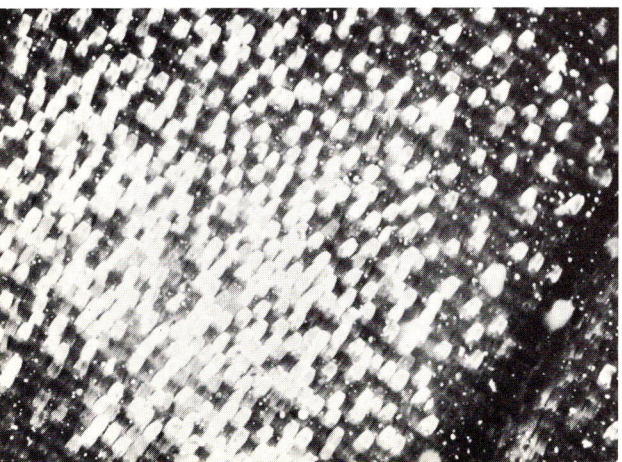
ing through the camera is that the viewing screen image darkens as the magnification rate increases. When using more sophisticated viewing equipment, use the camera eyepiece mainly to ascertain the photographic range of the subject. The Minolta Photomicrography System II includes a virtual-image finder with a pellicular mirror, which allows 80 per cent of the image-forming light to pass to the camera while deflecting 20 per cent of it into the finder. The relatively bright virtual image formed in this way by the deflected light allows you to focus accurately and even to follow a moving subject at high magnifications.

Depth of field is a critical problem in the photographic recording of an image, but it is somewhat less critical in viewing. This may create some problems because you may think you have an object in sharp focus in some depth only to find later, upon inspecting the film, that the image is slightly out of focus. In ordinary photography depth of field is measured in meters or feet and, at close distances, in millimeters, inches, or fractions thereof, but in photomicrography the measurements are in terms of microns. A partial solution to the depth-of-field problem is to use a specimen that is sliced as thin as possible. The ideal is for the thickness of the specimen not to exceed the depth of field in microns.

If the image brilliance is sufficient, the built-in exposure-metering system of the Minolta SR camera might be usable. Otherwise, when not using an exposure-metering system suitable for photomicrography, such as the Minolta Photomicrography System II or something comparable, you would need to run exposure tests using the same bracketing procedure as in ordinary photography. However, you will want a wider range of exposure tests when you use a microscope. Upon visual inspection of the developed films, select those exposures that are most satisfactory and use them as a basis for making additional exposures with the same combination of objective, magnification, film, and lighting source. You can convert the experimentally derived exposure time, using it as a standard, for a higher or lower magnification with the following formula:

$$\frac{\text{New exposure time}}{\text{Standard time}} = \left(\frac{\text{Standard N.A.}}{\text{New N.A.}}\right)^2 \times \left(\frac{\text{New magnification}}{\text{Standard magnification}}\right)^2$$

Assume, for example, that the film calls for an exposure of 1/125 sec., which can be rounded to 0.01 sec. Assume also that you have a magnification of 200× using an eyepiece of 10× and an objective of 20× (N.A. = 0.50). The standard conditions for that exposure would be 0.01 sec. for the shutter time (or 1/125 sec.) with a magnification of 200× and N.A. of 0.50. Suppose, now, that the new exposure is to be made at 430× using the same 10× eyepiece but substituting an objective of 43× with an N.A. of 0.65.



Butterfly wing, 50×, Photomicrography System II.

Substituting these numerical values in the above formula, you would get the following:

$$\frac{\text{New exposure}}{0.01} = \left(\frac{0.50}{0.65}\right)^2 \times \left(\frac{430}{200}\right)^2$$

$$\text{New exposure} = 0.0276 \text{ sec.} = 1/60 \text{ sec.}$$

The practical effects of exposure can be evaluated as in ordinary photography. You want both adequate density and sufficient pictorial contrast. Highlights should have discernible tonal rendition without being burned out and details should be clearly rendered.

More sophisticated equipment, such as the Minolta Photomicrography System II, enables you to adjust the color temperature to the specifically rated value for the film in use. The color balance obtained might not be satisfactory to all users. Experimental data obtained by the Minolta Camera Company indicate that more pleasing results may be obtained at 70 to 80 per cent of the rated color temperature. The voltage regulator of the Minolta system is used for making fine adjustments in color temperature, but for major adjustments filter substitutions must be made. With color films for which color temperature adjustments are important, shutter speeds should be used that are faster than one second, since reciprocity effects may come into play at lower speeds. Adjustments in exposure can also be made through variations of the condenser aperture, but, as a rule of thumb, the condenser aperture should be set to yield about 60 per cent of the light afforded at the largest opening.

Filters of the following types can be used between the light source and the specimen in photomicrography:

1. Frosted filters for uniform lighting.
2. Neutral density (gray) filters to adjust light volume.
3. Colored or polarizing filters for adjusting specimen contrast and/or color.
4. Blue filters to obtain proper color temperature.
5. Filters for absorbing ultraviolet or infrared rays.
6. Heat-absorbing filters.

The use of filters usually increases the length of exposure necessary, since some of the available illumination is absorbed. The exposure factor for use with the particular filter must be calculated to find the correct shutter speed. The TTL exposure-measuring arrangement of the Minolta Photomicrography System II, however, automatically yields correct exposure, even when filters are used, so that no special calculations are necessary.

When you take black-and-white photographs of dyed specimens, be sure to give due consideration to dye and/or specimen color in relation to the filter(s) being used and the spectral sensitivity of the film emulsion in use. Adjust the photographic contrast of the specimen to stress desired features.

As with ordinary photography, of course, suitable films for photomicrography must be selected and treated properly based on adequate knowledge of their attributes. For example, when you use an achromatic objective lens, choose an orthochromatic film and use a green filter. With a direct-positive black-and-white film, use a blue filter to improve image sharpness. When high sensitivity is desired for phase-microscope work, use an ASA 100 film or an X-ray film, which has a harder tone and higher sensitivity than ASA 100 film but yields inferior grain. Photomicrographs tend to be low in contrast. Hard-tone, fine-grain films produce clearer pictures.

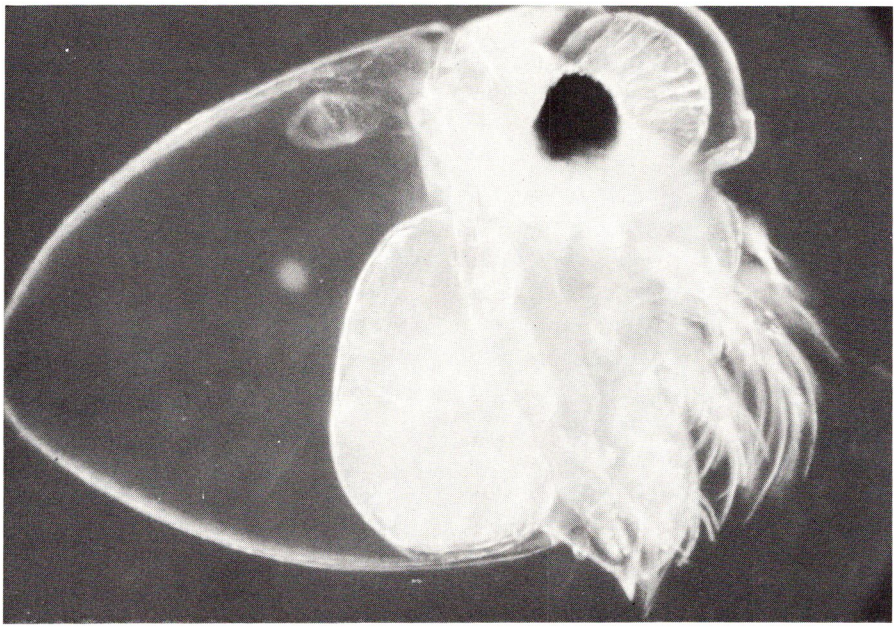
Contrast can be modified by: (1) an effective combination of filter and film; (2) the use of long-wavelength light with film of ordinary sensitivity; and (3) the adjustment of the microscope condenser lens.

When you determine exposure and contrast, consider the contrast and brightness ratios that can be satisfactorily reproduced by the emulsions to be used. A black-and-white negative should have

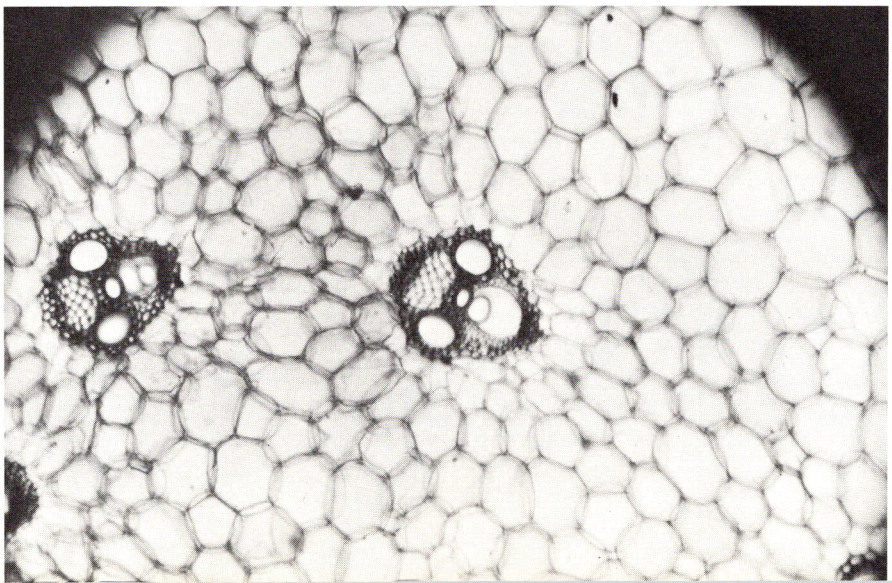
a sufficient tonal range to produce an adequate positive when printed on No. 3 paper, although contrast of the positive print can be adjusted to some extent by using a harder or softer printing paper.

For normal materials, a high-contrast developer, such as Kodak D-11 or Kodak D-19, is often used to attain the desired density; in more extreme cases, special formulas involving added hydroquinone or sodium hydroxide may be needed. However, comparatively contrasty photomicrographs can be made by proper adjustment of lighting and using contrasty film. In such cases, ordinary developers may be used with good results.

The Minolta Photomicrography System II can also be used, without its microscopic apparatus, as a convenient arrangement for making close-ups as shown in the accompanying illustrations.



Above, plankton, 40×, through microscope used with Minolta Photomicrography System II. Below, cross-section of stem of corn. 10×, no ocular. Photographs on this page reproduced from color transparencies, courtesy Minolta Camera Company, Ltd.





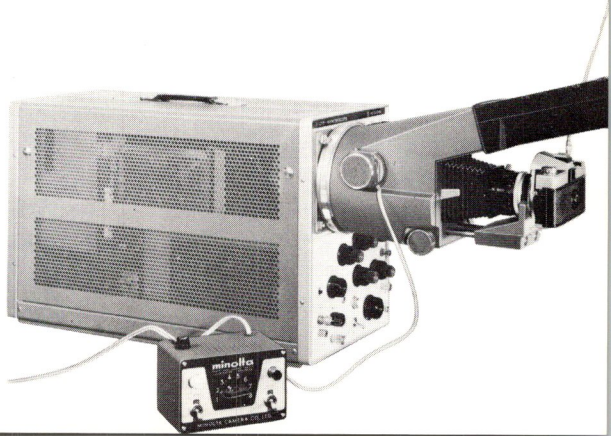
When the moon is photographed in full phase, a fast film can be used since the craters will not show and it is not necessary therefore to have maximum image resolution. When the craters are more sharply delineated by sidelighting, a slower film should be used that can be developed for maximum detail. Minolta SR camera body coupled to Bushnell Spacemaster. Tri-X. Byron S. Cooper.

THE PHOTO OSCILLOSCOPE

The Minolta Photo Oscilloscope Unit-2 is an adapter and viewing mechanism designed for photographing images appearing on a Braun tube oscilloscope screen. The important feature of this unit is that, in addition to having a large observation window, it has a built-in data-numbering device.

The combined use of the Minolta SR camera system and the photo oscilloscope unit makes it possible to record electrical wave forms with complete fidelity. The Minolta unit permits critical focusing through the camera viewfinder together with image area determination incident to use of close-up extensions. The direct observation window permits easy examination of the projected wave forms and, through the use of a cable release, picture-taking at will.

Minolta SR camera coupled to Minolta oscilloscope attachment.



CHAPTER X

Creative Variations

A whole new world of creative photography is accessible if you understand the normal rules and procedures of photography well enough to deviate from them to achieve desired effects. Some of the procedures are simple: They merely call for the selective control or non-control of focus or the selective use of slow shutter speeds to achieve blur as a creative effect. Thus, procedures that are ordinarily termed errors become creative adventuring. These are among the simpler of the procedures for image control at the camera—one of the topical subdivisions of this chapter. This chapter also covers the creative potential in the reflective and refractive properties of various objects, many of which are commonly encountered; the achievement of arresting, out-of-the-ordinary effects using special films; and several interesting techniques available to those who have darkroom facilities.

The word creative is emphasized because it is the effect with which we are mainly concerned rather than the means by which that effect is achieved. Occasionally you will read editorial columns in photo fan magazines or journals that deplore what one might call the "rush to newness"—the propensity of the many to try out the latest fad. Hence, there is hardly any special technique that has not come in for some criticism, whether it be the use of the fisheye lens, infrared color film, pseudo-solarization, prismatic image multiplication, or extreme perspective distortion with wide-angle and telephoto lenses.

The phenomenon of emulating a style leader and, in so doing, overworking the technique is common to practically all areas of human activity, both creative and otherwise. Not only has it characterized photography from its earliest days; it has also been a factor in such diverse areas as ladies' apparel, interior design, creative art, and many others. In due course the new is replaced by something else, but if the new has anything going for it, it retains a place in the order of things.

What it all comes down to is good taste. This, too, is something that might change with the season. The prevailing wisdom for the longest time was that one of the criteria of a technically good photograph was that subject motion had to be arrested. Now, style leaders have established the principle that for many subjects it is desirable to show blurred movement of the main subject, provided

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Bird on a basket combines original with a red gelatin to make a sandwich. 200mm Rokkor, Kodachrome II. Dennis Rizzuto.



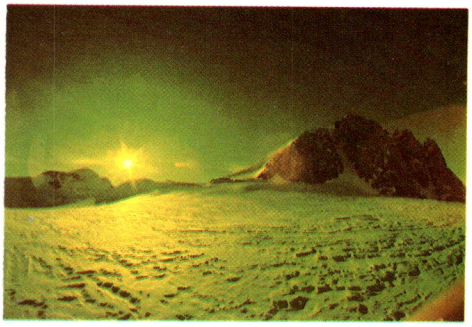
Reflection in water in Venice shown upside down as creative distortion of nature. Focus on reflected image distance rather than from camera to water surface. Kodachrome II, 58mm, f/8 at 1/60 sec. Francisco Hidalgo.





Interesting color effects achieved with built-in black-and-white filters of Rokkor Fisheye 16mm lens. Independent filters can be used for special effects with any other lens. Ektachrome-X. Robert Dehesdin.



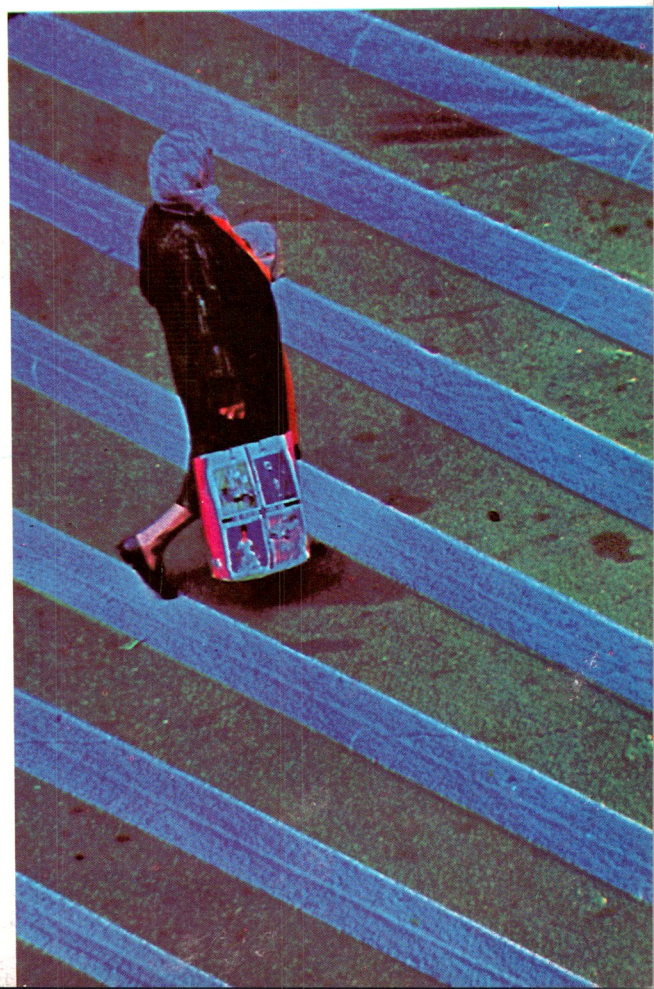


This blue fantasy was created by placing a filter over the main light source rather than over the lens. As an alternative procedure it has advantages in minimizing additional reflective surfaces added to the lens. Macro Rokkor 50mm, bounce flash, Ektachrome-X. Robert Dehesdin.

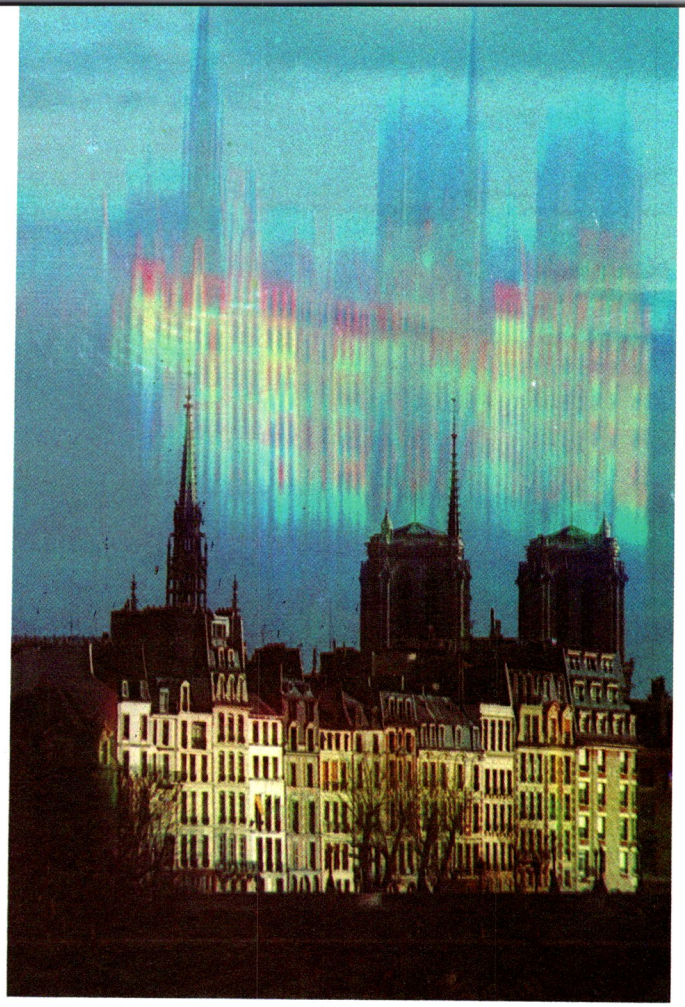




New York photographer Dennis Rizzuto combined a diffraction grating (for the streaks) with daylight High-Speed Ektachrome pushed to ASA 400 (for the exposure and color) to produce this nightclub shot with the 58mm lens. "Sometimes this works," says Denis, "and sometimes it doesn't."



The woman shopping is a creative derivation from an original made with the Rokkor 300mm lens and Ektachrome film, shooting down on a traffic pattern from the Williamsburg Bridge. A negative was made by projection onto Kodalith black-and-white film. This negative was then contact printed onto Technifax Diazochrome film. The developed diazo transparency was combined with the original shot in a sandwich, which was then copied using a slide duplicator. Dennis Rizzuto.



To create an unusual aspect of a Parisian standby, Francisco Hidalgo used both a 200mm lens and a multi-image prism attachment, at 1/30 sec. on Agfachrome film.

Picture of underwater leaves combines surface and sub-surface effects. Rokkor 135mm, f/2.8 lens with 12mm extension tube. Agfachrome CT18. Dennis Rizzuto.



that the background does not show movement. So here is a reversal of acceptable style.

Your own guide should be whether you and others in whom you are interested will be pleased by the results achieved in a certain way. If a particular technique seems to be overworked currently, you might deploy your talents in other directions, with the knowledge, however, that if you wait a while, what was previously done excessively may eventually become part of the library of the worthwhile.

IMAGE CONTROL AT THE CAMERA

The techniques discussed under this heading include the creative use of focusing, blurred action, multiple exposures, perspective distortion, black-and-white filters with color films, and multiple-image devices.

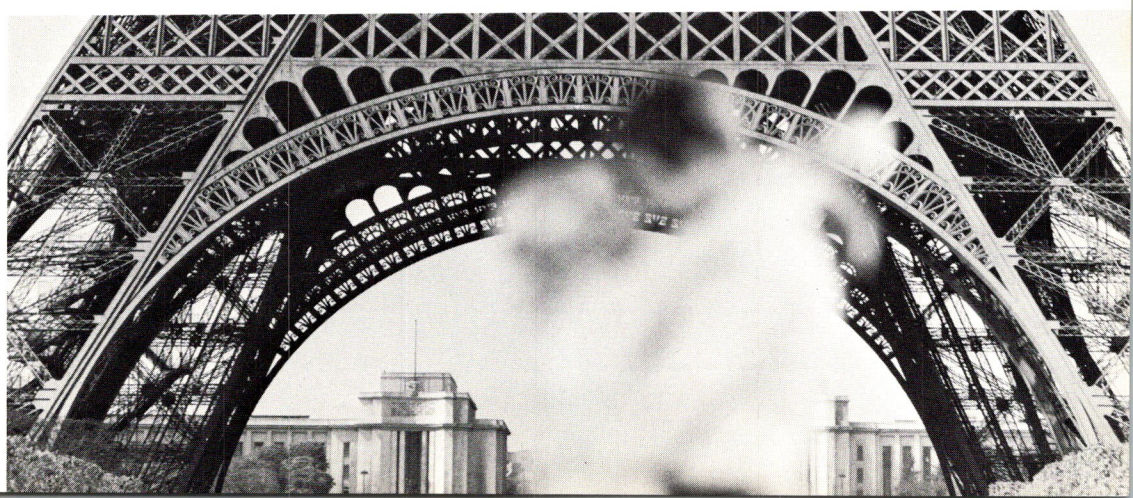
Selective Non-Focus

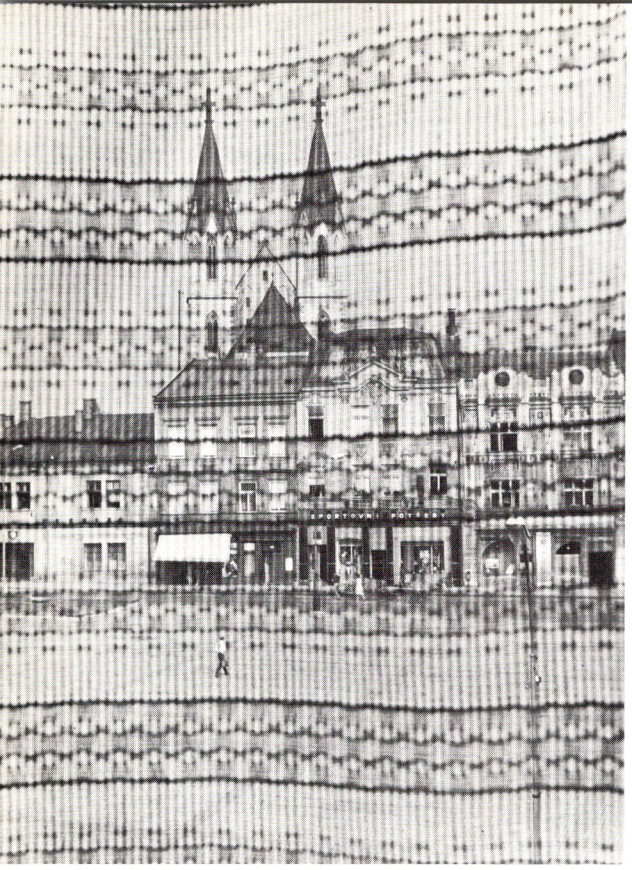
In selective non-focus you do the opposite of what is ordinarily expected with respect to the main object of interest: Your aim is to throw the principal object of interest out of focus so that it is rendered least sharp. For example, instead of focusing sharply on the lighted windows of an office building at night, turn the lens mount so that the plane of sharpest focus is closer to the camera to obtain an interesting pattern of fuzzy-edged, rectangular dabs of light. Just where that plane should be is easily determined by viewing-screen inspection. If you intend to shoot at maximum lens aperture, whatever you see on the viewing screen is what you will get on the film, but if you plan to use a smaller lens aperture or if you wish to previsualize the effect achieved at a smaller aperture, you will have to stop down the lens with the preview button.

A more conventional use of selective focus is to render a foreground object sharp, using essentially the same technique, while causing bright spots in the background to be rendered as globes of light, sometimes overlapping if they are closely spaced. With color films, the blown-up points of light in the background can have the variegated colors of Japanese lanterns. When mirror reflex (catadioptric) lenses are used, out-of-focus bright spots in the background tend to resemble doughnuts.

Interesting contrasts can be achieved by combining an out-of-focus, screenlike material, which should be fairly close to the camera, with a sharply focused area beyond. Screens of different degrees of fineness or coarseness can be rendered more or less sharp to set off the subject beyond the screen. This can be done with

Use of selective non-focus. Two lovers in front of Eiffel Tower. 58mm f/1.2 lens, 1/500 sec., f/2, Plus-X. Francisco Hidalgo.





The activity in the public square in a Czechoslovakian town was photographed in early morning through the lace curtain of the hotel room. The curtain provided an additional dimension for this otherwise barren scene. 58mm *f*/1.4 lens. Tri-X. Joseph D. Cooper.

a chain-link fence or with chicken wire, for example. If the lens is focused for the more distant subject at a wide aperture, the screen might not be visible at all, or there might be just the slightest suggestion of a crisscross pattern in front of the subject. By stopping down the lens and moving the plane of focus closer to the camera, as observed in the viewfinder by using the preview button, the screening pattern will become more evident. In each case, through trial and error, you can determine the pictorial effect while making sure that the lens aperture and shutter speed are properly correlated.

A more creative use of this technique lies in photographing outdoor scenes through lace curtains. The sharpness of the textured effect that the curtain renders can be controlled by selecting just the right combination of lens aperture and focusing distance.

When photographing night scenes in which there are bright points of light, you can turn the lights into star patterns by using fine wire or nylon screens, such as those on doors. The fine-screen material is attached to the front of the lens as if it were a filter.

Front lens attachments made of scored glass produce starlike patterns, which radiate from point light sources, highlights, and catchlights. Examples are the Spiralite Crostars, although other makes are available from independent photo sources. The Crostars come in three patterns: 1 SQ (1mm square), 2 SQ (2mm square), and 2 P (2mm parallel). The square patterns yield right-angle cross patterns; the parallel pattern yields angle-line highlights. The Crostars and other makes are attached to Rokkor lenses through intermediate screw-in lens attachment adapters.

Multiple Exposures

The simplest way of making more than one exposure of the same subject on a single frame of film is to declutch the film while rotating the film advance lever. This is done by depressing the film rewind button and holding it down while turning the lever through its full rotation.

Another method is to position the subject against a black background and then, with the shutter held open with a locking cable release (the shutter dial must be set at "B"), to make successive flash exposures. You need to sketch out a rectangular area corresponding to that of the camera viewing screen; within the sketched area, mark out the placement of the subject each time you make a flash exposure. You can make as many exposures as the area of coverage permits, but you should strive for a pleasing layout. Ordinarily this technique is used in trick photography when you want two, three,

or four replications of the same person talking to himself, but you can apply it more creatively. Each exposure can be distinct and uninfluenced by the others made before it, or the images can overlap, appearing transparent where this occurs. This is typical of stroboscopic flash sequences as described under special lighting equipment in the chapter on artificial lighting. The flash unit automatically sets off a series of closely spaced bursts of light, each of which lasts about 1/10,000 sec. A moving subject, therefore, is seen as a series of overlapping images.

Whether you make individual flash exposures or use a stroboscopic flash, you must work at very low light levels that will not register discernibly on the film. This is not too important when you have a black background, but other objects or props within the field of view will register progressively while the shutter is open.

Ghost images can be recorded by having a higher level of prevailing light register on the film during a predetermined interval of time while the shutter is held open. Moving people and other objects will record as blurred, ghostlike images with a sharp, action-frozen rendering of the main subject made with the flash.



Combination of selective non-focus and Crostar taken against sunlight. 200mm lens, 1/60 sec. Francisco Hidalgo.

Control of Effects Through Shutter Speeds

The creative goal is to achieve contrast between the main object and its surroundings by having one blurred and the other sharp. The slowness of the shutter speed is relative to the pace of action to be recorded. A hand-held exposure calls for a relatively brief shutter speed that would be insufficient to stop the action of a fast-moving subject. If a very slow shutter speed is used, beyond the limits of hand-held technique, a tripod or other solid support will be needed. An example of pictorial effect is a football player, running with the ball, who appears as a blurred image on a sharply recorded field. The same effect might be achieved with a racing car. And so on.

The reverse of this procedure is called *panning*. In this case you follow a subject moving rapidly across your path of vision and, at a critical moment, make the exposure. Since the camera is in motion while you are pivoting, the background is blurred, but the action of the main subject is stopped.

Other ways of using slow shutter speeds result in total blurring of the image. A familiar example is the use of zoom lenses at slow shutter speeds. This technique, explained more fully in the chapter on lenses, calls for a tripod support while the lens is zoomed in or out. Only a single central point will appear relatively sharp; all else will seem to explode away from the center.

With suitable subjects, particularly architecture and geometric forms, a directional blur can be achieved by using a relatively slow speed, such as 1/8 or 1/4 sec., while moving the camera upward or downward in a single steady motion. The shutter button should be released just after the camera has been started on this vertical sweep. You can also experiment with "B" exposures, but you must cultivate a fine sense of timing, which will enable you to press and release the shutter while the camera is in motion. Another experimental technique is to mount the camera on a tripod equipped with a panhead, which is swung around in a single horizontal movement while the shutter is fully open. For easier or better control in this case, you may want to have a cable release positioned for use with the same hand that turns the panhead.

Prismatic and Optical Effects

This group of techniques involves the use of optical materials in front of the lens or attached directly to it to achieve multiple-image effects or distortion. Included in this group of techniques is the use of prismatic, multi-image devices that attach to the lens, split-field close-up lens attachments, transparent lenticular materials, water lenses, diffraction gratings, and multi-lensed thermoplastic sheeting, which can be used to create interesting moiré effects. The ingenious photographer will find other optical materials with which he can achieve new or varied effects.

Multi-image effects are achieved very easily with clear, multifaceted prisms that attach to the front of a lens through use of adapter rings—52mm or 55mm for most of the Rokkor lenses. These prismatic devices are usually standardized in series VII and VIII sizes. Typically, these prisms yield three or five images, which can be composed as desired on the viewing screen of the camera. The prisms usually can be rotated so that you can observe and record various positions of the multiple images. This rotation can be performed while using a slow shutter speed, which produces sharp central images with blurred secondary images. The distance between each of the images is governed by the focal length of the lens in combination with the *f*/stop at which the exposure is made; hence, to observe the effect, you should depress the depth-of-field preview button before making the actual exposure. Generally, no change in exposure is needed, although this must be subject to your own experience.

Multifaceted prisms are available from most well-stocked camera shops and by mail from sources advertised in camera fan magazines. A leading line is the series of Spiratone Multimage Prisms, which are available in three different patterns: the 3P, which produces three images of a subject aligned alongside each other; the 3C, which yields three concentric images; and the 5C, which produces one central image surrounded by four secondary ones. All of these can be rotated as described above, but only the 3P and 5C yield sharp central images when turned during exposure.

Lenticular materials have numerous built-in lenses, usually of glass or plastic, with non-photographic applications. For example, some drinking glasses have molded bases consisting of small lenses. When you hold one of these up to your eye, you can see each of these lenses gathering its own image of the object or field in front of it. This cluster of images can be recorded by the camera if a suitable close-up technique is used. Another common lenticular material is the light-gathering grid of an exposure meter. You might salvage one from an old exposure meter. You can also find surplus grids listed in the catalog of the Edmund Scientific Company, 101 E. Gloucester Pike, Barrington, N.J. 08007. Edmund Scientific also sells a Fresnel-lens group-





Francisco Hidalgo, who rarely uses a tripod, likes to experiment with slow exposures and a moving camera. The picture of Big Ben in London was made by moving the camera downward during the relatively long exposure of 1/8 sec. 135mm lens, f/16, Plus-X. The action of the monocled actor in Nazi uniform was made with the standard 58mm f/1.2 lens with the camera held stationary but the subject moving during an exposure of 1/15 sec., f/8.

ing embossed on a plastic sheet. Owing to the special optical properties of the flat Fresnel lens, it appears to have the same light-gathering and image-producing attributes as an ordinary magnifying lens when you hold it in front of you. The Edmund material (Fresnel Lens with 25 Images, No. 60511) is a 7¾″ x 10″ sheet containing 25 embossed Fresnel lenses. When you hold the sheet in front of you, 25 images of the same subject appear; each image is slightly different because of differences in the point of view.

A pattern of water lenses can be made with screen materials held vertically in front of the subject: Simply pour water from above onto the piece of screening so that each little square is converted into a small water lens. Photograph immediately.

The particular close-up technique that you should use will be governed by the size of the lenticular area to be covered as well as by the size of each of the lenticular units. Thus, to photograph the Edmund Fresnel-lens sheet, you can use most Rokkor lenses, because at their nearest focusing distance they approximately cover the equivalent of a sheet of letter paper. To photograph the more conventional lenticular materials, use one of the Macro Rokkors or one of the other Rokkor lenses with close-up lens attachments or extension tubes. If the camera is mounted on a tripod, you can hold small pieces of lenticular material, such as meter grids, between thumb and forefinger while you move the grid in and out to achieve the best focus. This calls for a well-coordinated effort, during which you release the shutter at the moment of sharp focus. It might be much simpler to attach three or four stiff wire supports to the sides of the lenticular material and tape the other ends of the wire to the front rim of the lens mount. The Macro Rokkors are ideal for this purpose. They are also very useful in photographing fine-screen water-lens configurations. The finer the screen, the greater the enlargement

needed; hence, it might be best to use slower films, whether black-and-white or color, because these yield finer grain and better edge sharpness.

Water drops alone can also be used as image-gathering devices and subjects. Droplets suspended from a twig, a flower, a spider's web, or even a medicine dropper all can be photographed at very close range to release their tiny bundles of optical information.

A journey through the Edmund Scientific catalog (available free upon request) will reveal to the imaginative photographer a great variety of optical and other materials that can be used to attain creative effects. For example, there are the multilensed thermoplastic sheets, which have 10,000 parabolic lenses molded into each square inch—a pattern of 100 × 100. When you hold two separate sheets together and rotate them, you can achieve innumerable effects consisting of neatly ordered rows of lenses of different sizes or of elongated lenticular distortions. One use might be to superimpose a particular pattern over a color slide, either for projection or for slide duplication. The same can be done in conjunction with black-and-white and color negative materials when you make prints in the darkroom. Other types of moiré material are available from Edmund, which also offers a book entitled *The Science of Moiré Patterns.* Then there are the diffraction gratings that break up light prismatically to yield fascinating rainbow effects. These gratings, which are best used with color films, are attached to the front of the lens.

The split-field close-up lens is a recent comer to the photographer's gadget bag. This is a close-up lens attachment of ordinary configuration, but half of the attachment is a curved meniscus lens, whereas the other half is made of clear, optically flat glass, which is not intended to affect the photographing of the subject. Close-in, or foreground, objects as well as more distant objects are rendered sharply. In effect, the split-field lens is a depth-of-field stretcher. These lens attachments are available in different dioptric strengths ranging from about +½ to +3. They attach to the camera lens through intermediate screw-in adapter rings.

Of course, there will be a split line, which is really not a line but a separation between the two halves of the image area. How the split shows up—usually as an area of softness—depends on how you position the subject within the viewing area and on how you position the attachment. Different effects can be attained with lenses of different focal length and attachment lenses of different dioptric strength. These attachments are not really suitable for use with strong backlighting. Also, as explained in the chapter on close-up photography, simple meniscus lenses such as these should be stopped down to about *f*/11 or *f*/16.

Color Filter Effects

The standard guidance on the use of filters with color film is based on the assumption that you want to attain pleasing, normal color rendition. For interesting mood pictures with color film, you could use color filters primarily intended for black-and-white film or color correcting filters to accentuate cool or warm tones.

A light-tinted color filter gives a more pronounced effect to corresponding color areas within the scene without completely obscuring other colors, which become slightly contaminated. The overall effect achieved with deeply colored filters is most pronounced when red or blue filters are used. Red filters impart a flaming hot or fiery mood to a scene. Dark areas tend to appear as black, and strong highlights tend to burn in as orange, gold, or yellow spots.

Blue filters impart coldness; they can create a somber or eerie feeling. You

can experiment with blue filters ranging from light to dark. A light blue filter imparts an overall coldness. Dark blue filters can simulate moonlight.

Although you can experiment with yellow and green filters, they do not come through quite as positively as red and blue. Moreover, yellow mixes with the blue sky to render it an uninspiring, muddy green. A green filter, being in itself a mix, tends to have a degrading, non-esthetic effect.

With black-and-white film, red and blue filters can be used to get extremely impressionistic results. A deep red filter darkens the sky almost to the point of blackness, setting white clouds apart in sharp contrast while imparting to green foliage a silvery look suggesting moonlight. Red objects tend to come out very light. With a deep blue filter, objects of the same color are rendered almost white, whereas red, orange, and yellow are rendered progressively in very dark to gray tones. A deep blue filter also contributes a murkiness or foglike effect to daylight scenes.

REFLECTIONS

The mirror on the wall has been a long-standing prop in photography, for it makes it possible to reveal both the front and back of a subject. Such a use is straightforward. On the other hand, image reflections from other surfaces are usually avoided when they introduce confusing or distracting elements; however, interesting effects can be achieved with these secondary and ordinarily unwanted reflections from windows, curved silver objects, chromed automobile fixtures, water surfaces, and so on. The beginning point is an understanding of how mirror reflections are brought into focus.

Mirror Reflections

When you focus on an object visualized through a mirror, the distance setting on the lens must take into account the combination of the separate distances of (1) the subject from the mirror and (2) the mirror from the camera. Thus, if the subject is two feet away from the mirror and the camera is five feet away from the mirror image, the focusing distance will be seven feet. Since depth of field is limited when you work close to the subject, the mirror frame and surrounding wall could be out of focus while the mirror image is in sharp focus. On the other hand, if you should focus on the mirror frame itself, the objects reflected as mirror images could be out of focus. Hence, when taking pictures of mirror images. you will tend to use smaller lens apertures in order to have a depth of field within which both the foreground and the mirror image will appear sharp. On the other hand, the demands of creativity in a particular situation could call for more selective focusing on either the foreground or the mirror image.

Multiple image effects can be achieved when two or three mirrors are placed upright, edge to edge, at angles of less than 180° and the subject placed within the mirror enclosure. Both the subject and the camera must be positioned by trial in order to obtain the desired multiple imagery.

Semi-Optical Effects

Interesting image-gathering properties are exhibited by curved reflective surfaces of various kinds, such as the mirror-like surfaces of some sunglasses, the inner and outer surfaces of polished silver spoons, the chromed ornamentation on automobiles, and a diversity of



ornamental glassware. These act as light-gathering devices, like lenses, and depict images in miniature. In these cases, the focusing distance is from the camera to the surface of the semi- or pseudo-optical source. You must be careful to position yourself so that you do not pick up your own reflection as well as that of the camera, unless you deliberately intend to make such a self-portrait.

The most convenient arrangement is to use one of the Macro Rokkor lenses, although you can use other combinations of lenses and attachments or extensions to get closer to the reflective surface in order to record it in enlarged detail. Depth of field is not a problem here unless you want to show foreground and background objects in reasonably sharp focus.

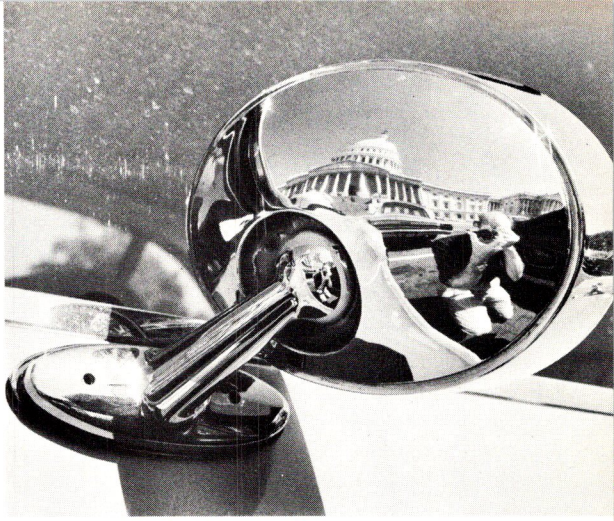
Water Reflections

The surface of water makes an interesting subject under varied conditions. Ordinarily, if you want to record the texture of water, particularly when it is studded with small whitecaps, the most dramatic effects are achieved with the camera facing the light source. This causes the backlighted whitecaps to record impressively as white dots. A

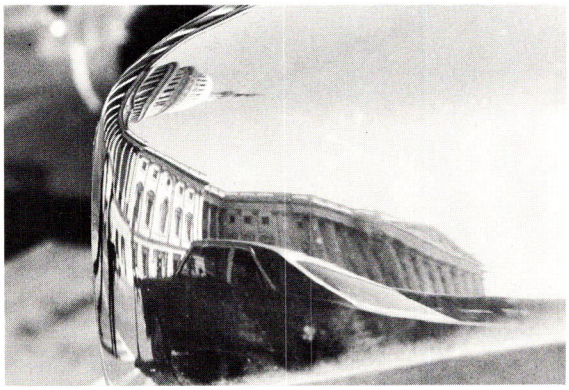
Above, multiple image of store window display made with prismatic lens attachment. Note mottled image of photographer reflected in window. 135mm f/2.8 lens, 1/8 sec., Tri-X. Francisco Hidalgo. Below, the 135mm f/2.8 lens was focused in two zones during the same exposure. The first exposure was at infinity for the background for a period of about 1/4 min. The lens was then rotated forward for another 1/4 min. in order to present the street lamps as round blobs of light. At f/22. Bob Collins.







Reflections from metallic surfaces and from lens-shaped glass are focused upon as though the distance of the image is from the reflective surface to the camera. Unusual shapes of the U.S. Capitol are recorded here. Macro Rokkor 50mm f/3.5 lens. Joseph D. Cooper.







Reflection of nude in metal sculpture of William Pye. Standard 58mm f/1.4 lens. Graham Finlayson.

fairly slow shutter speed helps dramatize the scene, and a lens hood helps avoid the direct rays of sunlight.

You can get a more interesting effect, especially with color film in your camera and an original subject to provide the color configuration, when you photograph the reflection of an above-water structure. If the water is rolling only slightly, so that it is not really turbulent, the original subject will reveal itself in a pattern of interesting distortions. You might decide to cut out the above-water subject during picture-taking or during display, in which case you would orient the water line toward the bottom. The effect is of a distorted building, tree, or other structure with its outlines and patterning governed by the movement of the water. For such pictures you need to find the best combination of shooting height and camera position relative to the subject. Sometimes, from a very high camera position, you will obtain very interesting geometric patterns of color influenced by the quality and direction of the light source. An oil slick on the water surface, made prominent by the lighting source, might contribute a "polluting" effect of some artistic interest.

The exposure for water reflections will vary according to the lighting. You should make an independent exposure reading in each case. In some cases, the exposure settings for the water reflection will be almost the same as those for the original three-dimensional subject.

When making close-ups of miniature, table-top subjects, you can use mirrors to simulate water; however, you need to construct a suitable shore line, and some realism can be lost if the surface of the water appears too placid. A light sprinkling of salt, with proper spacing of the particles, can simulate the presence of whitecaps.

Water puddles on the ground can also be used as sources of reflection. When the rain has stopped, you might observe interesting image formations, which reveal the full details of their

originals. The size of image detail will be governed by the distance of the original subject from the water puddle and by its distance, in turn, from the camera. The focal length of the lens will have a bearing on size. The focusing and depth of field problems are the same as those you will encounter when taking pictures of flat, mirror images.

Windows

When window reflections are not desired, they can be minimized or eliminated with polarizing filters, as described in the chapter on exposure. Otherwise, window-reflection images can be photographed creatively in accordance with the techniques for mirror photography. An important difference, however, is that a window can act as either a one-way mirror or a two-way mirror, depending upon the lighting ratios between the inside and outside sources and upon the angle of reflection on the side of the window facing the camera. If you are facing directly toward a window from the outside—say a shop window—you will have maximum pick-up of the interior scene when the illumination level is most brilliant on that side of the glass. If the interior is darker than the outside, the image of the latter, reflected from the outer surface of the glass, will dominate. Keeping these simple rules in mind, you can experiment with both daylight and nighttime window reflections.





"Framing" a reflection in a mirror was one of the earliest of photographic tricks. Focus on the image rather than on the mirror surface. For measuring purposes, the distance is from camera to mirror surface to subject. Above, live subject is sharp as is mirror frame, but mirror image is out of focus. Below, mirror image is sharp but live subject is soft. 58mm lens, Tri-X. Joseph D. Cooper.

SPECIAL-EFFECT FILMS

The special-effect films described here are listed in the tables in the chapter on exposure. These cover both color and black-and-white effects.

Infrared: Black-and-White

Infrared illumination is a radiation source beyond the red range of the visible spectrum. The photographically useful infrared wavelengths are found in the range of 760 to about 1350 millimicrons with a concentration mainly in the smaller band widths of about 768 to 860 millimicrons. Conventionally, infrared black-and-white films are used with artificial sources of infrared radiation, such as special infrared flashbulbs

for surveillance and detection work. The focusing distance, as explained below, is set manually on the lens and a flash picture taken of an intruder. The picture may be taken automatically, as when an intruder intercepts a beam and triggers off a mechanism that makes the exposure—a use for which a motorized camera is ideal. The picture can also be taken by the photographer himself. The results will not be of portrait quality, but then, that is not necessary in surveillance photography. When a face is recorded on this type of film, the face will appear pallid, vein structures close to the skin will be apparent, eyes will appear black, and lips will be pale gray. Infrared black-and-white films are used in document detection to reveal messages that have been otherwise obscured. These films are also used with contrast-building red filters in long distance photography to penetrate watery haze.

In pictorial photography the more creative uses are in achieving striking landscape effects and in simulating moonlight. The ideal components of a striking infrared landscape in black-and-white are: green foliage, which will be rendered white or very light; blue sky, which will be rendered black; and white clouds, which will appear even whiter by contrast with the darkened sky. Water bodies that reflect blue sky will also appear black. Coniferous trees and shrubbery will, however, reproduce darkly, even though they are green in their natural state. When all of these elements are present, they create the impression of a moonlit landscape. You can still achieve striking effects, without the moonlit aspect, if you do not have a deep blue sky.

The two key technical factors in black-and-white infrared photography are the proper use of filters and the making of an adjustment in focus because infrared radiation requires that the focusing distance be shifted forward slightly.

When you take pictures in full or near darkness and use special infrared flashbulbs, numbers 5R and 22R, no filter is needed. With all other light sources, a filter must be used in front of the lens. When only infrared radiation is to be recorded, a Wratten filter No. 87, 88A, or 89 can be used. These filters are an extremely deep red. For general photography any deep red filter can be used to achieve most of the desired pictorial effects under daylight illumination. If a deep red filter is not used, the blue and green light, to which the film is also sensitive, will be recorded.

To focus, determine beforehand the distance for which the lens must be ordinarily set and then shift the focus by using the infrared index mark opposite the desired distance. This is most critical when you work at close distances and at wide lens apertures; it is less important as you approach the infinity distance setting and as you use smaller lens apertures for greater depth of field.

Exposure settings must be determined by rule of thumb and through precautionary use of the exposure-bracketing technique—one best-guess exposure, one with twice the amount of light, and one with half the light. Exposure meters cannot be used, since they are not sensitive to infrared radiation. Some guidelines will be found in the package insert accompanying the film. Development for normal use may be done in a standard developer such as Kodak D-76; for greater contrast Kodak D-19 or the equivalent may be used. Literature on the use of black-and-white infrared films may be obtained by writing the Eastman Kodak Company, Rochester, N.Y. 14650, attention the Professional Commercial, and Industrial Markets Division.

Infrared Color

For the modern psychedelic look, you might have a go at using Kodak Ektachrome Infrared Aero film. This film, originally designed for aerial use in



Big Ben photographed *through* the window panes. Each pane provides its own refractive index and distortions. The slight double image results from two superimposed panes of glass. 135mm, *f*/4, 1/30 sec., Plus-X. Francisco Hidalgo.

camouflage detection, is sensitive to ordinary blue, green, and red as well as infrared. When this film is used for military surveillance, it records live green chlorophyll-laden foliage as red, whereas objects painted or dyed green for camouflage purposes are recorded as purple. When surveillance film is developed, it makes deception conspicuous. The film also has horticultural and botanical uses and is very important in medical photography. It has attracted the attention of adventurous, experimental photographers who wish to indulge their flair for the dramatic, the weird, or the way-out forms of pictorial expression.

When this film is used without filters, unusual reversals take place in the rendition of strong subject colors: A strong or dominant blue becomes red, red changes to yellow, and yellow is rendered blue. When the subject's original colors are exposed to either ultraviolet or infrared radiation, either will cast its own influence. A picture taken without a filter in the open shade, on a bluish day, or when blue sky light is reflected onto the subject by snow or water, would be rendered a dominant red.

When a deep yellow filter is used, as Kodak recommends, green will be rendered blue, red will be rendered green, blue sky will be rendered blue, and white clouds will be rendered white. Skin tones will wander all over the color spectrum, because there is no standard skin tone or coloration, regardless of racial characteristics.

The Kodak recommendation for a deep yellow filter is the Wratten No. 12. If you have difficulty obtaining this filter, the next best choice is the common G (Wratten No. 15) filter, designed primarily for use with black-and-white film. Some photographers prefer an orange filter for more pronounced effects. The medium-red filter—the Wratten No. 25, the Minolta red filter for black-and-white, or the common A filter—will render blue sky and blue sea as green, whereas white clouds will be rendered yellow. Green foliage will appear red-orange; shadows will be greenish.

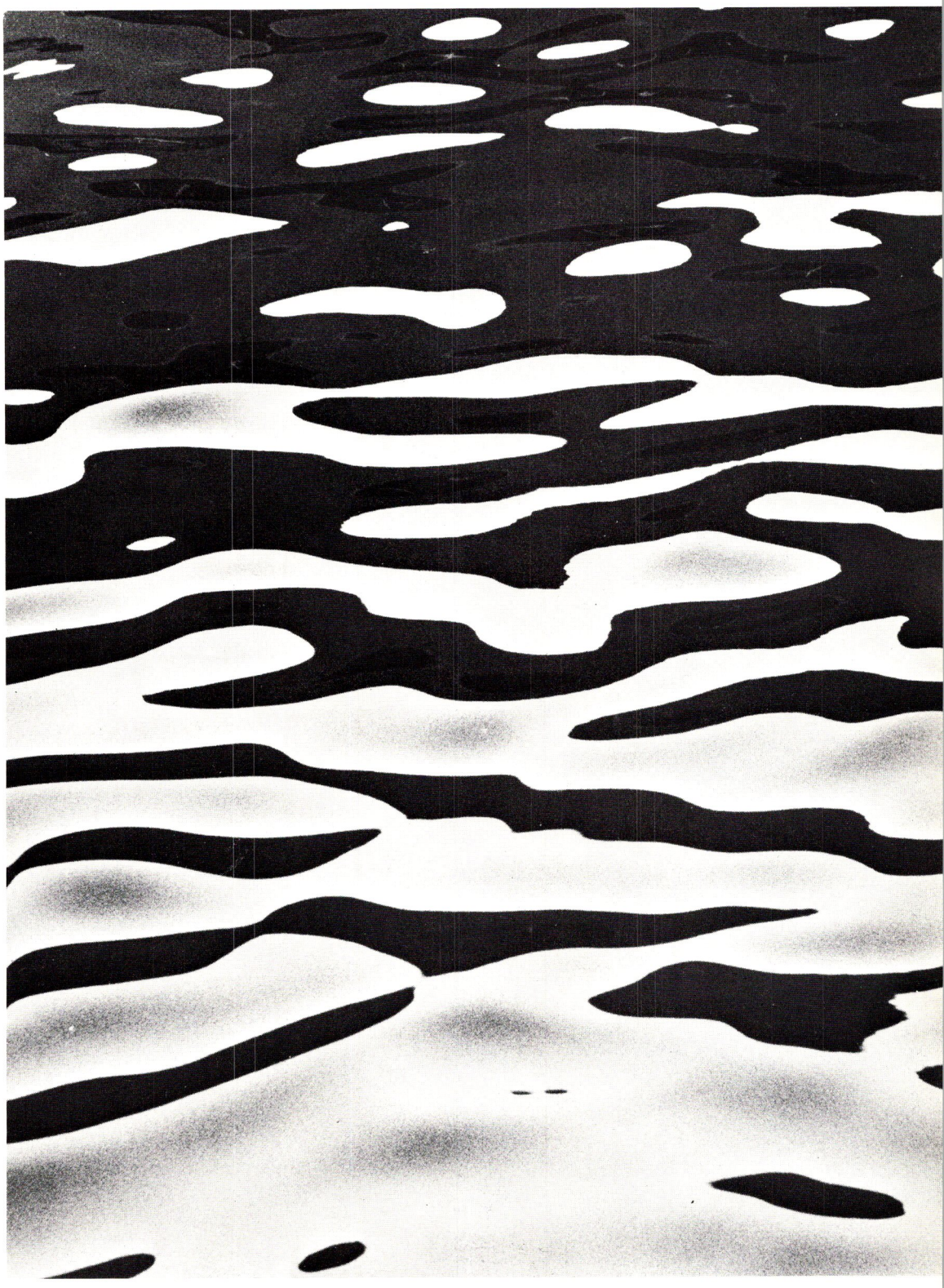
If you wish to adhere as closely as possible to reality—at least for some anchor colors—use a green filter, for it will render blue sky and blue sea as blue. Cloud coloration will veer toward magenta. Green foliage will be rendered red. (Effects of color filters with dyed hair are unpredictable, because of the variation in the chemical constituency of the dyes used.)

Exposure must be judged by rule of thumb. The Kodak recommendation, based on the use of a deep yellow filter, is for a meter setting of ASA 100, but this is only a point of departure, which depends upon the intensity of the light, the time of day, and other factors influencing the quality of the light. As a rule, you could start with an exposure of 1/125 sec. at *f*/16. Because this film has a relatively narrow latitude, you might wish to bracket three or four exposures. Another guide to exposure in bright sunlight, without any filter, is 1/1000 sec. at *f*/11 or 1/500 sec. at *f*/16.

Although the Eastman Kodak Company does not process this film, you have a choice of using independent laboratories or developing the film yourself with Kodak Ektachrome E3 or E4 processing kits.

Black-and-White Variations

You can obtain a black-and-white reversal print by using Kodak Panatomic-X film, provided that this film is developed as positive transparency material. When the film is so developed, it will be suitable for screen projection as a direct positive black-and-white picture, but if you use this positive transparency to make a black-and-white print, the result will be a complete reversal of



Water reflection at Brasilia as an abstraction. 100mm, *f*/16, 1/250 sec., Plus-X. Lucien Clergue.



Nude on the beach. Turn page around for another view. Backlighting with sun obscured by head created halo effect. Macro Rokkor 50mm. Lucien Clergue.

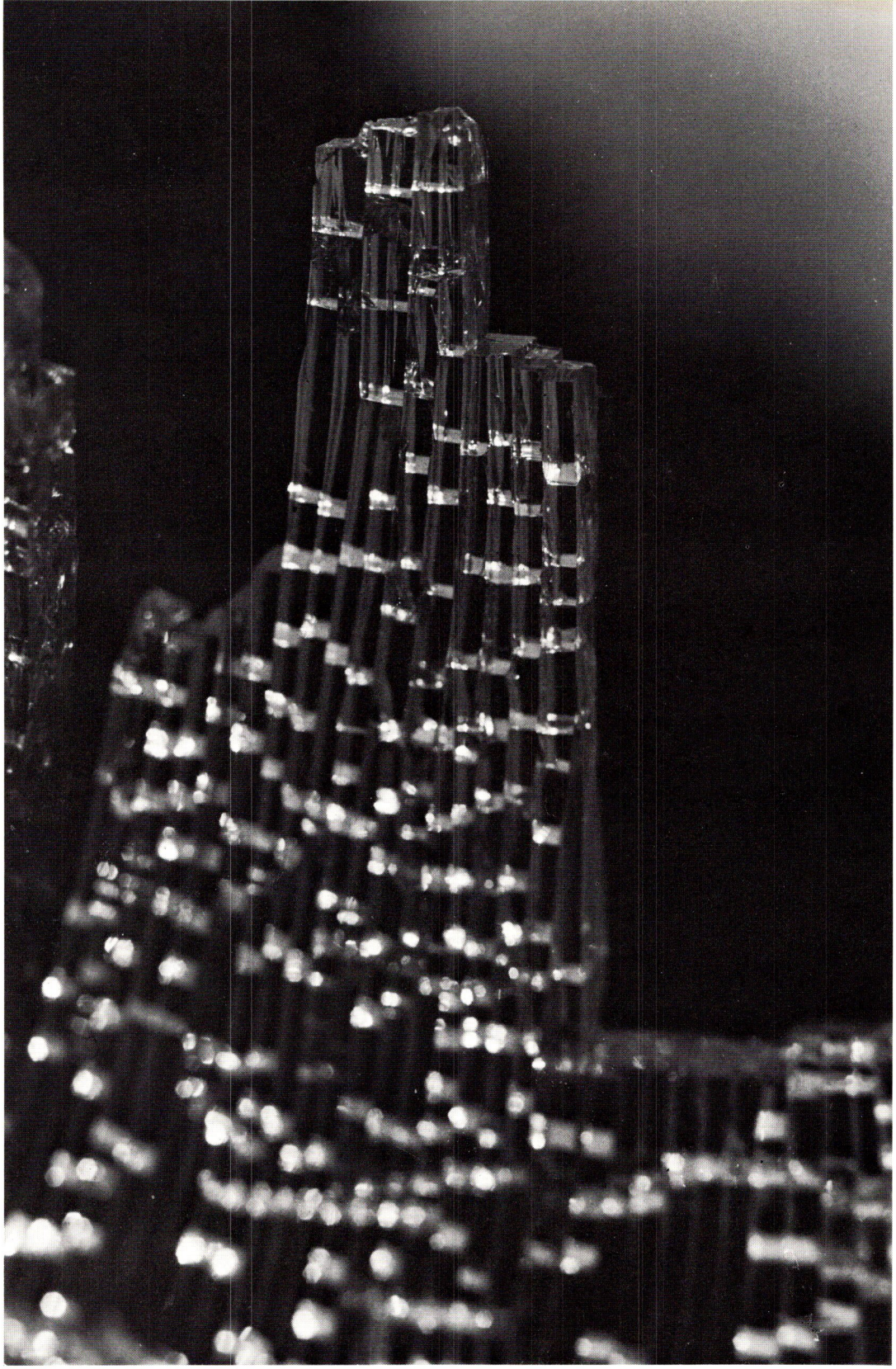
tones: White will be rendered black, and *vice versa*, whereas middle gray will remain the same. Used this way, Panatomic-X should be exposed at ASA 80. You will need to purchase a Kodak Direct Positive Film Developing Outfit, which includes complete processing instructions.

You can achieve the same effects by having a photofinisher make black-and-white copies of suitable black-and-white negatives already in your film files. Since a double negative means a positive, you can use the latter for making a negative print. Photographers who do their own darkroom work or are willing to have custom processing done can have black-and-white negative prints made directly from color slides or transparencies simply by printing them on enlarging paper. Kodak Panalure paper is marketed specifically for making black-and-white prints from color films.

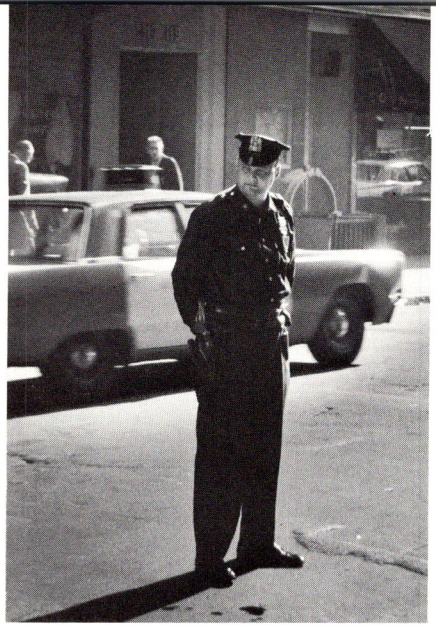
Another black-and-white variation is the use of a high-contrast copy film, such as Kodak's, with ordinary, continuous-tone subjects. Since this material is designed to copy black-and-white line subjects, the effect with ordinary subjects is to drop out middle tones. Especially when the developed negative is printed on a high-contrast paper, such as Agfa No. 6, the effect can be similar to that of a line drawing. Although this technique is suitable for initial exposure in the camera at an experimental rating of about ASA 24, a preferred method of achieving the unusual effects is to use a continuous-tone negative as the original and print it on high-contrast sheet film in the darkroom, as explained below. The latter method allows you to retain the original negative for standard continuous-tone printing.

Grain Textures

Although the usual aim in black-and-white and color photography is to achieve fine-grain pictures, a creative



Fragment of glass in automobile door. The dark background was achieved through selection of just the right angle of view. 58mm *f*/1.2 lens, *f*/16, 1/30 sec., Plus-X. Francisco Hidalgo.



The policeman's head (below) is a grain derivation from the paper print opposite. The original showed the policeman standing full figure in the street, taken with a 135mm lens. Then, with the 58mm *f*/1.2 lens mounted on a bellows, the head alone was reproduced and blown up again for the grainy effect. Francisco Hidalgo.



variation is to use graininess to provide pictorial impact. This can be done either by using an ultra-high-speed film with inherent graininess or by extreme magnification of the film image. The latter method offers some advantage in preserving the film for ordinary use, but it tends to be cumbersome.

The choice of subject is important. You would not want to use a very grainy film when fine details in the subject must be clearly delineated. Large blocks of middle-tone areas are preferred, especially when the subject matter suggests strength, movement, and other dynamic properties.

CREATIVE DARKROOM TECHNIQUES

The several techniques touched upon here require that you have access to a darkroom. The procedures are really quite simple, although they call for some experimentation. The techniques covered include tonal dropouts or derivations, solarization, texture-screening, and sandwiching.

Tonal Dropouts or Derivations

The term *tonal dropout* is used because it correctly describes the process and effect of using an ordinary continuous-tone picture and reproducing it so that it yields a high-contrast print with the appearance of an artist's pen-and-ink drawing. The original can be a black-and-white negative or a color slide. In either case, the best subjects are those that are inherently contrasty, including sidelit and backlit subjects, architectural subjects, seascapes, snow scenes, and others.

Assuming that you start with a color slide that meets the desired criteria and is otherwise of artistic interest, you must enlarge this slide through projection onto a sheet of graphic arts film such as Kodalith, a material commonly used for this purpose, although it is primarily intended for high-contrast line-reproduction work. This film is available from graphic arts dealers or on special order from camera stores. One technique is to make the enlargement on a sheet of 4″ x 5″ Kodalith for projection in an enlarger; another is to project the original color slide onto a sheet of 8″ x 10″ Kodalith for subsequent handling in a contact printer.

The Kodalith print made from your color slide, which is a positive, in turn becomes a negative. The latter must then be printed onto a sheet of high-contrast enlarging paper in order to achieve the pen-and-ink drawing effect. If you use a 4″ x 5″ sheet of Kodalith, you can project it onto the enlarging paper, which can be any size, provided you have an enlarger that accepts 4″ x 5″ film. Alternatively, you can make a contact print on high-contrast enlarging paper either with a contact printing frame, a regular contact printing box, or an improvised contact printer, which consists of a sheet of heavy glass, with turned edges, placed on top of a sandwich composed of the large Kodalith negative and a sheet of printing paper. A simple contact printing frame or the improvised one can be used with the projected light from the enlarger as the source of exposure.

When you make both the Kodalith negative and the final positive print, standard darkroom procedure is to use test strips experimentally to find the correct exposure. Details on developing Kodalith are included with the original film package.

If you start with a black-and-white negative, the first step is to make a Kodalith print that, because it is a positive, must be contact printed again to derive a Kodalith negative for further printing onto paper.

One variation of this technique is to combine it with the use of a coarse-grained original subject. Another variation is to make a positive Kodalith master, 8″ x 10″, from a suitable black-and-white negative and then make contact prints on colored diazo film. Diazo film, used in the graphic arts industries, is a transparent sheet material that is contact printed with a high-contrast positive or negative to produce a duplicate image. Thus, if you make a print on diazo film from a Kodalith negative, you will get a diazo negative duplicate. For this reason, your Kodalith master should be a positive, unless you deliberately seek a negative effect.

Diazo film must be exposed to strong ultraviolet light and developed in ammonia. If you have access to a diazo printer and developer, you are in business. Otherwise, you can use bright sunlight as your source, and base your exposure on trial and error. When exposing in this way, you might start with a minute and work up or down from that. A contact printing frame will be needed. The film sandwich inside the contact printing frame consists of the Kodalith master, emulsion side facing the diazo sheet, which in turn is placed on the sheet of foil furnished with diazo film.

To develop, suspend the diazo film over household ammonia in an enclosed tank. Development is accomplished by the ammonia fumes. This may require two to three minutes, depending upon conditions influencing the rate of evaporation.

As you familiarize yourself with these various graphic arts materials, you will find yourself experimenting with different combinations to produce an infinite variety of striking pictorial effects.

Pseudo-Solarization

The technique of pseudo-solarization, or *solarization*—it is sometimes called the *Sabattier effect* after its discoverer—involves the brief introduction of light during development of a negative or print, which causes a partial reversal of tones. Here again, the creative technique is the utilization of what ordinarily would be regarded as an error. Dr. Armand Sabattier discovered the effect about 1850 when he accidentally exposed some photographic plates to daylight while they were still being developed. When he examined his plates after development had been completed, he found that a positive image had superimposed itself upon the negative image. Incidentally, Sabattier was a physician and scientist as well as a photographer. Only in this century, and particularly as a consequence of the great interest in psychedelic display, has the Sabattier effect become popular. The Sabattier effect can be achieved with either color or black-and-white film. Mastery of the latter is recommended, however, before you attempt color manipulation.

In black-and-white photography you can solarize either the original negative or the derivative print from a normal negative. The safer technique is to manipulate the print rather than the negative so you do not risk irretrievable failure if you should fail to get just the right combination of development and exposure. The three key control elements in solarizing the print, as well as in solarizing film, are (1) determining how long initial development should proceed before the light-flashing takes place, (2) determining the duration of the light-flashing for the light source at its particular distance from the photosensitive material, and (3) determining how long subsequent development should go on before fixing and washing take place. All of this you must work out by trial and error for the kinds of picture you take, your working conditions, and the effects you desire.

One technique with black-and-white paper is to stop development as soon as all of the important features have

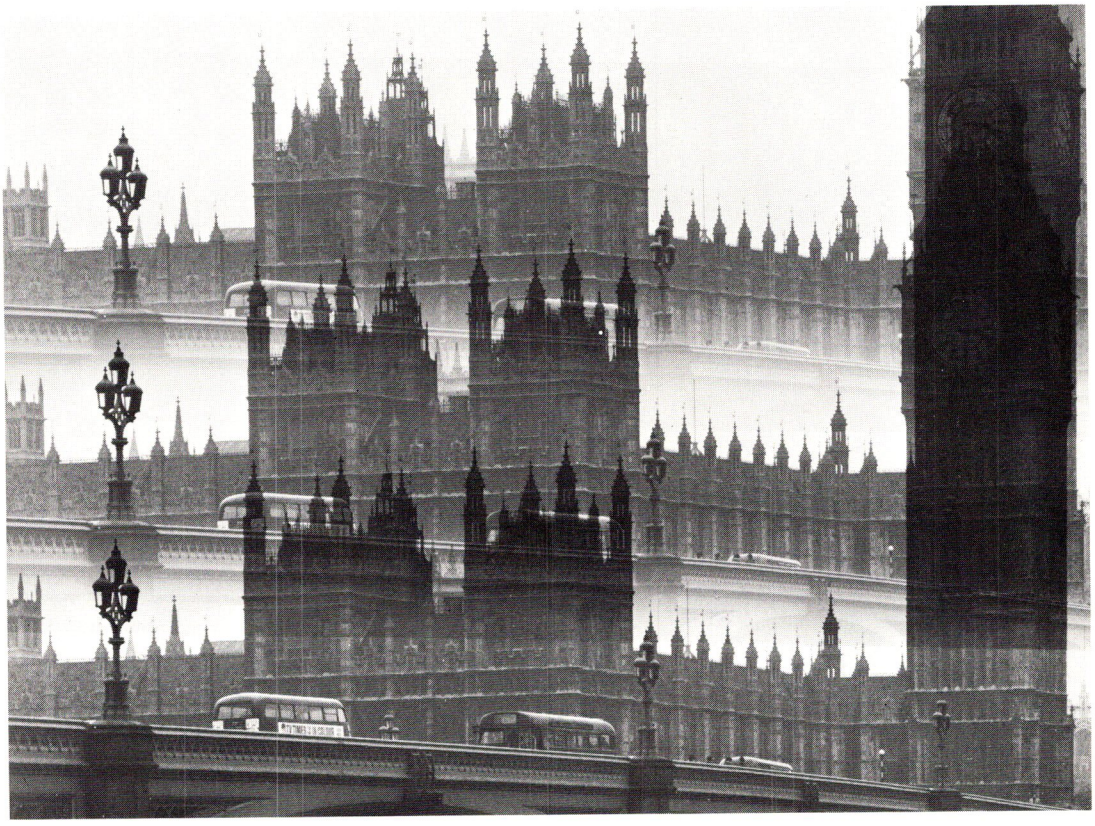
become visible. The print is then rinsed in clean water, light-flashed, and transferred back to the developer. A variation of this is to flash the print for a few seconds, or less, in a tray of weak, diluted, or depleted developer and continue development until the desired results are achieved. Then the print is fixed, washed, and dried. The creative artist can add color with brush, pen, crayon, or felt-tipped markers.

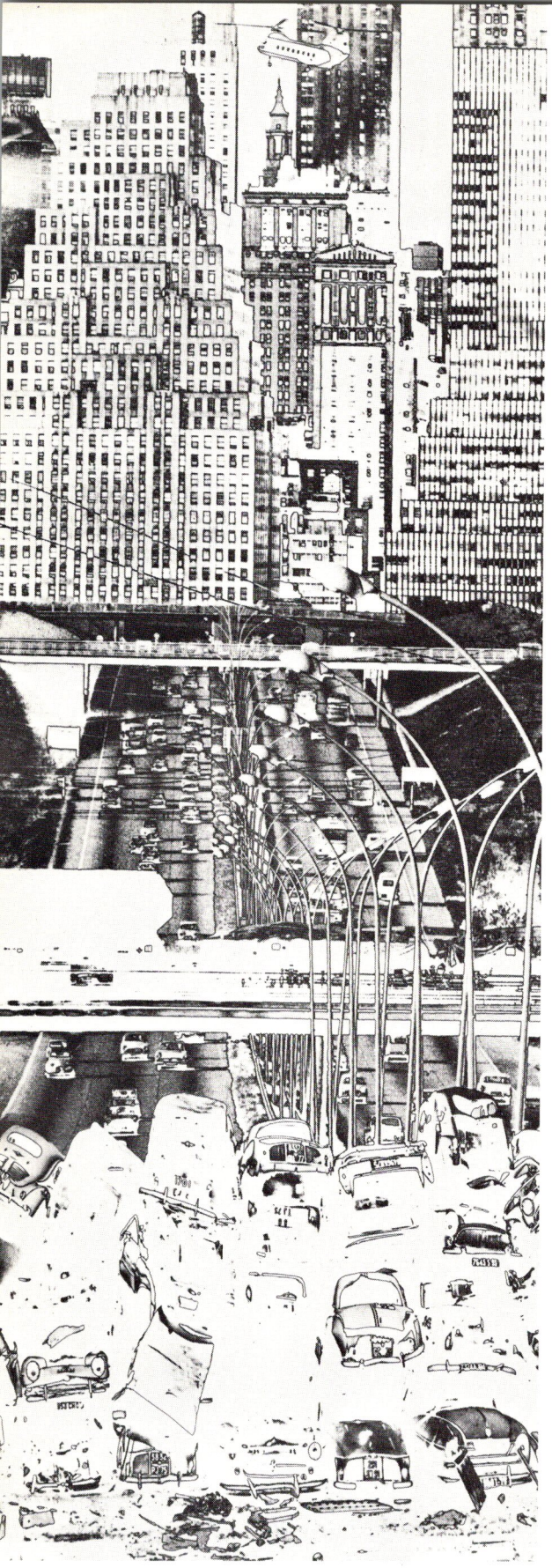
The film-solarization technique using the original black-and-white negative is to stop development after one-half the normal time, rinse the film, re-expose the film, redevelop the film for the remainder of the normal development time, or less, and complete the fixing, washing, and drying stages. Theoretically, the total development time is the same as that for normal development, but you might find it better to slice a little time off the second development stage. There are many variations of the black-and-white technique. One of them is to print from the original negative onto Kodalith and to proceed from there toward the eventual production of a black-and-white paper print or to proceed further with diazo color duplicates, as described earlier.

Texture-Screening

The original texture-screening technique was popularized by William Mortensen, a master of pictorial control. A texture effect, printed on film, was placed in contact with a sheet of enlarging paper and followed by the projection of the image onto this sandwich. The developed picture combined both the original image and its added screen. Screen effects have been used to simulate etching, linen, canvas, mezzotinto, fresco, and so on. A recent variation is the

Multiple exposures in the darkroom. Original picture of the Houses of Parliament was made with 135mm f/2.8 lens, f/11, 1/125 sec., Plus-X. Francisco Hidalgo.





manufacture of miniature texture screens, which are sandwiched with the original negative in the enlarger.

Apart from your preference as to where you want to exercise control over the final result, a key difference between the two types of screen is that the screen for paper, which is much more expensive because of its larger size, assures you that regardless of the degree of enlargement you will have the same size screening effect. This occurs because it has been superimposed by contact. When you use a screen with the negative, the size varies with the degree of enlargement; however, this might be an advantage if you should want to make big blow-ups for viewing at a distance.

A commercial source for these screens is Texturefects, 7557 Sunset Blvd., Hollywood, Calif. 90046.

Sandwiching

The technique of combining two color slides or one color slide and a solid color gelatin into one slide for projection or for use in the making of a color print is called *sandwiching*. The definition practically explains this straightforward technique, but there remain a few details to be mastered. One is that for slide projection the two pieces of film should be mounted emulsion facing emulsion; otherwise there might be a shift in focus from one plane to the other. You could have this problem when making paper prints as well, but by using smaller lens diaphragms, you can get greater depth of focus on the enlarger easel.

Lightly tinted color gelatins can be

Montage made of three photographs mounted in a long vertical panel and then photographed on Kodalith sheet film to drop out the middle tones. During development, an electronic flash was used to solarize the film. Francisco Hidalgo.

used to compensate for excessively warm or cool transparencies. More deeply saturated color gelatins can be used to achieve effects such as those described above in the discussion of the use of filters with color films.



The conventional picture at right was made from a color slide, keeping all tones in the original picture. Below is a print made from the same slide using a high-contrast film (such as Kodalith) as an internegative. This darkroom procedure produces prints that have the appearance of artists' drawings. Courtesy Eastman Kodak Company.





Straightforward use of store windows as mirror reflectors producing a set of matched images, providing some additional depth to this part of the small and unlovely town square in Helsinki. 55mm, f/11, 1/125 sec., Ilford FP4.

CHAPTER XI

People, Places, and Things

Most of this book is oriented toward general techniques for using the camera, lenses, exposure-metering aids, lighting, and auxiliary equipment. Here, we approach individual subjects for picture-taking and bring to bear relevant aspects of the use of camera and lenses. Discussions of lighting and exposure will not be treated here in detail. The reader should refer back to the pertinent chapters. This is particularly true in the discussion of portrait techniques, which should be read in conjunction with the chapter on lighting.

PEOPLE

People are the most common and popular of photographic subjects, especially if they are family, relatives, or friends. The discussion of people will center mainly around portraiture, but it will also progress through the recording of various stages of a child's growth and the photographing of parties and special ceremonies. The initial emphasis in this chapter will be on candid photography, for the 35mm camera has done much to make it possible to photograph people as they are, without affectation.

Candid Photography: The Pursuit of Realism

Candid photography is the recording of spontaneous, unposed human activity. The subjects should not be aware of the camera or, if they know they are being photographed, should be so at ease that they lose their sensitivity to the camera. Candid photography has for its subject matter people at work or at play or just simply involved in the business of living. It is people enjoying life or expressing pain or grief. It is street photography, parties, indoor events, and informal portraiture. It is spontaneity that comes naturally for little babies and most people under some circumstances, except when they are self-consciously aware of the presence of the camera.

Candid photography is something apart from surveillance activity in which secret cameras are posted to record events without the knowledge of the



Above, three horses waiting to be judged. Below, the old, familiar cry, "Get a horse," is implicit in this scene. Both with 100mm lens. Tri-X. Al Paglione.



subjects. It is not the invasion of privacy, even though one might say that this encompasses any picture taken without the knowledge or consent of the subjects. The dividing line, for our purposes, is one of good taste. It is the avoidance of the picture that might have value in sensationalism or public display to the embarrassment of the subject. In short, within the overall constraint of that important element of good taste, it is naturalness that includes the peaks and valleys of human emotion.

In the early history of 35mm photography the candid was relatively easy to take, because people were not generally aware of the immense capabilities of this small instrument with its powerful lens; moreover, the spread of the so-called *candid camera,* as 35mm cameras were tagged in the early 1930's, to the most remote corners of the earth had not yet taken place. The growth of tourism changed all that. The local people (I avoid the sometimes offensive word *natives*) in exotic places throughout the world may be expected to know what you're after when they see a camera suspended from your shoulder. They are almost certain to know what you're up to when you lift the camera to your eye. They know all this because people with cameras were there before you. This is why a special set of techniques is needed for candid picture-taking without the awareness of the subject.

The awareness factor should not be discounted. You can see it in the billions of pictures, sometimes called *Aunt Minnie pictures,* which show subjects standing or sitting in front of public buildings, monuments, tourist attractions, and other things that might in themselves be of pictorial interest. Always, the pose is the same: a stiffish awareness of the camera and a tightening of the body with some occasional squinting into the sun. Aunt Minnie might take the grand tour of Europe with Uncle Harry, and at every place they visit he will take a picture of her—always the same pose with the local attraction in the background—and she will take a picture of him in the same way. Sometimes they will manage to have a picture taken of both of them, either through the kindness of a stranger or through use of the self-timing device with the camera mounted on a tripod. Aside from the lack of pictorial imagination, these pictures interest no one but the subjects themselves. How much more interesting the pictures could have and would have been if they had revealed the spontaneous expressions and activities of the subjects while actually doing things in the course of their travels.

The main problem, even with an accommodating subject, is that when he becomes aware of the camera, he changes the situation. He is no longer engaged just in what he is doing: He is also trying to display himself to best advantage while at the same time trying to conceal any visual aspects of himself that he does not want recorded.

This awareness factor is minimal with babies and little children, but as they grow older, people tend to become more conscious of themselves in the presence of others. With adults who have devoted most of their lives to presenting and displaying themselves to best advantage in the presence of others, the loss of spontaneity is greatest when there is a stranger present. Even among familiars, the camera becomes the stranger.

Before we get into operational techniques, a little might be said about equipment. The lens you choose should be suitable for the distance at which you will be working from the subject. If you are working indoors, your two most versatile lenses will be the 35mm $f/1.8$ and one of the normal lenses—55mm or 58mm. By indoors is meant the ordinary room in which you are working fairly close to your subject. Ideal lenses for head shots are the 85mm $f/1.7$ or the

100mm *f*/2.5. These make it possible for you to work at comfortable distances from your subject, thereby making him at least a little less self-conscious, or even totally unaware at the moment you take the picture. If you are able to put your subject at ease while doing an informal portrait, and if you are engaged in conversation at close quarters, you might use one of the standard lenses or one of the wide-angles, depending upon how much of the picture area you want to cover. Thus, if you are taking a picture of someone engaged in an activity, you need wider coverage than if you are just taking full-frame portraits.

When you are working outdoors, the ideal lenses for distance coverage are those in the range of 85mm through 135mm. If you use even longer lenses, the advantages of working from afar may be offset by compression, or flattening effects, unavoidable attributes of long-distance photography. When you are working at close range, the 28mm and 35mm lenses afford great flexibility, letting you take in entire situations while including your main human subjects. A standard lens is a good compromise for maximum flexibility. Remember, though, that the selection of the focal length of a lens in itself governs your distance from the subject, since focal length determines image size on the film. If you use any of the surprise or "quickie" techniques described below, you will tend to use wide-angle lenses from 35mm on down. When you work quickly, you have less time to compose; therefore, you need more of a margin within which to capture the subject on film. Moreover, when you work very close to a subject, the quick taking of a picture with a wide-angle lens is not likely to be anticipated.

Although any of the camera models can be used for candid photography, the motor-driven SR-M has some advantages in that you do not lose time in rewinding, and you do not alert the subject as much, since he does not see you winding the camera. When you use the camera at waist level, without sighting, you can run off a whole series of shots with your hands in your pockets and a remote control cord in one of your hands. For this setup you would have to use a wide-

Is she crying, laughing, or just blowing her nose? 21mm lens, *f*/5.6 at 1/250 sec. Bob Collins.



angle lens, 28mm or shorter, to allow a margin of error in framing the subject. Waist-level and right-angle viewers, as described in the chapter on basic camera operation, will also help minimize the awareness factor. Ordinarily, you would use the faster films, because they afford greater depth of field when used with smaller lens apertures outdoors and allow you to use faster shutter speeds when working indoors. If you are working outdoors and have the advantage of reasonably good depth of field, you can use slower films. These are advantageous when you wish to crop out significant parts of the picture and blow them up a greater number of diameters than would be the case with carefully composed pictures.

There are a few basics that should be mastered as prerequisites to learning more specific shooting techniques. First, the way you carry and handle your camera can draw attention to it. You must really be a master if you are to get good results while dangling two or more cameras from your neck with another bag full of lenses supported from one of your shoulders. You should work with one camera and one lens, possibly keeping a spare lens available. The camera is best held at waist level and supported by a neck strap. Your hands should not touch or be near the camera until the moment of actual operation. Remember that putting your hands on the camera draws attention to it. Lifting the camera to your eye is a signal that could almost be shouted. Winding the film for the next exposure, after having just taken one, is another signal. Hence, unless you are taking pictures in rapid sequence under appropriate conditions, you might find it best, if you want to keep the subject at ease, to delay the film advance a bit.

Another basic is that you should perform the mechanical aspects of picture-taking quickly—in a flash of activity—yet retain a casualness in your own behavior. This means that you must know your camera and lenses thoroughly. You cannot be fumbling with your controls just before, during, and after making an exposure. The accomplished candid picture-taker seems unhurried, non-purposeful, and relaxed, but when he has drawn a bead on his quarry, he moves spontaneously, swiftly, and smoothly into and out of action—so rapidly and neatly that his subject might not even believe that a picture has been taken. If the subject is aware of the photographer, the practiced motion will tend to build his confidence.

If you are getting ready to take a picture, you cannot maintain a relaxed relationship with the subject while focusing on him, taking exposure readings, and setting the camera and lens controls. All of this must be done beforehand. If necessary you can focus on another subject or object at an equivalent distance from the camera. If you cannot make exposure readings beforehand, you may have to estimate exposure settings, although a camera with an automatic shutter would more accurately accommodate such a situation and free you to concentrate on the subject itself.

If you are studying your subject, do so in the stream of activity. That is, don't appear to be sizing up your subject or to be fixing your gaze on him for any prolonged period of time. Let your eyes rove over other subjects and objects while returning occasionally and casually to your target subject to discover if the critical moment is about to occur. This is especially important when observing strangers who regard you as a stranger to be observed carefully in return.

Eight candid shooting techniques follow, some of which have already been touched upon in our preliminary discussion of the subject:

1. *The wrist technique.* Hold the camera in your right hand at your side, with the distance and exposure controls

set beforehand. Put yourself at the same distance from the subject as that set on the lens, or work within the depth of field that you have predetermined by reference to the lens scale. Use a lens in the normal to wide-angle range. At the critical moment, when the subject's pose and the composition are right, lift the camera in a quick, but smooth and self-confident, motion to your eye while positioning your finger on the shutter release. Then, without any further lapse of time, press firmly but smoothly on the shutter button. Drop the camera to your side once more. To repeat, all of this must be accomplished in a single smooth action. This should be a one-handed action for greatest effectiveness.

2. *The neck-strap technique.* If you do carry a camera visibly suspended from your body, it is best to have it at chest height with the strap around your neck. Then, with either one hand or both, you can raise the camera quickly to your eye and release it again. This can be accomplished more quickly with the camera in this position than if it were suspended from your shoulder or from your neck with the strap drawn underneath your arm. Of course, the advice about being camera-ready is applicable here.

3. *The fumble technique.* Here you are engaged in some legerdemain using diversionary tactics similar to those employed by stage magicians. Do real or fake shooting of just about everything except your subject. Fumble with your controls. Raise the camera, sight it at another subject, and take no picture before letting the camera drop again. All the while keep your main target in view through indirect or peripheral vision. At the critical moment zero in on your subject and take your picture. Then continue your stream of activity with additional fake or real shooting.

4. *The panning technique.* This is a variant of the fumble technique. Start at one end of the subject area, snapping away or seemingly doing so while gradually moving your camera toward your subject, whom you must reach at a critical moment. After you have taken your picture, continue the panning movement a while longer. You can repeat this, but not too often, because then you will become too conspicuous.

5. *The walking zoom.* Preset the distance ring on your lens. Locate a point between you and your subject at which you will want to take the picture. This should, of course, match the distance for which the camera has already been set. Then start walking casually toward your subject and, when you have reached the predetermined mark, lift the camera smoothly but quickly to your eye for the critical-moment release of the shutter. A faster shutter speed is desirable. This is achieved by using the widest lens aperture possible consistent with the film-speed rating and the depth of field needed. After taking your picture, continue moving, seemingly without having paused at all.

6. *The face-to-face technique.* You are very close to your subject and want to take a picture of him without introducing the awareness factor. The technique varies, depending on whether you are with strangers or with familiar people. In either case, you could use the wrist, neck-strap, or fumble techniques. With strangers, you should rely on the element of surprise, although you should also take advantage of anything that diverts your subject's attention. With subjects you know, particularly if you are engaged in conversation with them, you should take advantage of the diversions they create for themselves. With either type of subject, but particularly with strangers, if you are discovered in your pursuits, the best tactic is simply to smile. This can be most disarming. If you observe any hostility from a stranger when you are traveling in a tourist locale or taking pictures in an area in which the residents are sensitive to





Late Autumn and Early Spring. Shooting blind with Minolta SR-M. 28mm lens. Black-and-white prints from color slides. Joseph D. Cooper.



outsiders keep smiling—but also keep moving.

7. *The blind-shooting technique.* Using a wide-angle lens, preferably with a waist-level viewer for sighting, direct the camera toward the subject by waist or side movements. Use a long cable release at your side or in your pocket or, with a motorized camera, use a remote-control cord for snapping the picture. If necessary, the camera can be steadied by an apparently casual touch of the left hand on the camera body or the strap. Wide-angle lenses are useful to provide a margin of error in composing the subject within the picture area.

8. *Remote-control shooting.* This is a variation of blind shooting. Moreover, it need not be too blind, for you can prefocus the camera and previsualize the picture. The camera can be set on a solid surface or on a tripod, or it can be clamped to an upright support and operated with a long cable release.

People in Action

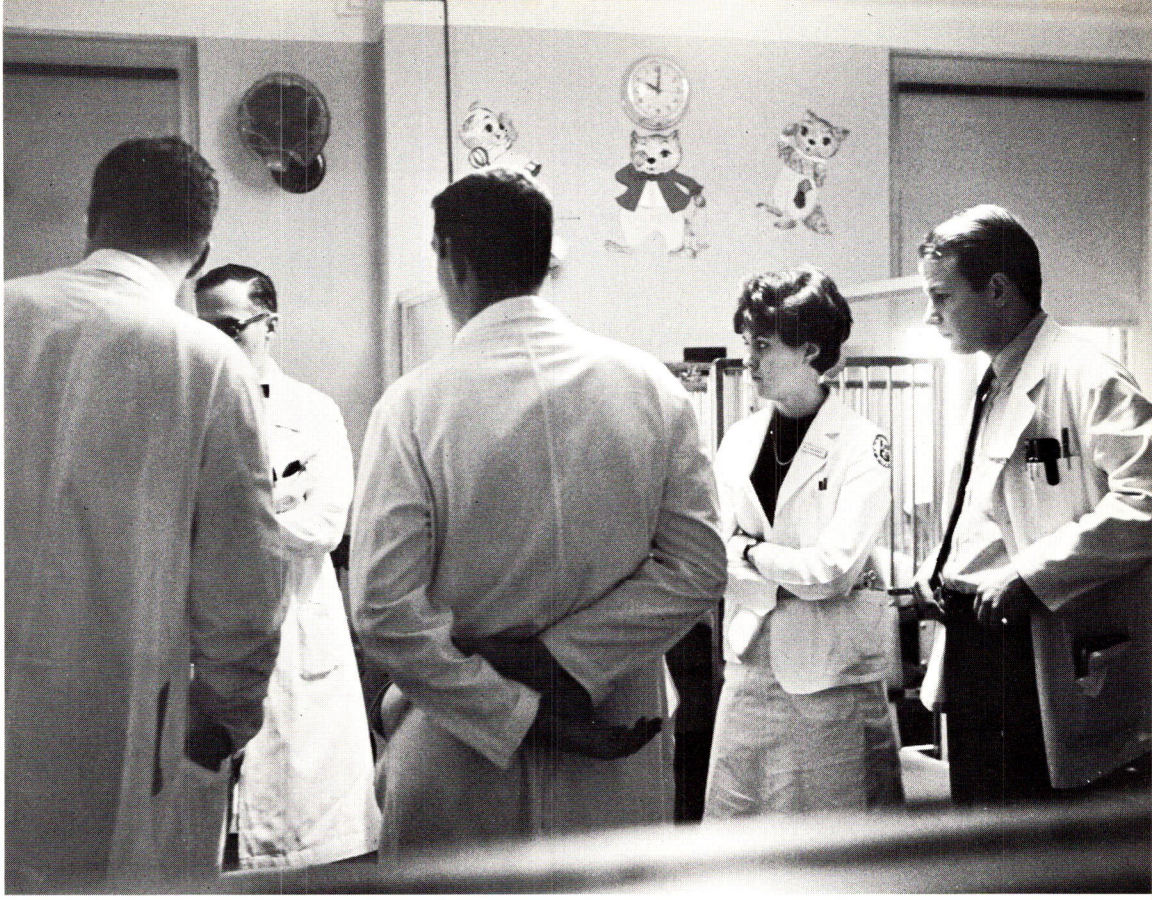
The easiest candids to take are those involving people of all ages engaged in moving activity, whether at work or at play, and particularly people engaged in sports. The unposed look is practically assured, because the subject is largely preoccupied with the activity.

To stop action you should use the fastest possible shutter speed consistent with the lighting conditions and the depth of field you desire. You can help freeze the action on film by either catching it at a dead moment or by catching it in a line of movement that is as close as possible to the axis of view, which extends from the center of the film through the lens to the subject.

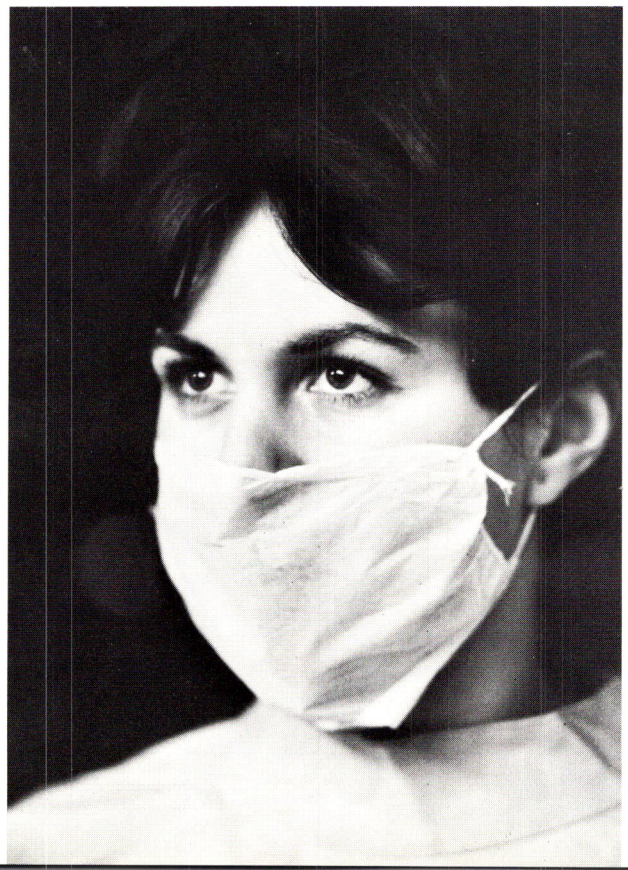
The latter is solely a matter of the rate of displacement of the image on film. The subject is moving just as rapidly toward or away from you as he would be if he were running across your path, but when a person moves across your line of view, he is taking himself away from the optical axis, which causes maximum image displacement on the film. This calls for use of the fastest shutter speeds. On the other hand, movement directly toward or away from you keeps the image at approximately the same position within the field of view. Visually, the image becomes slightly smaller or slightly larger. Stopping action in this case can be done with comparatively slow shutter speeds —as slow as 1/30 sec. if you can take hand-held pictures at that speed. An intermediate shutter speed could be used when the line of movement is roughly at an angle of 45° toward or away from the camera. The accompanying table provides a guide to the selection of shutter speeds relative to the direction of movement.

For some subjects, total freezing of action is not desirable. For example, assume that you are taking a picture of a speaker vigorously bringing his hand down on a podium. His moving hand can show up as a blur, provided that the rest of the speaker and his background are recorded sharply. Creative uses of blurred image are discussed in the chapter on creative variations.

A real challenge in action photography is to record the moment of arrested motion—the dead moment referred to earlier. For example, when a child is being pushed on a swing, the swing stops momentarily at the end of its swing before it begins its return trip. At this dead, or peak, moment the moving object stops just long enough to be caught with a relatively slow shutter speed. The same principle pertains to many other kinds of reciprocating movement. In photographing an active dance —the kind where one partner swings the other around—you will notice a variety of peak moments, depending upon the particular dance sequence. Throw a ball into the air and observe how it hovers



A day in the life of a woman doctor at Babies' Hospital. Dr. E. McSherry listens intently while on rounds. These pictures and those on the next two pages are representative glimpses of varied activity in the course of a day, all on Tri-X rated at ASA 800. Suzanne Szasz.





Opposite above, a painful duty: discussing a difficult and risky operation and trying to help the father of a very sick baby decide what to do. Opposite below, Dr. McSherry examines a child in the well-baby clinic. Above, at day's end while waiting for an elevator, Dr. McSherry relaxes. The photographer doing the picture story must be alert to all the shifts and peaks of mood and action.

for a split moment before it begins its descent.

With practice and with increased sensitivity to the way action patterns repeat themselves, you will learn to anticipate the critical moment and correlate it with your own reaction time. Remember, you must always begin releasing the shutter a split moment before the irretrievable critical moment comes and goes. Examples of critical moments you can anticipate are the top of the jump to put the ball through the basket, the kick of the football, the baseball bat hitting the ball, the punch thrown out in a boxing match, and the jumper clearing the high bar.

Knowledge of a particular sport or game will help you find the best position for picture-taking. Stay there until the action comes your way. You cannot be running after the players. In basketball, for example, you might want to stand behind the basket and off to the side. In football and soccer, the goal posts could be your waiting position. In baseball, you might want to catch a slide behind first base. In each of these situations you prefocus the camera and then wait for the action to occur.

Whether you stand or kneel depends on how much of the playing field you want to cover and whether you want to emphasize one or more key players. When standing, you have a higher point of view, which brings in more of the field at close range but does not usually affect a distant view. A low point of view will lower the horizon line and place emphasis on the key player(s). If you kneel, you should rest on one knee only in order to have leverage, which will enable you to get out of the way in a hurry if necessary.

The Picture Story

A single picture can tell an entire story of an event or of a situation, but it should not try to tell more than a single story. The picture story consists of two or more pictures, which together bring out either the elements of a situation or a sequence of events. We will cover both of these treatments; in common, however, they bring together people, places, and things—although sometimes you might not have any people.

The single story-telling picture should be limited to one main subject or scene. Don't make the common error of trying to crowd too much into the picture, or it will present confusion. This does not mean that you are limited to one object. A single theme or idea can be suggested by several, or many, closely related details. Several people engaged in related activity would constitute a single subject. The thing to avoid is two or more competing centers of interest in which different kinds of activity are going on simultaneously.

In the single picture, when you have more than one center of interest, photograph selectively. Move in closer to the subject, or use a telephoto lens. For example, take two or three people engaged in conversation or play. Move in closer to capture the animated behavior of only one person. This is one of the advantages of the zoom lens: It provides a range of selectivity without obliging you to change your picture-taking position or perspective.

The notion of the single center of interest in one picture should not work to the rigorous exclusion of detail. The subject must be recorded within its natural setting. That is, it must be perceived in context. You must, therefore, have enough surrounding detail to give the picture meaning.

The chapter on image management includes material on elements of pictorial composition. You might refer to the various factors that arouse interest on the part of the viewer. Arousal of interest should be sustained through elements of self-identity. That is, the viewer should see within the picture things to which he can relate.

The picture story can take many forms. It can be the recording of the individual actions or elements of an important event or ceremony. It can be a how-it-is-done sequence for interest or instruction. It can present the features of interest in a particular locale. It can be a report in picture form. It can also be part of a larger documentary comprising a whole book or report. In each case, there must be a unifying theme or purpose. You need to plot the story out beforehand to organize the key elements of action or interest in a logical sequence. Always there is a beginning and an end. The well-executed picture story is usually preceded by thorough research and preparation; otherwise, you will have to depend upon chance, and inevitably you will also lose some of the best pictures. The good picture story conveys not only sequences, close-ups, wide views, and a variety of viewpoints, but also tries to capture the mood or spirit of the situation.

Portraits

The most interesting subject in the world is the portrait. More pictures are taken of people than of any other subject. The photography of the human face offers the challenge to bring together an understanding of the interplay of light and shade, of perspective and viewpoint, and of personality of both subject and photographer. Ideal lenses for portraits are 85mm and 100mm in the Rokkor series, although you can take good portraits with shorter or longer focal lengths, provided you are mindful of the perspective problems discussed in earlier chapters.

Background treatment is important. It is most easily controlled in the studio-type portrait, as discussed in the chapter on lighting. In informal portraiture, the subject is usually photographed in his existing environment. This does not mean that he cannot be moved or that you cannot remove distracting elements

The young Yemeni has just been told that his father will not live. 35mm lens, 1/8 sec., hand-held. Graham Finlayson.



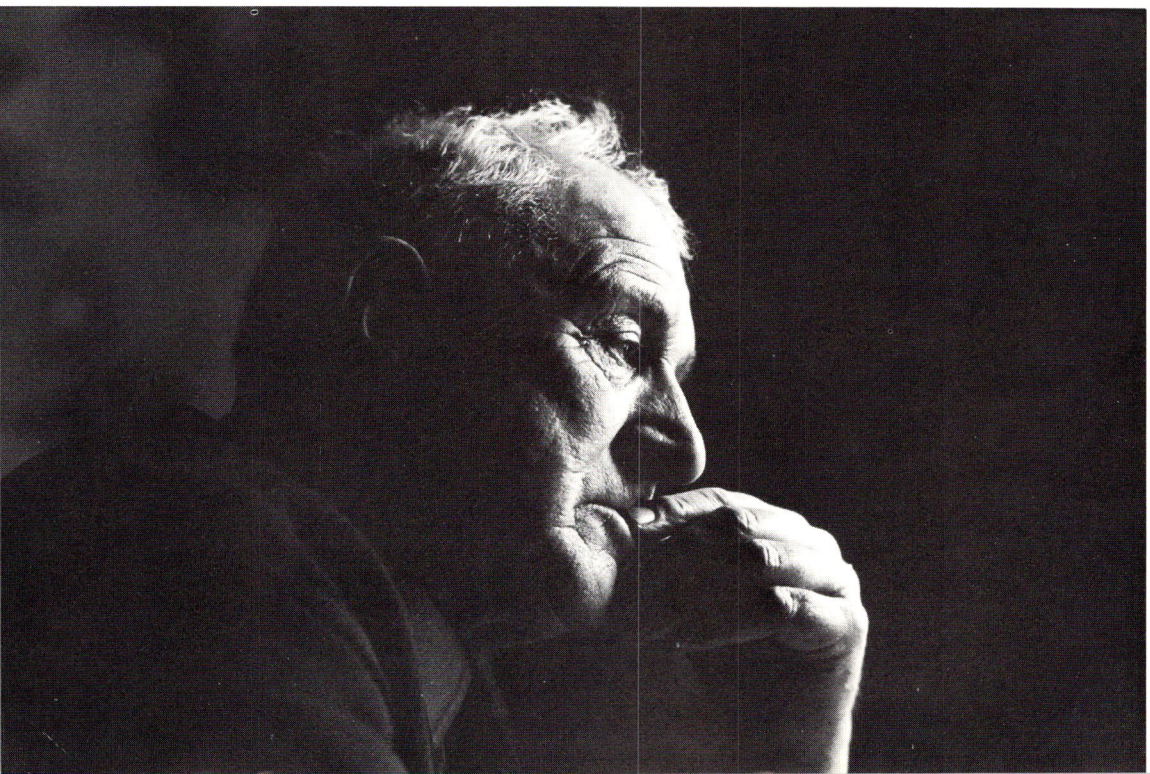
from the background. You can also choose a different shooting position, but bear in mind that the shooting position can also affect facial perspective.

The professional portraitist performs a creative function in emphasizing or de-emphasizing physical attributes. Unless he wanted to emphasize baldness, he would shoot from a slightly lower angle. He could move in close to a subject with a small nose and fairly flat features, but he would move back, using a longer focal length if necessary, in order not to accentuate unusually prominent features. In other words, by changing the distance between camera and subject, he can elongate facial features or render them either normal or slightly compressed, all based on the utilization of the principles of perspective. A low position helps to strengthen a weak chin and to de-emphasize a strong nose or a full forehead. A high camera position achieves opposite effects. The subject's head can also be turned or tilted to add or remove emphasis from particular features. The accompanying chart will serve as a useful guide to treatment of facial attributes.

Wrinkles are best managed by avoiding sharp lighting contrasts. A diffused main-light source will soften the edges of the shadows, and a soft fill-in light will open them up even more. Reflections on eyeglasses can be observed only by viewing the image on the focusing screen. The subject can be moved slightly, or the light or camera can be moved, in order to minimize the problem. When you make black-and-white portraits of men, a green filter will contribute to the impression of strength.

You must put your subject at ease. The technique of the candid photograph was discussed above. In the posed portrait the subject is aware that he is to be recorded on film. Some people adjust themselves to this more comfortably than others. Up to about age six, children are most spontaneous in expres-

Retired railway worker illuminated by single light source glancing across face presents dramatic contrast with dark background. Standard 58mm lens, *f*/2.8, 1/60 sec., Tri-X. Graham Finlayson.



CORRECTIVE PORTRAIT PROCEDURES

Difficulty	Suggested Treatment
Prominent forehead	Tilt chin upward Lower camera position
Long nose	Tilt chin upward Face directly toward lens Lower main light Lower camera position
Narrow chin	Tilt chin upward
Baldness	Lower camera position Screen to shield head Use no hair light Blend top of head with background tone
Angular nose	Minimize effect by turning face toward lens
Broad face	Raise camera position Use short lighting Turn face to three-quarter position
Narrow face	Lower main light Use broad lighting
Wrinkled face	Use diffuse lighting Lower main light Use three-quarter pose
Double chin	Raise main light Tilt chin upward Use high camera position
Facial defects	Keep on shadow side
Prominent ears	Hide far ear behind head Keep near ear in shadow Consider profile view
Glasses	Tilt downward by elevating bows slightly Adjust fill light laterally Have subject raise or lower chin slightly Use small light source and etch reflection from negative
Deep-set eyes	Lower main light Use lower lighting ratio
Protruding eyes	Have subject look downward
Heavy-set figure	Use short lighting Use low-key lighting Use dark clothing Vignette shoulders and body Blend body with background tone

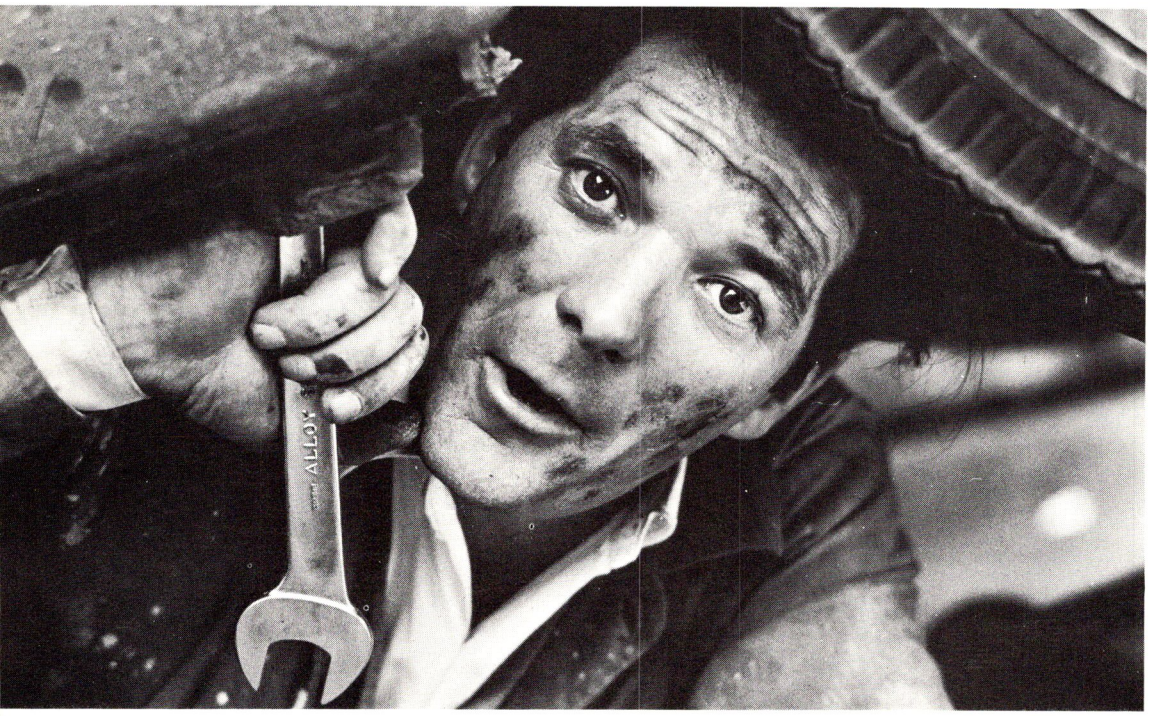
Reproduced with permission from the copyrighted Kodak publication, *Portrait Photography*

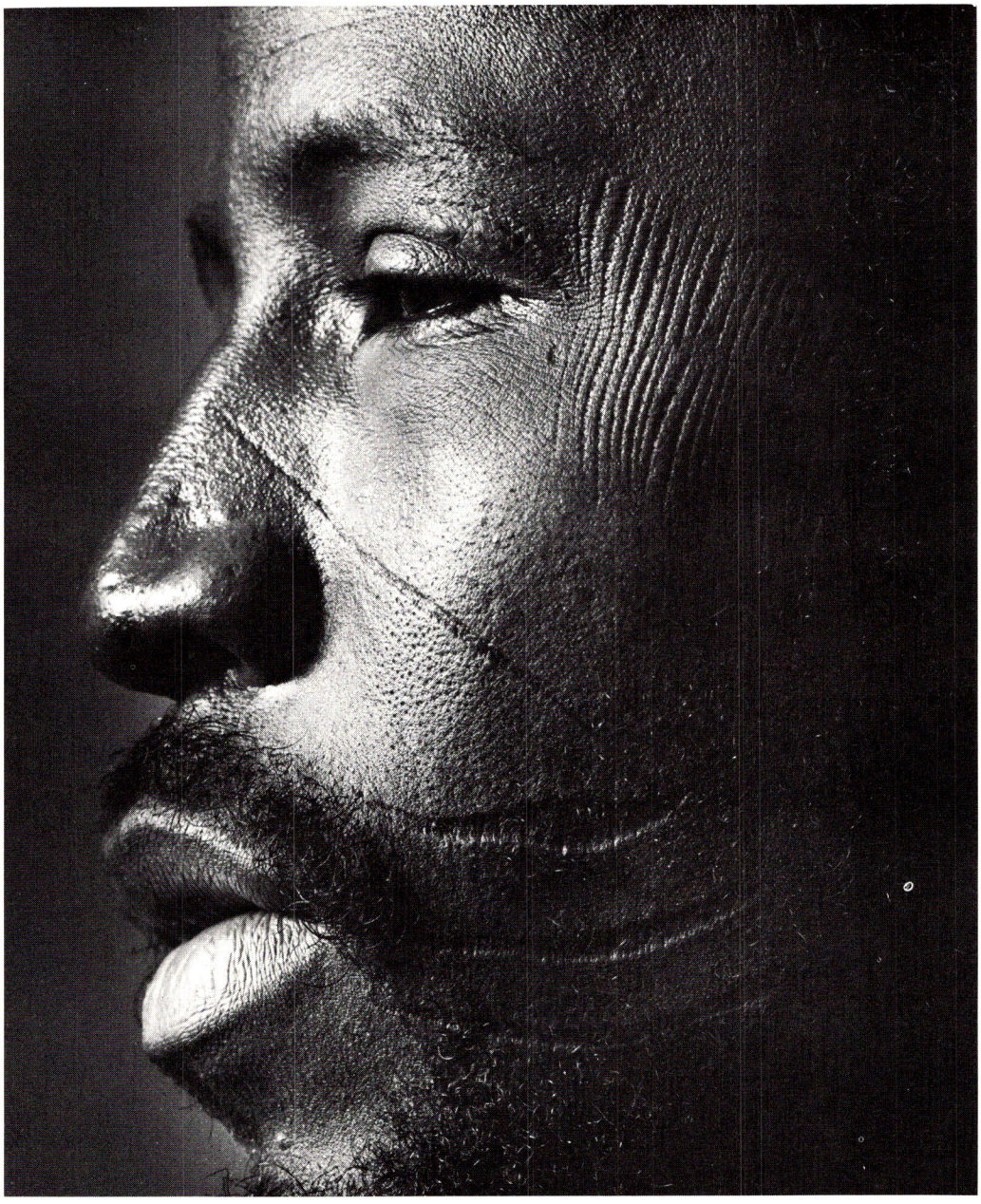
sion, but as people become older, especially the more sophisticated, they tend toward posed rigidity and an awareness of the problems of self-presentation. The photographer and the subject do influence each other, as in any two-party relationship. Each photographer must find his own personal approach to setting his subject at ease.

Glamor Portraits

The glamor picture aims to bring out the charm or poise of the subject. It draws heavily on make-up, costuming, and posing. The subject might be a girl friend, daughter, or wife. Ideally, the glamor subject should have photogenic qualities, which include high cheek bones, hollow cheeks, small features, and a clearly drawn chin and jaw line. However, not many people are so endowed, which puts a premium on the photographer's art. With make-up you can compliment the natural contours of features, making small eyes a little larger, extending the corners of the lips or building up their apparent thickness if they appear too thin, and so on. Costuming should not be elaborate and should not compete with the personality.

This is an occupational portrait with the subject put in context with the automobile and tool. 100mm lens used for selective framing on film. Recruiting ad for National Coal Board. Graham Finlayson.





The frontal lighting—electronic flash mounted in umbrella—acted as a sidelight relative to position of camera. Note how tribal scars of this Paris student from Dakar are finely etched and revealed through the careful lighting. Standard 58mm *f*/1.2 lens. Francisco Hidalgo.



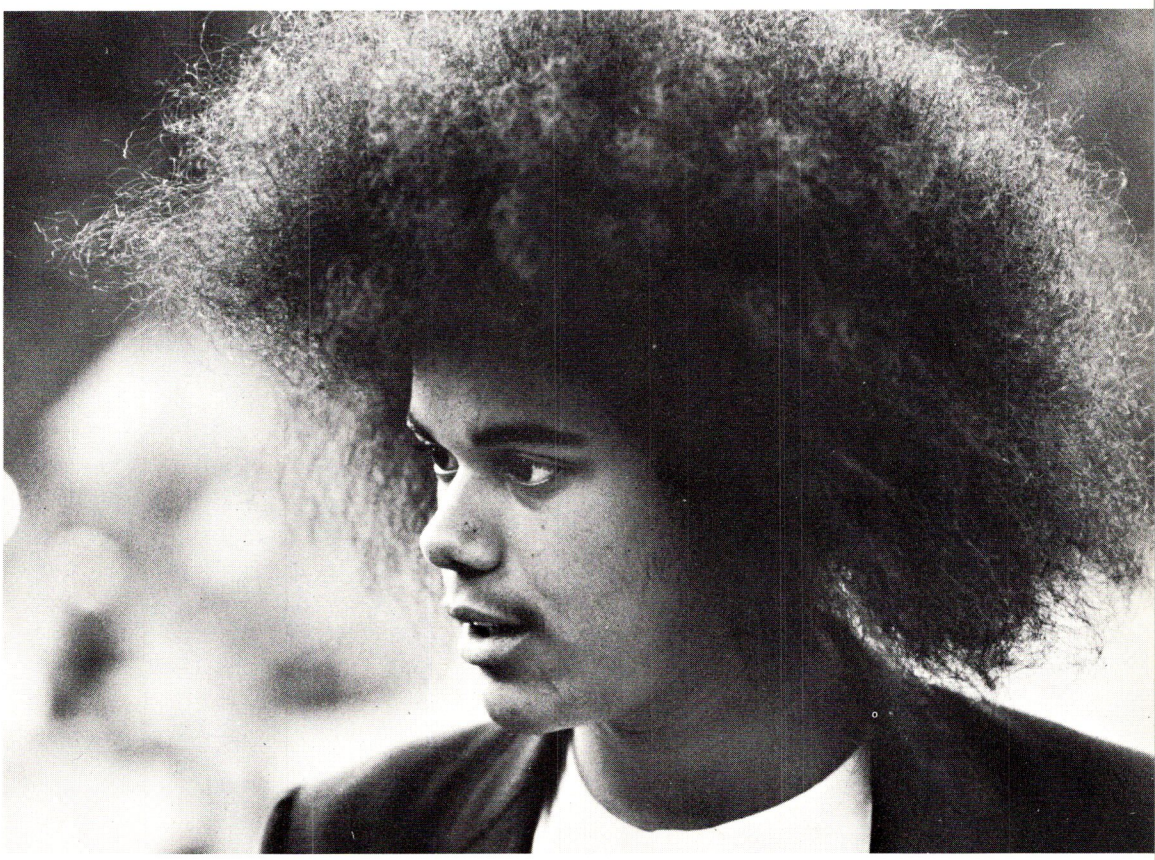
Bounce flash for soft shadows and skin texture. 300mm lens with extension ring. Robert Dehesdin. Opposite, Graham Finlayson used a standard lens to avoid any distraction that might be caused by unusual perspective effects and thus preserved the Victorian feeling suggested by the way the old couple posed themselves. Finlayson signaled to the woman to adjust her scarf, and at that moment took a picture with some animation in it. In all, the picture succeeds in portraying the quiet dignity of this couple. From the book *Portugal.*











Opposite top, festival mask. Dramatic effect achieved by combination of white robing and white background setting off the head. 100mm lens. S. Ozaki. Opposite below, to isolate the old lady from her background, Graham Finlayson used his favorite, the 200mm lens. Above, the well-endowed head of hair photographed by Francisco Hidalgo in Washington Square, New York, presented a depth-of-field problem, since it extended in front of and beyond the zone of sharpness. 135mm f/2.8 lens at full aperture, 1/30 sec., Plus-X.

Nudes

From the beginnings of man and woman, the undraped female has been a subject of universal interest as expressed in all forms of art. Painters idealized the female figure and in turn were joined by photographers. In common, they sought to idealize and glamorize, but as new tools of optical expression became available, some photographers began experimenting with the geometry of the female form, depicting the clash or contrast of curves and intersection of lines. Others sought to bring out the texture of skin. Some have focused their lenses on breasts, buttocks, and the pubic region with or without bikini. Depicting pubic hair was long considered an affront to the proprieties, but this barrier to expression of art, if such it be, has also been overcome. What differentiates art and pornography is





Latana, an American model living in Paris, is shown in a variety of poses that juxtapose roundness and angularity, which are often important features in nude photography. Macro Rokkor 50mm *f*/3.5 lens, bounce flash, Agfapan 100, developed in Atomal. Robert Dehesdin.







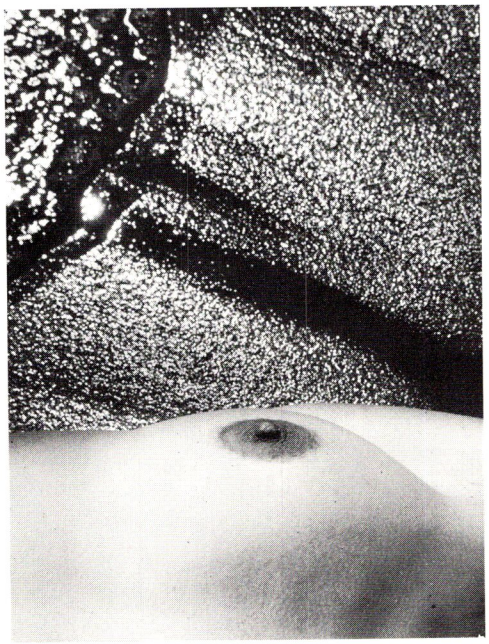


Latana walking into the distance clad in a thin waist chain. The soft sunlight cast a transparent shadow. 200mm lens, Agfa ISS developed in Atomal. Robert Dehesdin.



Lucien Clergue began cutting off the heads of his subjects at a time when French law required that the identity of the female not be disclosed if the photograph showed her in *all* of her nudity. 100mm lens.

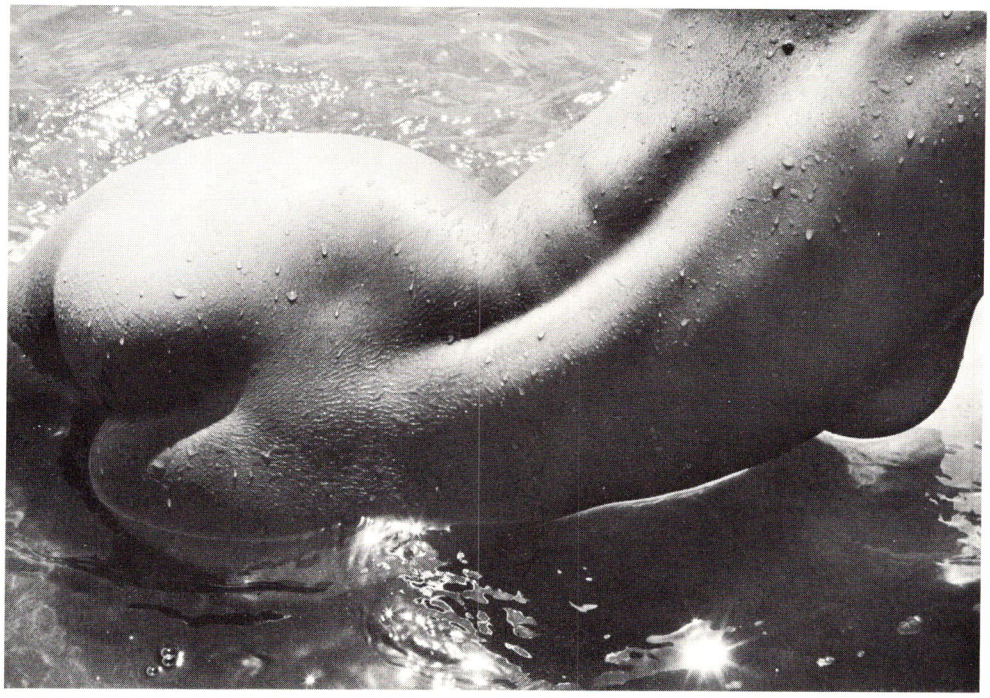




The softness of the breast in contrast with the strong texture of the edge of the sea. 50mm lens, 1/250 sec., *f*/16, Plus-X. Lucien Clergue.

To add to the texture of his dark-skinned subject, Robert Dehesdin used a grainy film, Kodak Recording Film 2475 exposed at 1600 ASA and processed in HC-110. Bounce flash. 50mm Macro Rokkor.





Another letter-of-the-law photograph of Lucien Clergue's. 50mm lens.

really good taste, which admits of interesting poses for varied effects, but rejects the sexually expressive, especially as it begins to assert itself through crude display.

The nude can be photographed in full or part figure. The model usually should be slender, firm of body, and poised. She should be consciously aware and proud of her figure. Such a model tends to be cooperative and relaxed in front of the lens, whereas the uncertain model is often stiff and tense. Although many amateur models can learn to pose well in a relaxed mood under the direction of photographers who know how to pose them, those who are likely to do best are women who have trained as dancers, athletes, and stage performers, for they know instinctively as well as through experience how to control body movement.

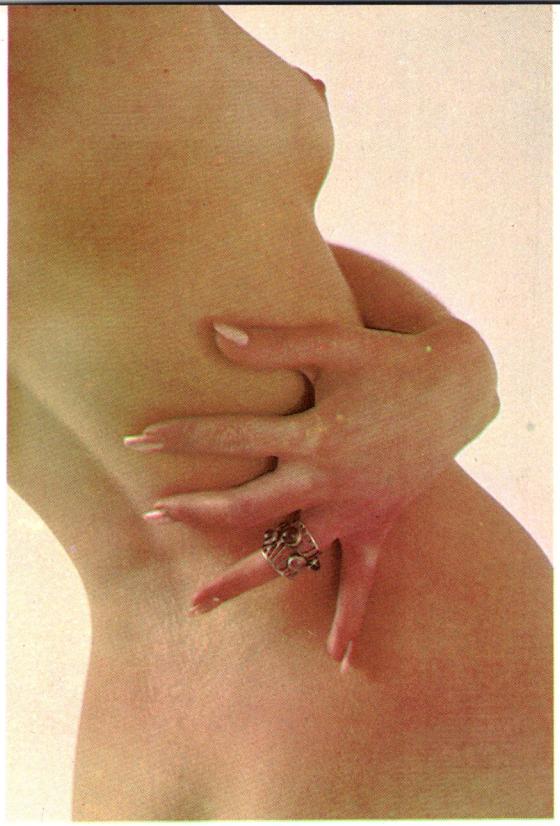
There is no reason why women cannot take impressive nude photographs, but men seem to dominate this field. The rule is to maintain a creative impersonality, although appreciation of the living art form should stir the creative impulses of the photographer.

The basics of good lighting are applicable to the nude, with an emphasis on a soft radiance, which is most easily provided by bounce and umbrella lighting. Coupled with this, you can use directional lighting to bring out surface textures and shadow patterns, which give form and depth to the turning and intersecting elements of the figure.

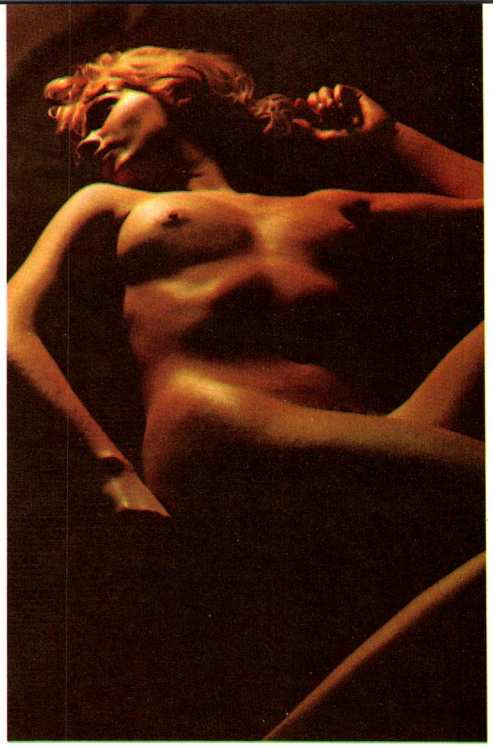
The aim in nude photography is always to find some refreshingly new pose, but since this effort has been made perhaps millions of times, it is very difficult to discover very much that is new except, perhaps, in the context of environments, backgrounds, and other aspects of the total pictorial setting, although these should not vie for attention with the model.



The action-stopping effect was achieved through use of bounce flash as the main lighting source. Seamless color paper provided the background illuminated by color filters on background flash lamps. Macro Rokkor 50mm, Ektachrome-X. Robert Dehesdin.



The main object emphasized in this fashion picture was a ring designed by Gerda Flockinger. Electronic flash, 58mm lens, Kodachrome II. Graham Finlayson, for *Daily Telegraph Magazine.*



One technique for emphasizing form and surface texture in nude photography is to use oblique illumination. The color tint was added by placing a Wratten 85 filter on the Macro Rokkor 50mm lens. Robert Dehesdin.

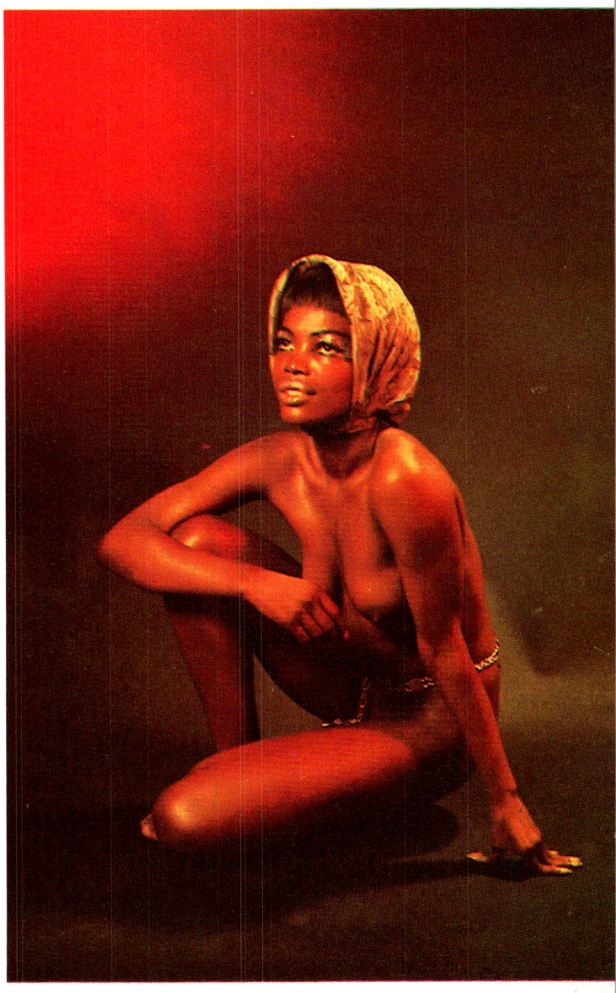


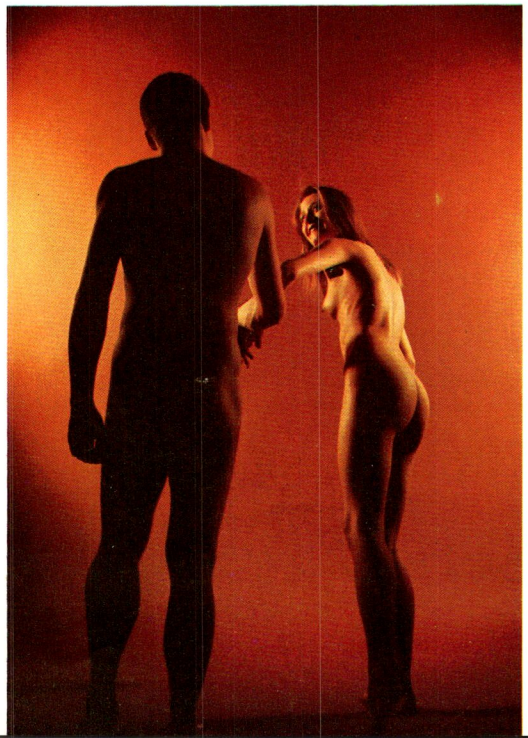
This one was posed quite naturally in the studio of the great outdoors in Stockholm by an unidentified model of the future. The medium long 135mm *f*/2.8 lens permitted shooting at a distance comfortably from eye level while maintaining the desired perspective effect. High-Speed Ektachrome rated ASA 400, 1/500 sec. at *f*/11. Joseph D. Cooper.



In sculptor William Pye's studio, the nude in repose, existing light, 58mm f/1.4 wide open, Kodachrome X. Graham Finlayson.

Small bits of costuming may adorn the model, but they should not be in conflict with her person. Electronic flash, Ektachrome-X, Macro Rokkor 50mm. Robert Dehesdin.





If a title were to have been supplied it might have been *The Temptress*. Background illuminated by colored flash. Macro Rokkor 50mm. Robert Dehesdin.



The woman in her soft outlines in contrast with her partner of strength. Bellows Rokkor 100mm lens with No. 1 Bellows, bounce flash, Ektachrome-X. Robert Dehesdin.

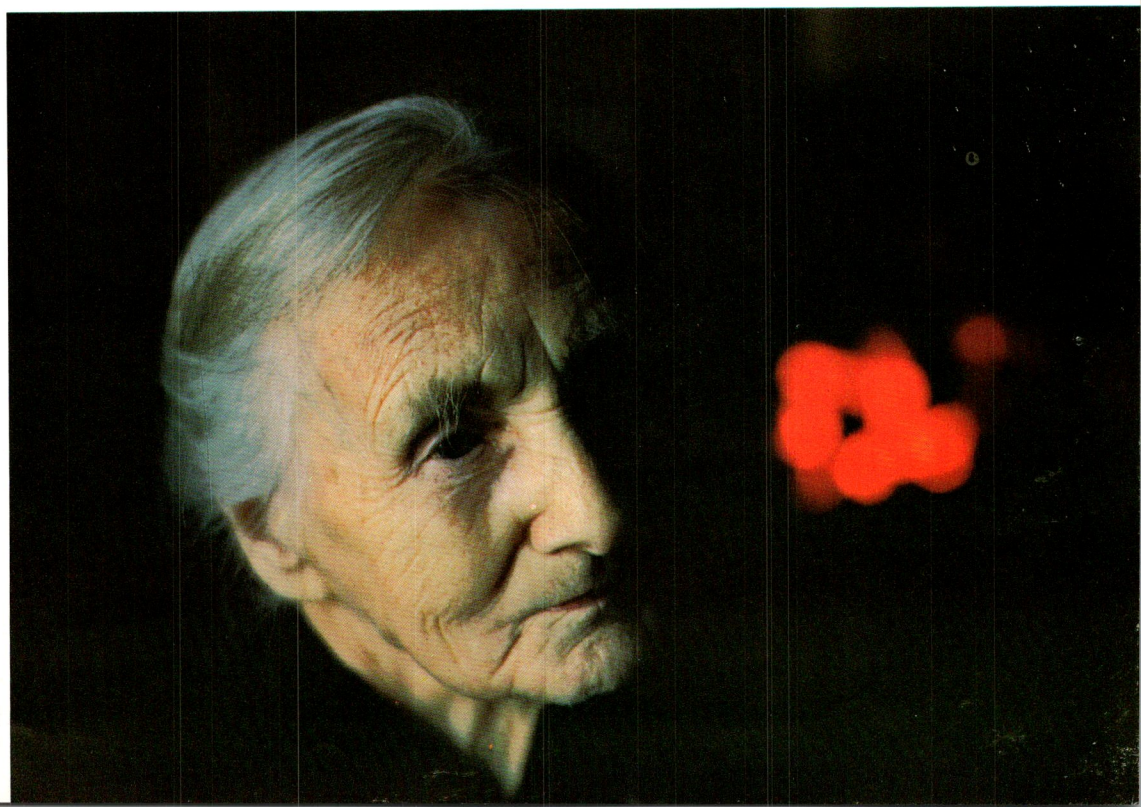
The soft highlights, skin texture, and shadow patterning are the results of using bounce flash. Ektachrome-X, Macro Rokkor 50mm. Robert Dehesdin.

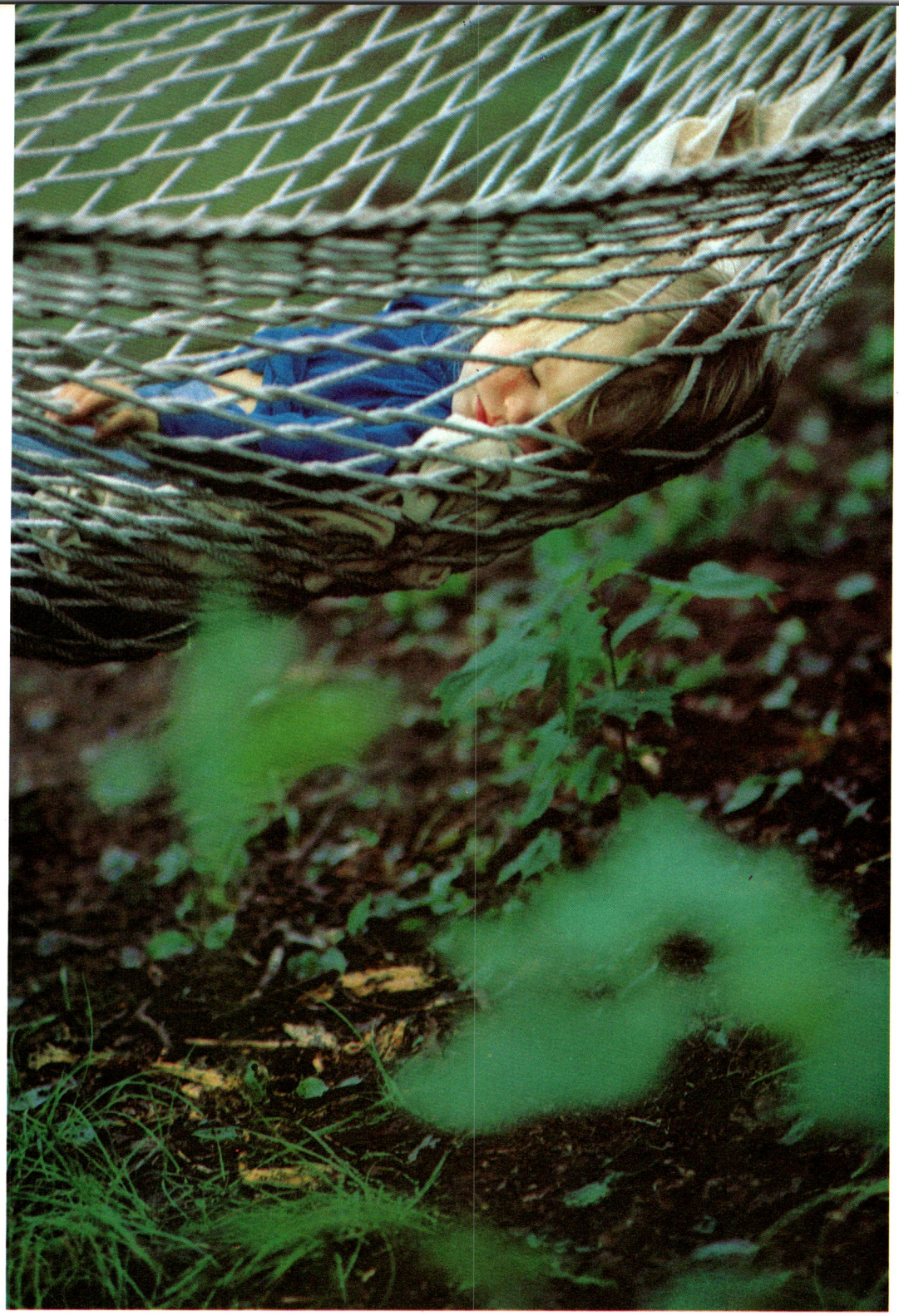


The model was photographed in late afternoon in a sand quarry using the 300mm Tele-Rokkor and an extension ring for close-focusing. High-Speed Ektachrome rated at ASA 320. Robert Dehesdin.

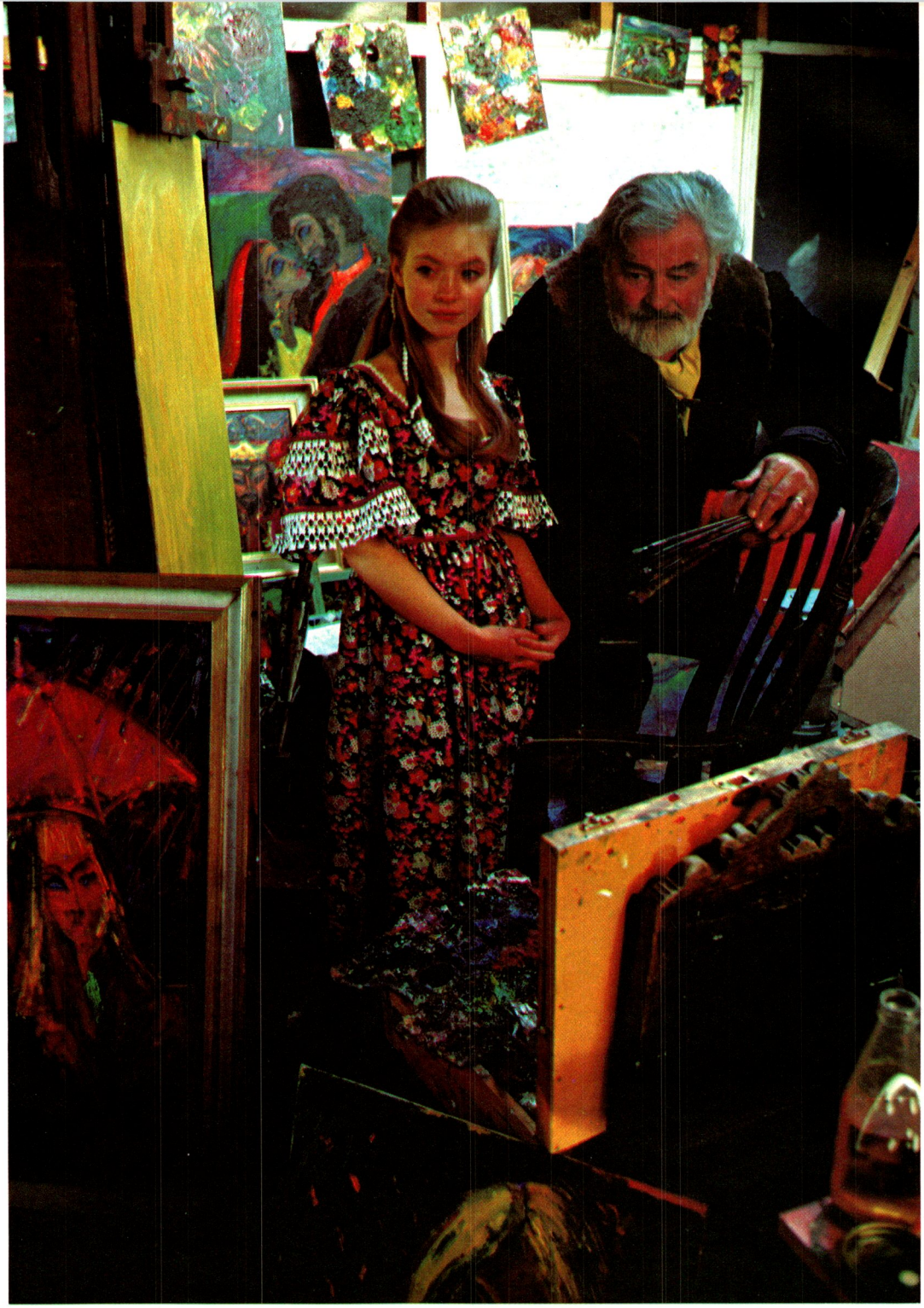


The old lady sits by her fire in her cottage with just enough illumination for Graham Finlayson to make his portrait using a 58mm lens wide open at *f*/1.4 with Kodachrome II. From the book *Just a Few Lines*.

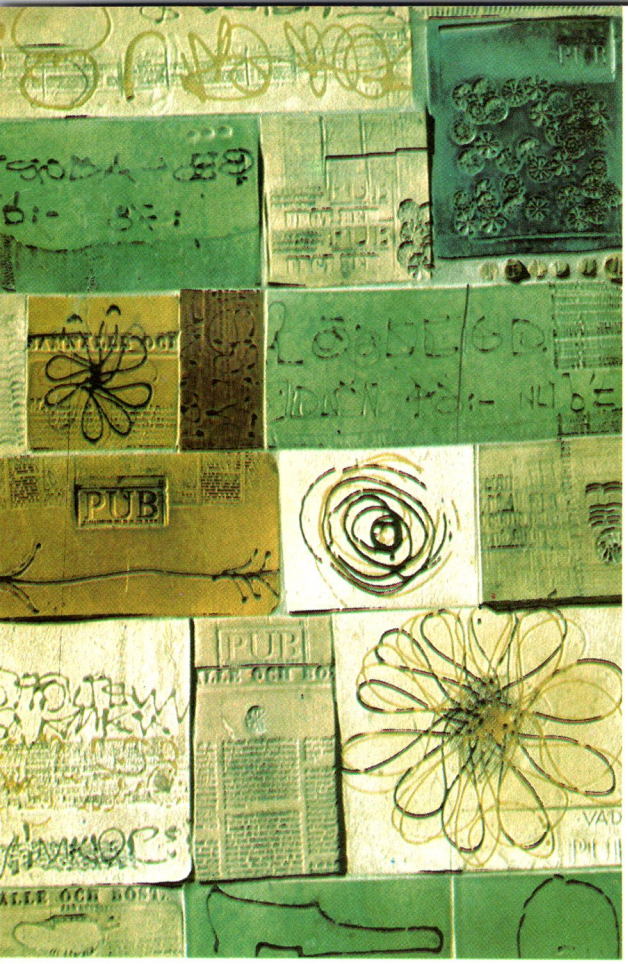




The child was asleep in the hammock when photographed by Suzanne Szasz who said, "I first made sure I caught the scene, then started to walk all around it until I was able to frame the picture in some green branches." 58mm lens, Kodachrome II.



Judy, the model, with Sven Berlin, the sculptor-painter-writer. The basic exposure was for existing light in order to bring out the background fully while for front fill an electronic flash was put through a white umbrella. Kodachrome II, 35mm lens. Graham Finlayson for *Daily Telegraph Magazine*.

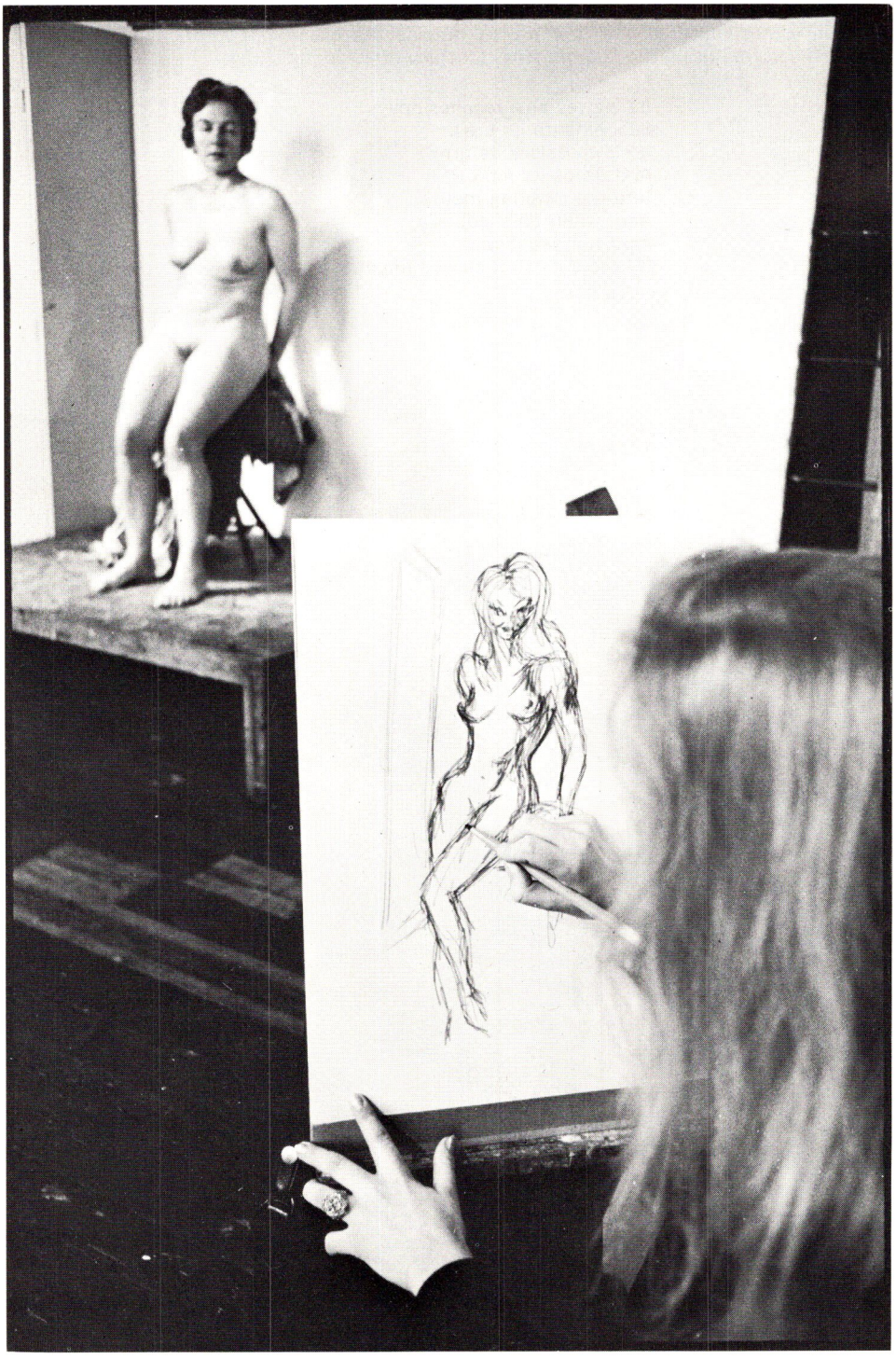


The sun was high and slightly to the side, thus casting tiny shadows which etched out the graffiti on the side of a department store in Stockholm. High-Speed Ektachrome rated ASA 400, 100mm *f*/2.5 lens, 1/500 sec. at *f*/16. Joseph D. Cooper.

Neither the geometric effect of the fisheye lens nor the lively splashes of color could provide the missing ingredient in the picture at the left. It can be seen in the companion picture where people animate the scene. Hight-Speed Ektachrome, rated ASA 400. Joseph D. Cooper.







The nude interpreted. The clue is in the hair of the sketched model. The artist is sketching herself, using a model's proportions only as a guide. 35mm lens. Graham Finlayson, courtesy *Daily Telegraph Magazine*.

Lucy McCall from the Blackheath School wrote the accompanying poem at age 9. She had seen a mechanical digger in the road outside the classroom. Graham Finlayson re-enacted the scene, using the 100mm lens to achieve this composition.

Its clawed arm reaches down
Scooping up its prey.
It slowly raises its arm
And drops its food
Into the awaiting mouth,
And, when finished,
As if not satisfied,
It lowers its stiff, clawed finger for more.





The difficulty of maintaining the interest of three children created its own kind of unity. 58mm lens.

Babies and Young Children

One of the paradoxes of child photography is that by the time the young one is old enough to be able to respond to your guidance in posing, he has already lost his spontaneity. The child through about age six is usually wonderfully spontaneous. While you might not succeed in getting him to respond to your stage direction, you can make use of an almost limitless variety of props to engage his interest—a toy, a wrapped piece of candy, a household pet, a moving object, a flower, jangling keys, and so on. You can't race after the child when he is at play: You have to learn his pattern of response to and involvement in situations and set yourself up in the path of action, just as though you were going to photograph a football or basketball game.

Unexpected and unposed picture opportunities occur almost every day. How often have you said, "Oh! If only I had a camera set up!" Well, the thing to do around the house is to have a camera always in readiness and available for use if you wish to accumulate a library of cherished possessions that you will never have another opportunity to acquire.

When children are photographed regularly, they become accustomed to the camera and learn to ignore it. Then it becomes much easier to photograph them in their games, activities, and diverse interactions. For a change of pace, introduce them to a new situation or bring something new into an accustomed situation, such as a new person or an unusual object. Approaches such as these will help you fill an album with something other than the familiar, hackneyed redundancies.

Most of us take pictures of the baby as it evolves through its early stages of growth and as it moves into successive stages of childhood. Unless we have a preplanned program for taking pictures at certain time intervals and on certain



Parting is such sweet sorrow. 100mm *f*/2.5 lens at full aperture. Ilford FP4. Joseph D. Cooper.



occasions—birthday parties, the first day of school, and so forth—we miss many of the key elements in a photographic story.

Keep in mind, though, that most baby and child pictures can become quite tiresome to other people and even to the child in later years when the album is trundled out for his inspection (and embarrassment when he is bringing home his first serious girl friend). How would you like to be displayed as a small bundle of naked flesh on a piece of fur? During the years, then, when you are in the position of photographer–captor, be ingenious in your awareness of opportunities for interesting pictures that your children will later cherish.

One technical problem is the common tendency to point the camera downward from your eye level to that of the child or children a few feet below. Doing so causes some apparent perspective distortion due to foreshortening. When working close to children, you have to get down to their level. When you work at a distance, using a moderate telephoto lens, the effect of shooting at normal adult level will be much less noticeable.



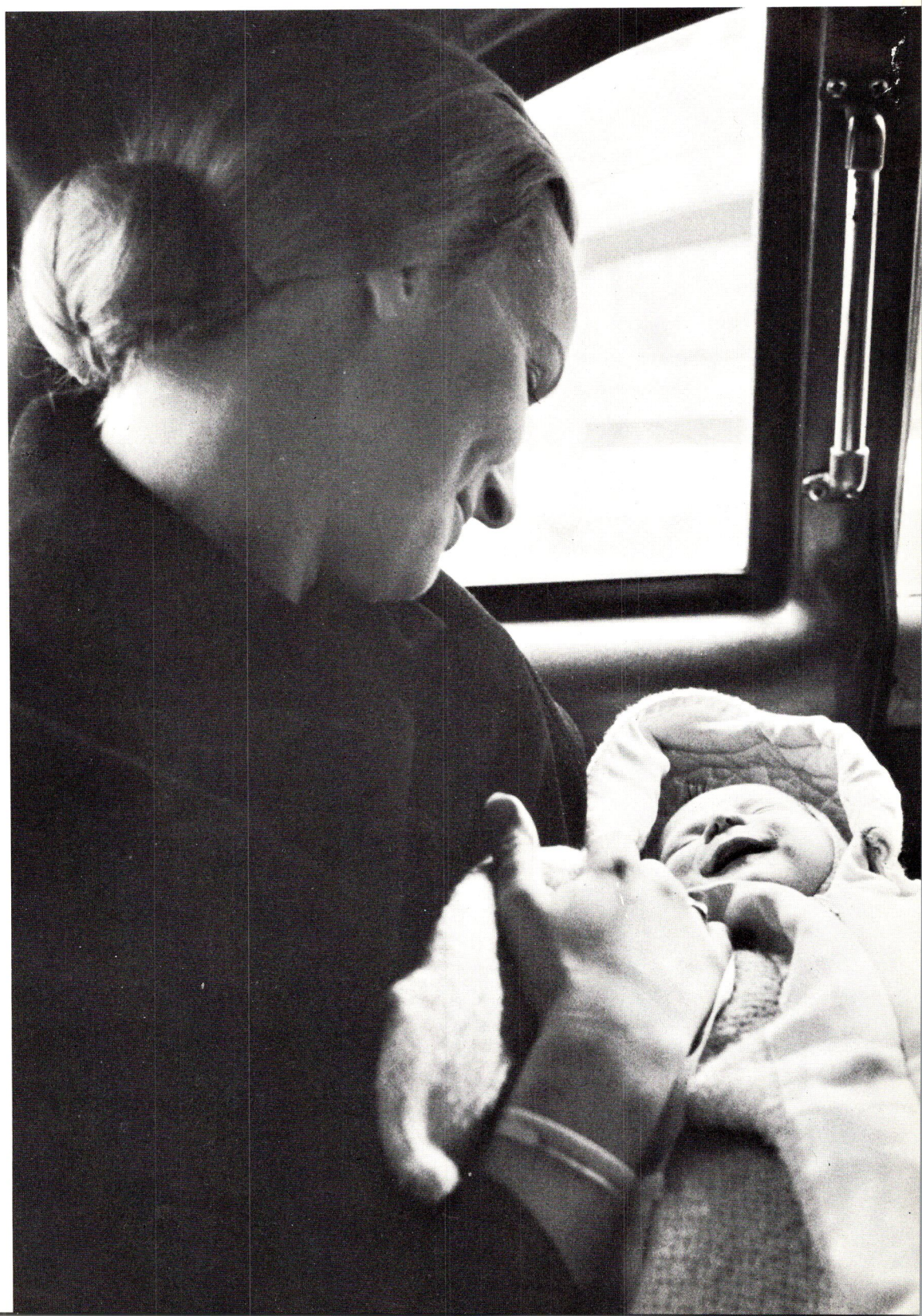
Joseph Nelson wrote a poem on loneliness at age 11 after a class discussion about the cruelty of children to one another. Joseph was actually a popular boy, but he was able to imagine the feelings of the outcast. The children acted out the drama of the situation, which was recorded by Graham Finlayson, using a 28mm lens to give emphasis to Joseph in the foreground.

They look like a pack of hungry wolves
Running towards me.
But I feel wanted.
Then suddenly they turn to go.
They go from me.
I feel like a wolf
Turned out of the pack.
"Let me play
I beg you."
But they shut me out.
I walk home.
It is terrible
Without friends.



An existing-light candid of a family group at home. Suzanne Szasz.

The pictures on this and the next four pages are from a series covering 15 years of the history of Chrissy beginning with her first ride in an automobile when her mother went home from the hospital in a taxicab. Suzanne Szasz accompanied them just to be of help after taking pictures at the hospital, but this spontaneous pose in the cab was her favorite of the day. Each year, Miss Szasz took another series of Chrissy of which these are representative.

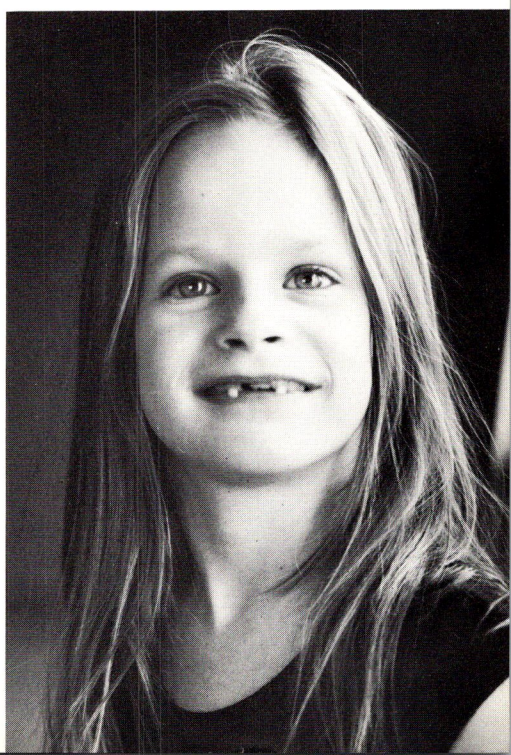






Above, Chrissy nearly two years old, when there is great delight in walking even if a little crookedly. Below, one photoflood was bounced from the ceiling so that the active three-year-old could be photographed anywhere in room. Opposite above, age four. Suzanne Szasz tries to get her child subjects to contribute picture-taking ideas through their own uninhibited, spontaneous acting. Opposite below, age six and one-half both front teeth were missing. The lighting was provided by two windows at right angles to each other.

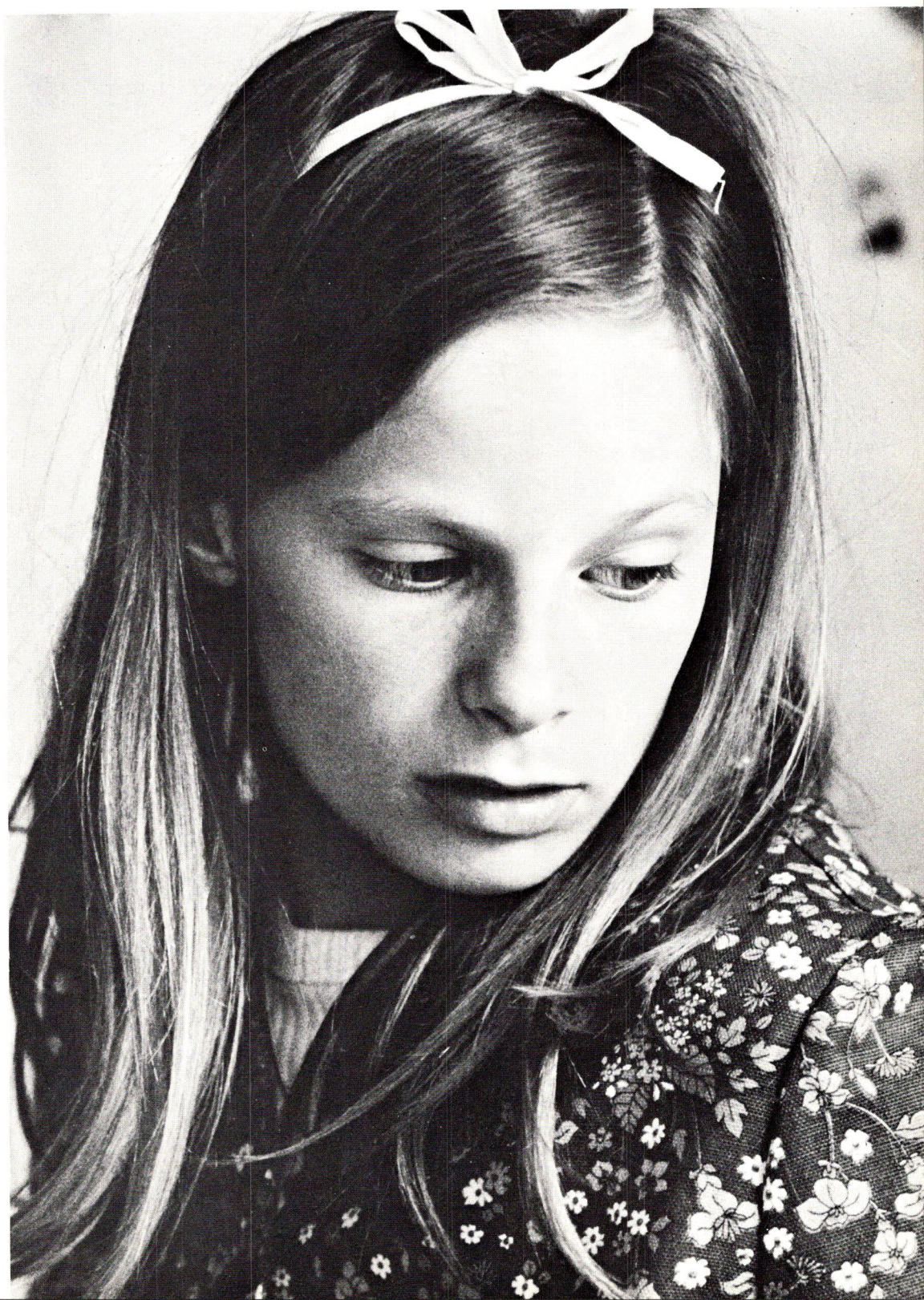








Opposite above, age eight. Some daylight plus two bounce photofloods made it possible to shoot at 1/250 sec. at f/4. Opposite below, age 15. The dancing to rock music was real. At age 15 (below) the child is becoming a young woman. Suzanne Szasz said, "I can't wait to photograph her wedding and her babies, I hope. She and some other children have become very special to me—substitutes for the children I never had." Tri-X rated ASA 800 was used for the pictures taken indoors; Plus-X rated ASA 200 for the outdoor picture.





And Life Also Begins. Young couple crossing street after wedding to get to their automobile. Al Paglione just happened to have a 200mm lens on his camera. Tri-X.

Family Events, Parties, and Groups

Any family occasion can provide material for an "event" picture—Mother's Day or Father's Day, the birthday party, the vacation trip, the visit to the beach, and so on.

Plan the picture-taking part of the event beforehand. Make a story outline. Take pictures of all of the advance preparations—preparing decorations, food, and costumes. Photograph guests as they arrive. If gifts are to be opened, record expressions of surprise and delight. Photograph guests saying goodbye. You might even take a picture or two of the remnants of the party and the task of mopping up.

When you are taking pictures indoors, a fast black-and-white film may be satisfactory in fairly high levels of existing light, particularly when you are photographing individuals or tight groups. If you wish, however, to have greater coverage in depth, particularly with color film, you will need to use flash. Bounce flash is best because it gives you fairly even distribution of light in some depth, whereas with direct, camera-mounted flash you have the problem of a rapid drop-off in the intensity of the flash as the light travels away from its source.

Also, when working indoors, you will find it convenient to use moderate wide-angle lenses, either 28mm or 35mm, although you can do much or most of your picture taking with a standard lens. Either the 85mm $f/1.7$ or the 100mm $f/2.5$ will conveniently pick off individuals from a comfortable working distance.

PLACES AND OCCASIONS

Strictly speaking, a place is a locale. Photographically speaking, a locale has something in it, if only the sky, the ground or land mass, and the atmospheric material that bridges the junction of sky and land. Some very fine pictures have been made of these elements alone, but usually a locale also has buildings, people, and a diversity of other objects that can add to or detract from pictorial interest. We think of landscapes, seascapes, rolling streams, vacation centers, the old sections of European cities dating back to medieval times, marketplaces, festivals, and so on.

Places and occasions also suggest travel, which in turn suggests the camera. In this section, we are travel-oriented, idea-oriented, and technique-oriented. It is within this pictorial situation that we bring together various elements of lens-and-camera technique. We have here problems in lens selection, perspective, viewpoint, lighting sources,

picture planning, and pictorial composition.

Suggestions for the Journey

Before you make any trip, local or long distance, check out your equipment to be sure it is in good working order. This applies whether you are driving out to the country for a look at nature or planning a vacation abroad.

Open the back of the camera and observe the shutter action in concert with the automatic-diaphragm operation. Try out the self timer. Check the viewfinder focusing at infinity and at closer distances. Make sure the built-in exposure action is responsive to light conditions. These checks should, in most cases, tell you whether or not the camera is working properly. If you have any doubts, bring it to an authorized Minolta repair service. If you are going on a vacation or on a long trip, shoot a film load and check the results before departure. Don't incur the double annoyance of a nonfunctioning camera (infrequent though this might be) and the burden of carrying it with you as so much dead weight.

Before going on a trip, do some picture-planning research. You can obtain books from the public library describing almost any locale on earth. Guide books are available from motor clubs and private publishers. Airlines, hotels, and motels are sources. Find out as much as you can about things of interest, local events, people. Talk to people who have been to the places you are to visit and ask them for suggestions, but make sure you are not asking people who are photographically insensitive. You might find a great picture where someone else sees nothing. Study the picture books of interesting places, not so that you can make the same pictures but so that you will be aware of place characteristics, which could help you find new interpretations.

Avoid replicating the typical postcard shots, which you can buy more cheaply as prints or slides. When visiting old city centers with their quaint architecture, narrow streets, interesting marketplaces, and historic buildings and monuments, look for a different viewpoint or pattern of light and shade—something other than Aunt Minnie replicating herself before three score and ten different churches, monuments, and historical sites. If you are driving, take some of the side roads, and when you find interesting places, park the car, lock it, and meander about in search of something you won't find on a picture postcard.

Your checklist of picture-taking opportunities will include public amusement centers, parks, beaches, gardens, the zoo, festivals, pageants, local industries and crafts, marketplaces, street stalls, outdoor cafes, quaint signs, interesting shop windows, local costumes, children at play, street vendors, some unique form of local transport, interesting statues and buildings, and night pictures of buildings and fountains.

Don't photograph local inhabitants if they do not want to have their pictures taken. Neither use your camera near military installations nor so much as lift the camera to your eye. In many countries you cannot take pictures inside restricted public buildings, which often include museums. Follow local practice strictly and correctly.

Be alert for the unusual in perspective and composition. Seek new viewpoints —high, low, or around the subject. Consider creative underexposure or overexposure. Take the same picture with and without filters. Take broad views and long views by changing either your position or your lens. Remember, you might not have another chance to come back to the same place. Bear in mind, also, that those great pictures by professionals and advanced amateurs are vastly outnumbered by the cullings that go into the wastebasket. Film is rela-

tively cheap; travel costs and time are not.

Pictures from Moving Transport

Pictures from airplanes. You can shoot good pictures from the shaded part of the airplane when it is at cruising altitude, for it has least vibration then, when it is making its descent, and when it is on the ground. Don't shoot against the sun, even though a lens hood prevents the light from striking the lens surface, because unwanted refraction patterns will interfere with image clarity and sharpness. Whenever possible, obtain a seat in front of or behind a wing to obtain an unobstructed view of the ground. If you must brace your camera against a support, use a pillow. Don't brace it against the window frame, because this will pick up vibrations.

Set the camera at infinity unless the plane is flying unusually low and you are using a telephoto lens. The lens aperture should be appropriate to the lighting conditions and the film speed; the shutter speed will then follow.

At fairly close levels to the ground, when you don't have a cloud cover obscuring the scenery, you can get a variety of interesting subject matter including harbors, snow-capped mountains, familiar scenic attractions, such as the Grand Canyon or Niagara Falls, neatly laid-out farms, and the configurations of city areas. Coming down into a landing glide, you can catch the night light of cities. To minimize image displacement resulting from the speed of travel, aim the camera at an angle when you point it at ground objects. Also, image displacement is least apparent at altitudes of 2,000 feet or more. When you get up to a mile, and perhaps before then, an abundance of ultraviolet radiation will make your pictures look hazy and add a bluish tinge to color transparencies. A skylight filter (warming) will balance out the blue. In black-and-white photography, colored filters will bring out clouds in contrast to a darkened sky. Also, cut exposure times in half, no matter what the meter indicates, to make up for the excessive brightness beyond about the level of 2,000 feet.

Pictures from boats. Fast shutter speeds are generally the rule, because of the varied patterns of movement of the boat. Exposure indications will change rapidly with turns of the boat. Be alert for those turns that might allow direct sunlight to strike the lens. In the typical small boat, the horizon line will be low when you are taking pictures from a seated position. To raise the horizon line and see more of the water surface, you must take pictures from a standing position. Pictures of occupants should show part of the boat, such as the stern of a motorboat with a water trail beyond. Racing boats are good subjects for telephoto lenses; if you were to get too close to them, you would have problems with spray and the movement of your craft.

Pictures from cars. You can shoot either through glass or through an open window, the latter being preferable. When it is raining, you can get some interesting effects by photographing subjects through the windshield. While the car is moving (driven by someone else!), don't rest the camera on the window frame. Instead, support it with both elbows dug into your sides. When the car is not moving, use the side window, raised to the desired height, as a support. Some clamps are available to fit over the glass, with tripod threads to fit into the base of the camera.

Landscapes

The very broad term *landscapes* includes mountains, rivers, parks, forests, the seashore, and seascapes. Unless you are pointing the camera downward or toward a limited area of view, the typical landscape consists of a land mass, a sky

mass, and the prevailing light characteristics. The interest of the picture is governed in part by the content and texture of the ground mass, the contours of objects reaching toward the sky, and the qualities of the light. Landscape subjects at fairly close range call for good modeling of ground objects through sidelighting and good pictorial composition. More distant views embody the same elements, but they achieve much of their impact through the delicacy of tonal shadings that blend sky and land. Familiar objects, such as houses, vehicles, and people, help provide scale. The deep landscape is anchored by including prominent foreground objects and framing the picture with natural objects, such as the overhanging branches of a tree. There should be at least one major center of interest, although some landscapes depend for their effectiveness mainly upon their delicate shadings.

The best landscapes are sidelit. Overhead sun should be avoided. Aerial perspective—the haziness associated with distance—conveys the impression of depth. Contrary to the usual recommendation about the use of filters to cut through haze, the haze may be pictorially important. A related phenomenon is that brighter areas seem nearer. Interesting effects are often achieved when landscapes are taken against the sun. Exposure readings must then be taken primarily on ground reflectance.

The more dramatic seascapes are shot against the sun in order to bring out the texture of the water illuminated by a low or setting sun. Some large object helps anchor the scene as a whole, while birds and boats in the background lend depth. Don't overlook close-ups of coastal flora and fauna or the curves and protrusions of rolling coast lines.

Lenses to be used range from wide-angle through telephoto, depending upon the areas to be photographed. Remember that entirely different pictorial effects can be achieved under different lighting conditions at the same time of day or when light is coming from a different direction. Although you cannot change the directional source of lighting, you can find different angles of view, which alter light-and-shade pat-

The edge of the sea photographed against the sun to give texture and depth to the water. 100mm lens, 1/250 sec., *f*/16, Plus-X. Lucien Clergue.

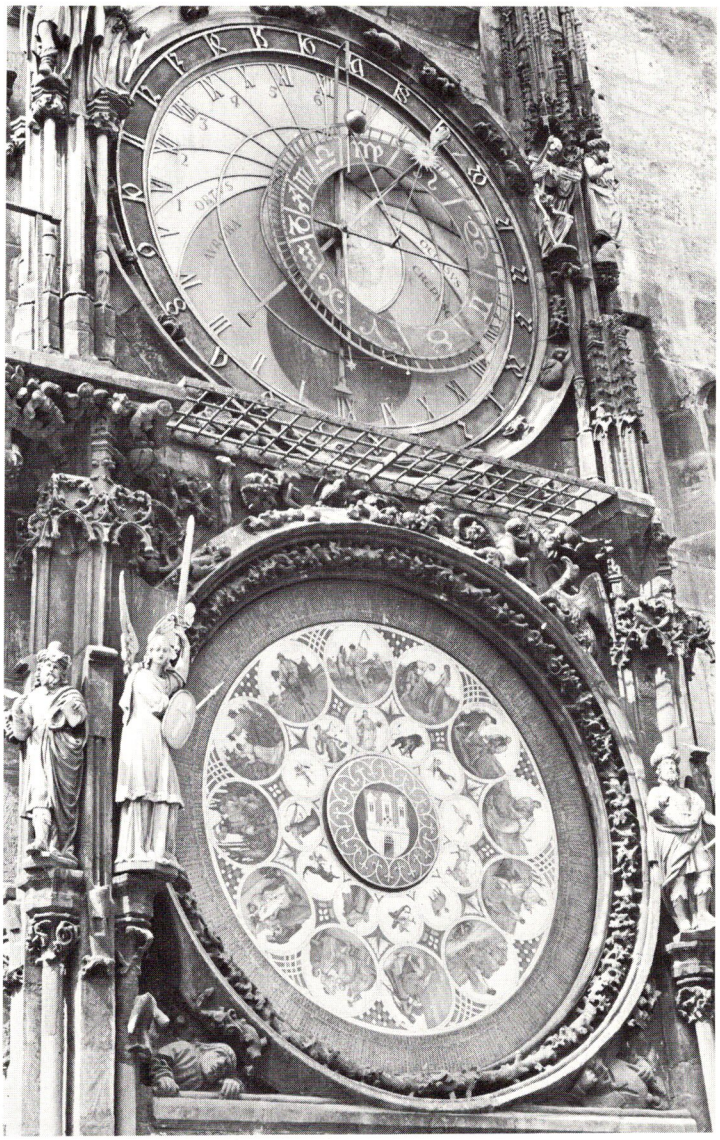


terns. Sometimes you must come back to the same scene for a more appropriate morning or afternoon light.

Architecture, Buildings, and Monuments

Purpose and intent play a more direct role in photographing buildings and monuments as well as other artifacts of man than in most other areas of photography. For a builder you might want to record all stages in construction history from the initial laying out of the site through the final opening of the building. There are innumerable communication and documentation purposes to be served in taking straightforward pictures of building exteriors and interiors. Sometimes these pictures are given dramatic emphasis through the judicious use of wide-angle lenses

The clock in the old town square in Prague. 55mm lens, 1/250 sec., *f*/11, Tri-X. Joseph D. Cooper.



or through dramatic lighting emphasizing contrasting shadow patterns. The picture might be a documentary shot showing the contrast of old and new, or a building or monument might be photographed in the context of people, vehicles, and goods that characterize the purpose of the structure. A building might present interesting geometric patterns. When photographing structures of historical interest, find a viewpoint out of the ordinary; otherwise, simply purchase a postcard or a commercially made transparency.

Wide-angle lenses have a very special place in architectural photography, because they enable you to enclose more area without having to tilt the camera. The familiar sign of tilting is the convergence of the parallel sides of a tall building, creating what might be called an *obelisk effect,* often referred to as *keystoning.* In the photography of skyscrapers this has become so typical that, apart from taking pictures of the very top of the building, the normal thing seems to be to achieve a convergence, notwithstanding that on a drawing board the sides of a building are rendered parallel and are so observed by the occupants of the neighboring skyscraper. This aspect of perspective is not important when you photograph statues and other monuments that display people, horses bearing riders, animals, and other irregularly shaped objects. You can shoot these subjects from any angle to achieve a desired pictorial effect under prevailing light conditions.

As opposed to total-view pictures, you can take photographs of the ornamentation on buildings and of interesting surface textures brought out by side-lighting. The buildings themselves are sometimes best photographed standing alone. Alternatively, they may be recorded in the context of other buildings, new or old. Particularly when photographed at a distance, they might be framed by natural or man-made objects. When you are making the picture, people or vehicles in view might be quite relevant, but otherwise you must wait until irrelevant interferences are out of the way.

Most outdoor architectural photography is done in early- or late-day light to avoid the midday sun, which does not adequately bring out the form, textural surface, and impression of depth needed for good architectural photography. As in outdoor portraiture, direct sunlight should be avoided.

Night shots can be exposed for the reflectance properties of the building or monument by itself, surrounded by utter darkness. If you want to show some of the ground and adjacent areas, the best time to take the picture, at a fairly slow shutter speed, is late in the day, before the sun has set. This enables you to record the dimly illuminated adjacent areas on film.

Interior pictures are usually taken with wide-angle or normal lenses, depending upon the area of coverage and the minimum working distance needed. The camera should be held so that its optical axis is parallel to the floor; otherwise, unattractive perspective effects—mainly awkward convergences of vertical parallel lines—will create an unsightly picture.

From a pictorial standpoint, good layout is important. Too much clutter should be avoided. A neat array of objects can sometimes be achieved by moving furniture and accessories. A piece of furniture can be placed close in and to the side, without occupying much of the picture area, in order to lead the viewer into the picture.

When you use color film, do not mix daylight and artificial light, unless they are in color balance. The two best sources for even illumination are bounce light and interesting arrangements of existing light through regular or alternate lighting fixtures.

Windows often present special prob-

lems, either because they are lighting sources in themselves or because the exterior view seen through the windows must be brought into balance, from an exposure standpoint, with the interior lighting. As to the latter, the first rule is to avoid wide disparities in contrast by taking pictures in the morning or late afternoon and avoiding the brighter noon light.

Marketplaces

A leading attraction for travelers is the marketplace. An institution as old as man, it is full of picture-taking potential. The subject matter will vary with the kind of market, the attributes of the patrons, the local cultural milieu, and the physical characteristics of the market. A bazaar in the Middle East or North Africa offers different material from a street market in Haiti, where the stalls might be carts, tables, or the ground itself.

The markets of London are fascinating. In them you can find vast throngs of eager buyers of every imaginable kind of merchandise—food, clothing, jewelry, antiques, flowers, animals, books, household supplies, souvenirs, and on and on. Some of the markets are neat and well-ordered; others sprawl and meander like water seeking its geographic outlets. Don't just photograph a market as a whole. Rather, seek interesting configurations of merchandise stalls or take close-ups of the bargaining between merchant and customer. In London's Club Row, for example, where household pets are offered for sale every Sunday morning, the drama that repeatedly unfolds has for its cast of characters the animal, which serves as the focus of action, the patient or persuasive merchant, the eager child, and the indulgent or equally eager parent. Working close, your lenses could range from wide-angle through normal, or working at a comfortable distance, the range could be from normal through moderate telephoto. Is it the animal you want, the entire group of actors in this small transactional drama, or individual faces?

Walking through certain streets in the Rive Gauche of Paris, you will encounter attractive displays of fruit and flowers in season. A close-up might be taken of one floral mass with droplets of water picking up the sidelight, which gives form and texture. Or you might shoot a close-up of a young man buying flowers for the lady accompanying him. The corner flower vendor could in himself be an interesting subject, depending on his character and his attire and on the background against which he appears.

In most markets throughout the world you can take pictures without encountering any resistance from the local vendors, but here and there customs may be different. In Tobago, for example, the people don't mind being photographed provided you pay them. In Haiti people will cover or avert their faces when they see you lifting a camera, but their resistance might be overcome through the transfer of a coin. For the truly interesting picture, however, the posed display is seldom worth the coin. Wherever it is and whatever the subject, your aim is to record moments of intriguing interaction in picturesque surroundings.

Your best lighting is in the morning or afternoon with the brightness of the sun obscured by a very thin cloud cover. This helps open up shadows while reducing contrast. At the same time, you still have directional lighting, which gives depth and form to objects. Bright sunlight casts hard shadows, especially when stalls or stands are canopied or when both sides of a street or passageway are lined with merchandise for sale. You cannot really find a compromise between the extreme contrast of bright sun and deep shadow; you might have to work with one or the other. Move



Petticoat Lane in East London at 6:00 p.m. Sunday after a busy day compared with picture below at high noon. Both 21mm lens, Ilford FP4. Bob Collins.






OFTERSHEIM

about, changing your position as you observe the patterns of light distribution. You don't have to raise the camera to your eye to do this. Follow the suggestions on candid technique given earlier in this chapter.

Carnivals and Festivals

Traditionally, most carnivals and festivals are associated with the seasons for sowing and reaping the harvests, particularly the latter, and with religious occasions. They combine pageantry and conviviality. You can photograph costumes, floats, elaborate decor, unusual foods on display, dances, and religious rituals. From the sidelines, you can take many interesting pictures showing costumed marchers, but you must position yourself on the side of the street that affords you the best opportunity for good exposure. If possible, you should know beforehand what will be coming down the street, because you cannot push through the crowded sidewalks for repeat pictures. Ordinarily, you should set the camera for a preselected distance so that you can shoot rapidly, with confidence, when the subject reaches the target of sharp focus. Take a variety of wide-coverage pictures as well as close-ups. Be on the lookout for human interest on the sidelines.

When you photograph parades and festivals, a mixture of groups and individuals helps you to catch the total spirit. The drummer (opposite above) was made with 135mm lens at 1/125 sec., whereas that below was made with the standard 58mm lens, 1/125 sec. between *f*/5.6 and *f*/8 against the sun. The patterning in the picture below was made with the 135mm lens, *f*/8 at 1/125 sec., which introduced some perspective flattening. Ilford FP4. Richard Gee.



Museums and Exhibits

Indoors you would use high-speed color or black-and-white film to take pictures of objects on display. Many museums permit flash, but some do not. Usually there are regulations concerning tripods. You can find out about these by making a telephone call beforehand. There may also be certain picture-taking hours.

When objects are enclosed in glass, you encounter the reflection problem. Polarizing filters are helpful, but then you need to offset the filter factor through the use of flash. For existing-light photography, hold the camera close to the glass, which should be clean. Do the same when using flash without a polarizing filter.

Paintings hung above eye-level are best photographed with telephoto lenses, which enable you to back away far enough so that you don't have to point the lens upward and cause perspective distortions. Make sure that the optical axis—the line from film through lens to subject—is at a right angle to the painting. One way of checking this is to determine whether the corner of the painting fits squarely within the corner of the film area. If not, adjust the camera angle accordingly. Sometimes paintings are hung at a slight angle for convenience in viewing, which calls for a compensatory angle of view with the camera. In addition to taking one or more paintings on the wall in a single picture, move in close for details. When using flash, hold it away from the camera, to the side, to avoid hot-spot reflections. You still might get many smaller reflections owing to the irregularities in paint surfaces. These can be controlled somewhat by placing diffusion material over the flash or through reliance upon existing-light photography.

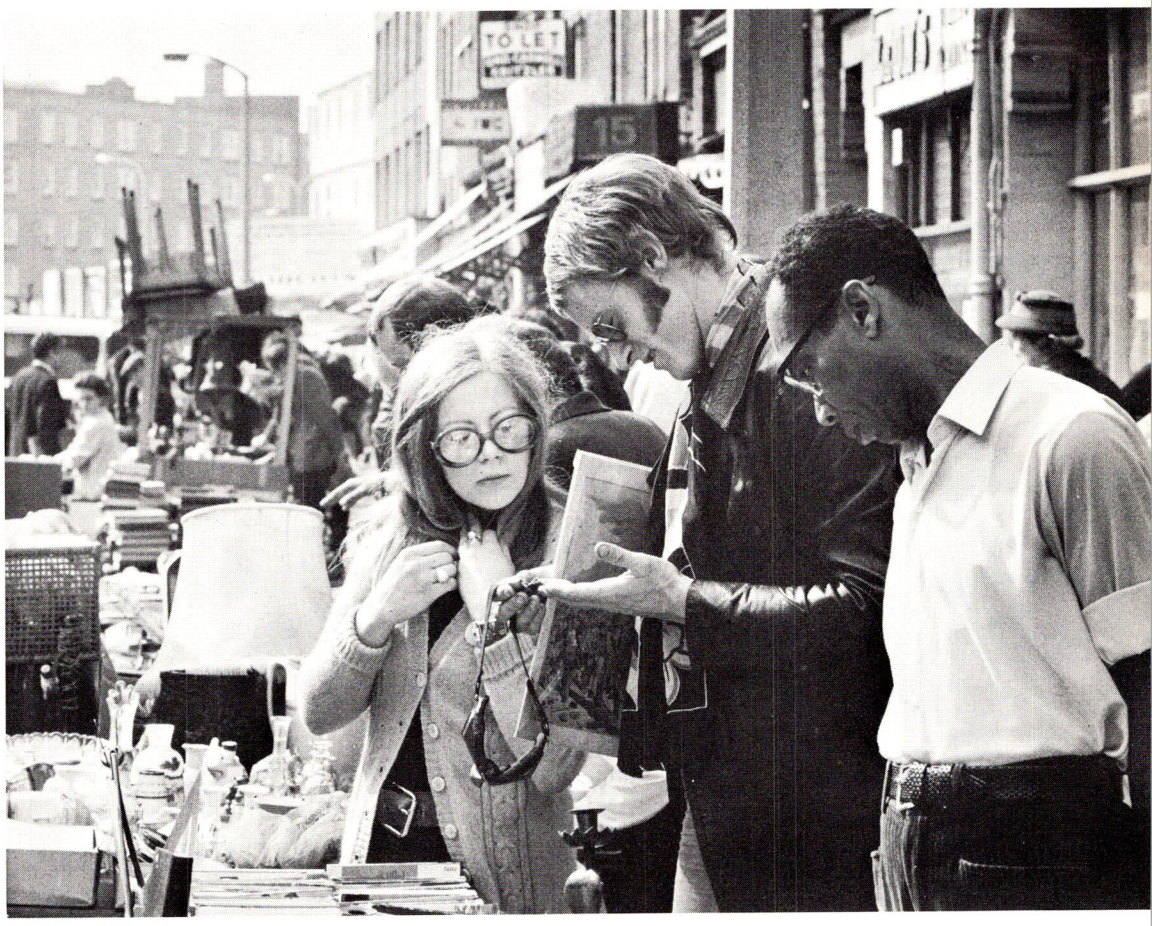
Be aware of other visitors, who are entitled to view the exhibits without obstruction. Work swiftly but deliberately. Be aware also of the picture-taking possibilities the visitors themselves present. Depending upon the kind of museum, you can anticipate opportunities for human interest shots of children interacting with the fascinating materials laid out before them.

Theater, Stage, and Night Clubs

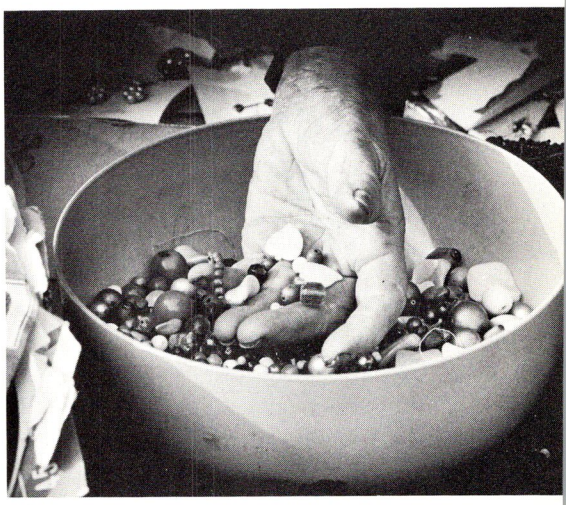
Cameras are generally not permitted in the audience during professional performances. Of course, they may be used by special arrangement during rehearsals, as well as from particular vantage points in the audience. These barriers are not usually encountered when you take pictures of the local high school play. You might on these occasions see people deep in the audience popping flashbulbs, but be assured that they are wasting materials at such relatively great distances. In any event, flash works directly counter to the lighting effects on stage.

Generally, you should use high-speed film in black-and-white or color. With color, consider using a film such as Kodak High Speed Ektachrome Tungsten (Type B) at a pushed rating, as discussed in the chapter on exposure.

It is usually best to attend two shows —one for planning and one for picture-taking. For the best view, sit about six rows back, in the middle or to the side depending upon the vantage point that you consider best. Decide beforehand whether you will use one camera with one or two lenses or two cameras with two different lenses. For the sake of simplicity and the convenience of those in seats next to yours, don't try to use more equipment. Practice taking slow exposures. A monopod might be helpful.



Street markets tend to be cluttered under any circumstances, but when you use a modern telephoto lens so as not to be in the midst of your subjects, the effect is to pack them more closely together. It is often interesting to pick out details more selectively as in lower picture, also taken with 100mm lens. Joseph D. Cooper.







Scene in south Yemen was captured with the 100mm lens, which in this instance had just the right angle of coverage to arrange the sizes and shapes in the picture while retaining the unifying flow of animals across the frame. Graham Finlayson, courtesy *Daily Telegraph Magazine*.

Opposite, the crisp, sharply delineated foregroup anchors the picture and lends depth, for otherwise the aerial perspective would tend to flatten the picture. 100mm lens. Lucien Clergue.



Detail from a ceiling at Hradcany Castle, Prague. 55mm lens at full aperture, Tri-X. Joseph D. Cooper.

Opposite, taken from the Brooklyn side of the East River wtih a 200mm lens. The slight side direction of the lighting lends depth to the buildings. Taken at *f*/5.6 at 1/125 sec., Plus-X. Francisco Hidalgo.


14

Shipyard at Reyjavik, Iceland. The patterning of the parallel poles and the boats of different sizes suggested the picture. 35mm lens, *f*/11 at 1/125 sec., Ilford FP4. Joseph D. Cooper.





At the zoo, a long lens is indispensable, because it selects individual animals and throws background out of focus. This picture was made in the zoo at Basel over a wall without bars. 135mm lens, 1/125 sec., Ilford FP4. Richard Gee.

THINGS

Much of the scope of *things* comes under the heading of moderate close-up photography, but it also extends to larger objects. Your picture-taking problems with animals are not too different from those that govern the photography of small children—both are reasonably predictable and unpredictable! With inanimate objects you are primarily concerned with problems of perspective, light and shade, background, and isolation of individual elements.

Animals and Pets

Your own domestic pets should be fairly easy subjects for pictures. If you know your animal's habits, how it reacts to different stimuli and what attracts its attention, you can create your own picture-taking opportunities. Most cats, for example, will rise on their legs and claw at a ball of yarn or other suspended object.

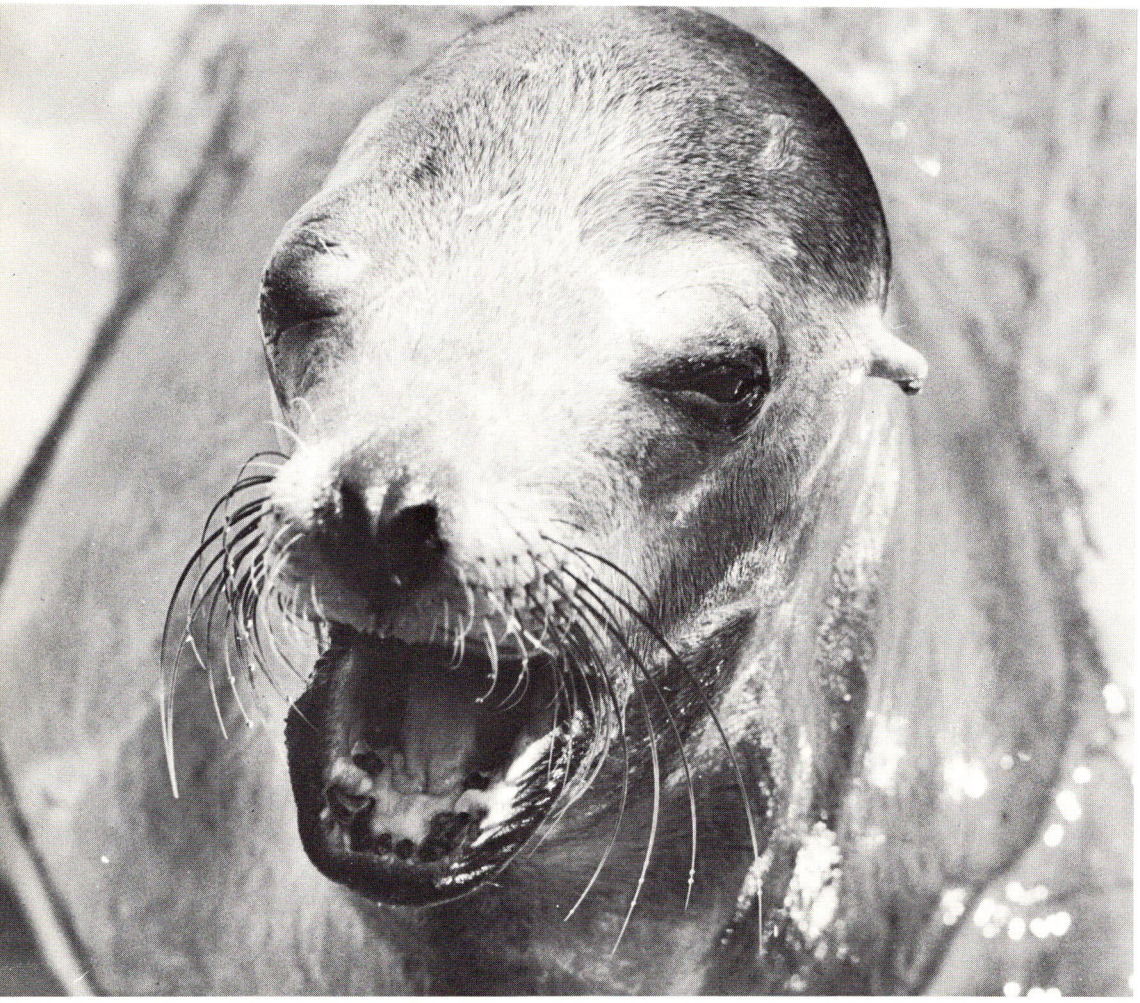
A good shooting angle is important with small animals. If you shoot from above the animal, there will be too much floor and not enough animal. Try dropping down to the level of the animal itself, and use a low-level finder.

Close-ups are important, for they bring out details of expression as well as fur texture. The latter depends upon good lighting and exposure, as described in previous chapters. You add interest by capturing the interplay of the animal

and its surroundings. The interplay between the animal and adults or children adds human interest, provided that the persons are attentive to the animal rather than the lens.

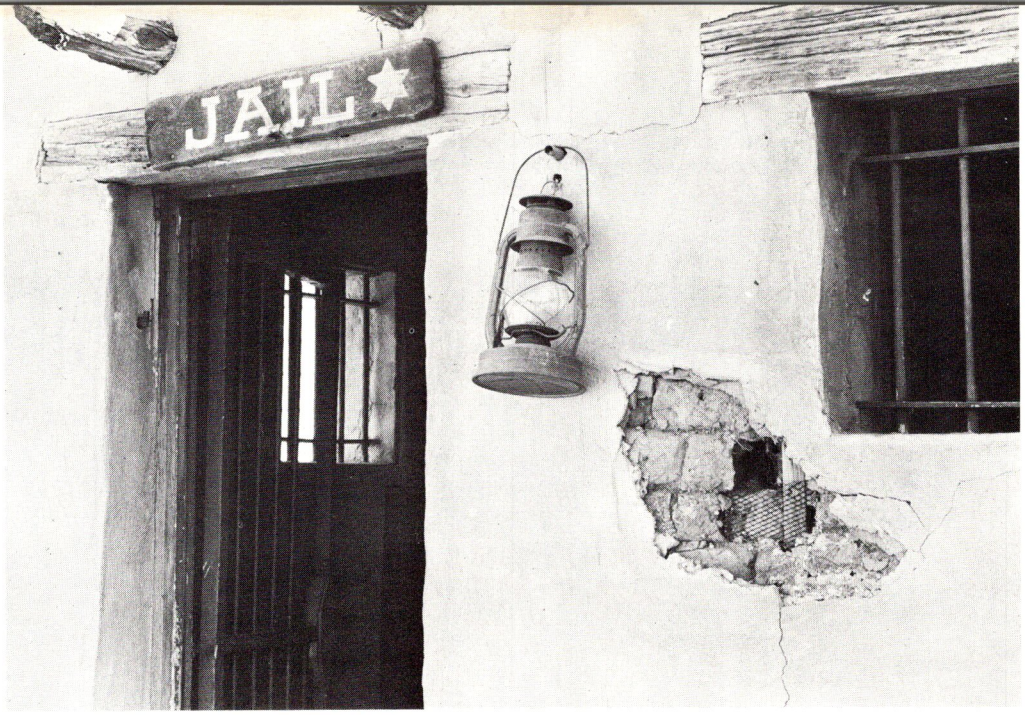
At the zoo you can take pictures through glass cages indoors with high-speed or ultra-high-speed films. Outdoors you can hold the camera so that the lens points between bars or through fence separations. Beware of savage, clawed animals, for they have been known to maim and kill people. They are captive, not tame. Check with the zoo guard if you have the slightest doubt. The telephoto lens is ideal, because it

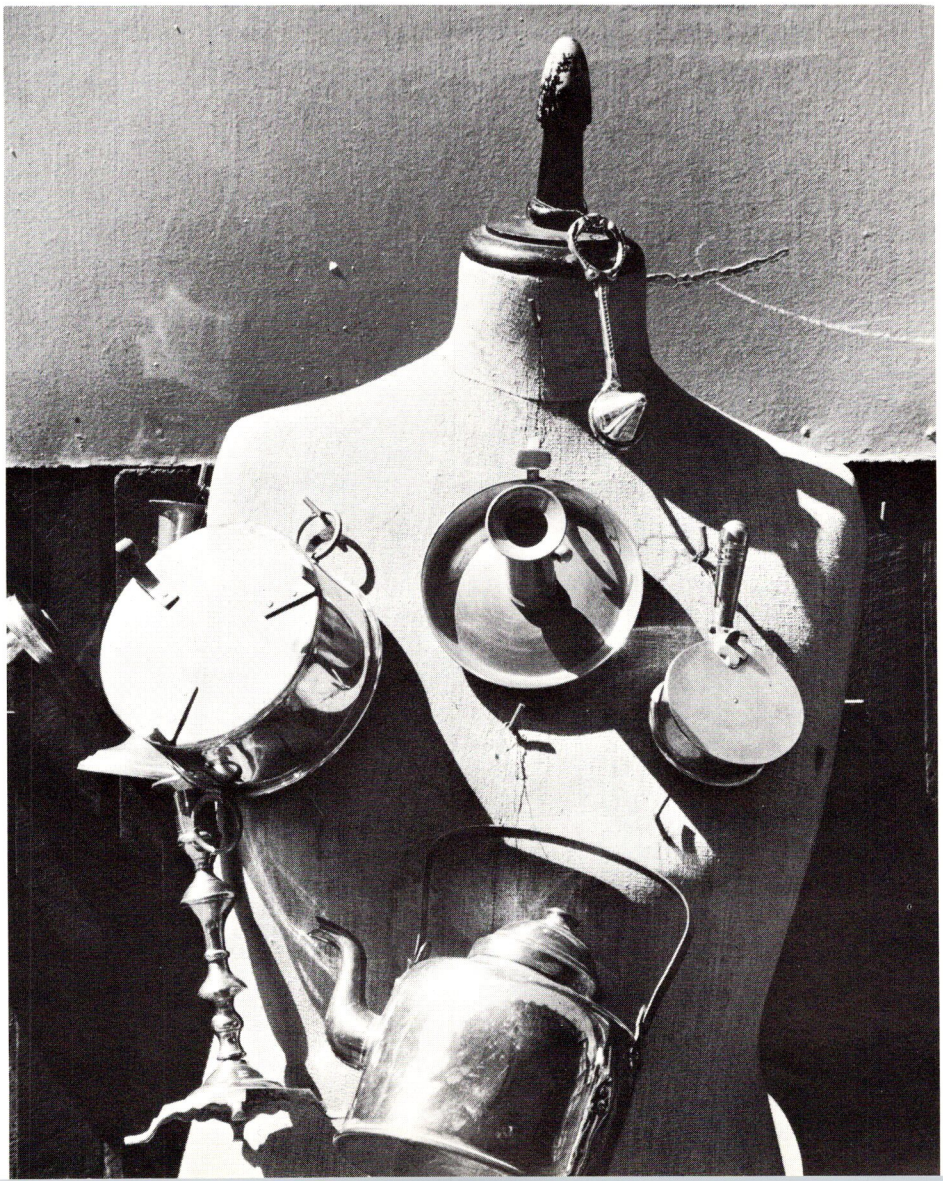
Sea lion at the Whipsnade Zoo. 135mm. Cleland Rimmer.



The pictures on this and on the following three pages are details here and there, all made with 55mm lens, to record the things one wants to recall about one's travels. Joseph D. Cooper.




JAIL



lets you back away from the reach of animals. Telephoto lenses enable you to take pictures of animals in their simulated natural habitats as though they were right out in the open. Sometimes animals are caged behind wire mesh, which disappears when the camera is held close. Allow for some slight exposure loss under such conditions. Get to the zoo early when the crowds are small and the animals rested.

Flowers and Foliage

Flowers can be photographed in small groups with standard lenses and with 28mm and 35mm wide-angle lenses. To isolate single flowers, use one of the Macro Rokkor lenses or a combination of any lens of suitable focal length and an extension device, as covered in the chapter on close-ups.

In good light exposures can be handheld, but a tripod has a number of advantages. It gives you better control over distance focusing and framing. With the camera on a tripod and a long cable release in your hand, you have the freedom to isolate individual flowers and their backgrounds.

Individual flowers can be isolated by tying back the others with string, wire, rubber bands, or garden "Twist'ems." If the flowers are your own, you can cut and transplant them. For background you can use opaque paper or cardboard to simulate light blue sky. You can also use black or white cardboard to obtain different backgrounds and contrasts. If the wind gives some slight difficulty,



use your body, your coat, or cardboard to make a windbreak. The best lighting outdoors is hazy-bright or cloudy-bright, both of which give you soft shadows and a delicate rendition of detail. They soften vivid colors. If you can get a low angle, with the help of a low-level finder, you can use the sky as a clear background. Translucent flowers can be photographed against the sun provided the camera is held close enough so that the petals completely obscure the sun. A small mirror can be used for sidelighting or spotlighting. Special effects can be achieved by spraying droplets of water or plastic spray on your subjects.



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THE ONE INDISPENSABLE ACCESSORY TO THE MINOLTA SYSTEM

THE MINOLTA SYSTEM HANDBOOK is several books in one. It is:

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ABOUT THE AUTHOR

DR. JOSEPH D. COOPER has been writing books on photography since 1958, and has scores of books and articles to his credit. His *SINGLE-LENS REFLEX PHOTOGRAPHY* was one of the first books on the subject. Besides having written numerous camera guides and handbooks, he has produced books in such specialized areas as photography through telescopic devices and ultra-miniature photography. For seven years his column appeared regularly in *Modern Photography* magazine, and he has contributed numerous articles to other leading photographic publications. He has also consulted with many leading photographic manufacturers on the development and design of photographic equipment.

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