KODAK DATA BOOK

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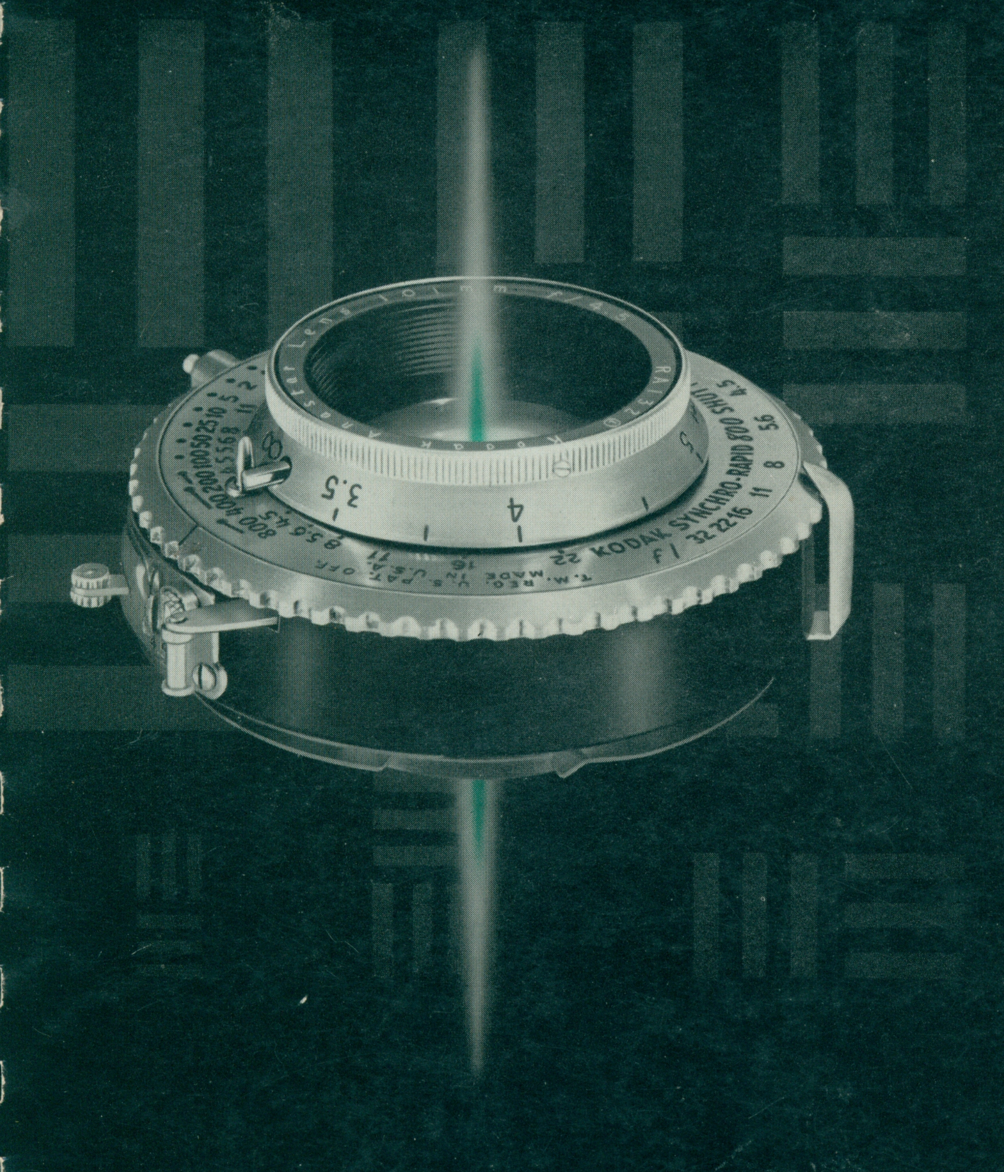
4th Edition

KODAK LENSES

SHUTTERS AND PORTRA LENSES



FOURTH EDITION

KODAK LENSES
SHUTTERS AND PORTRA LENSES

FIRST 1952 PRINTING

THIS Edition of KODAK LENSES, SHUTTERS, AND PORTRA LENSES contains several changes. Product information has been brought up to date, the Data Sheets have been revised, and most of the illustrations have been replaced. Several sections of the text have been enlarged for clarification, including discussions on the function of a lens, focal length, perspective, and angular coverage. The shutter section contains new information on shutter operation and synchronization.

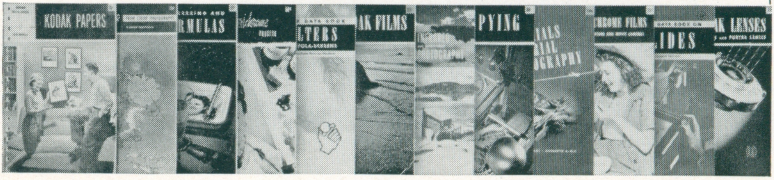
This new edition of KODAK LENSES, SHUTTERS, AND PORTRA LENSES provides owners of the *Kodak Reference Handbook* with a replacement unit for any Lenses Section bearing an earlier printing or copyright date than that at the bottom of the contents page of this book.

Kodak Lenses, Shutters, and Portra Lenses is one of a whole series of Kodak Data Books. Most of them are sold as units; some are also components of the various Kodak Handbooks, such as the *Kodak Reference Handbook* or the *Kodak Color Handbook*. Each is a complete unit in itself.

The *Reference Handbook* contains detailed information on the characteristics and uses of Kodak films, papers, filters, lenses, formulas, and related products. It also treats comprehensively such topics as picture taking, flash and flood lighting, processing, and other photographic techniques.

The *Color Handbook* contains four Color Data Books: Color As Seen and Photographed, Color Photography Outdoors, Color Photography in the Studio, and Kodak Color Films. Extra separators are included in the *Color Handbook* for indexing other color publications.

Additional Data Books and other punched publications describing materials, techniques, and processes for better photography are available for the *Kodak Photographic Notebook*. See your Kodak dealer for complete information.



KODAK LENSES
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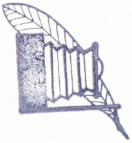

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FOURTH EDITION, 1952
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KODAK LENSES

SHUTTERS AND PORTRA LENSES

PHOTOGRAPHY finds ever wider application in specialized and technical fields on the part of both the professional photographer and the serious amateur. This has led to greater emphasis on the correct and accurate use of the most important part of the camera—the lens. Higher standards in picture quality, the extended practice of color photography, the greater interest in picture taking at all times regardless of adverse light conditions, and increased activity in photographing small objects—all demand more attention to such matters as lens correction, lens definition, exact focus, effective lens aperture, depth of field, proper use of supplementary lenses, etc. The excellence of a lens or shutter alone will not necessarily assure precise results; their properties must be fully understood and correctly applied.

The information presented on the following pages is intended to afford a better understanding of lens and shutter operation. In addition, the characteristics of many Kodak lenses are described in detail in the Data section. Optical formulas are included for the convenience of those faced with special problems.

Accelerated interest in close-up photography with Kodak Portra Lenses, and in flash photography with Kodak flash shutters, has prompted the inclusion in this book of detailed material on these subjects. Several graphs and drawings are included to aid the reader in understanding and applying the information.

Photographers who desire a more comprehensive study of the theory, use, and selection of lenses for various photographic purposes should consult Rudolf Kingslake's excellent book "Lenses in Photography," available through Kodak dealers everywhere.

Lens Properties

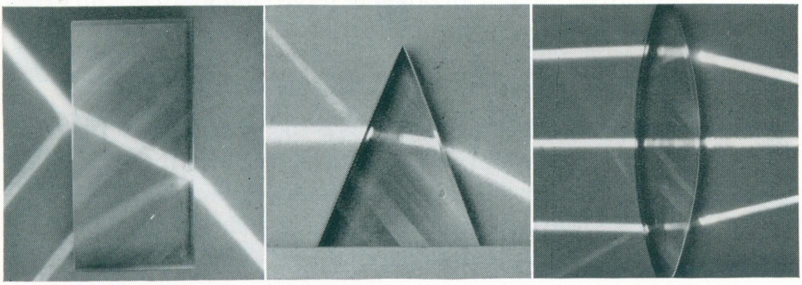
• In discussing lens systems, it is not necessary to consider other than a simple wave motion theory to describe the behavior of light as it passes through a lens. Light is one of a number of known forms of radiant energy which travel with wave motions. Fortunately for the lens designer, these waves are extremely small compared to camera lens apertures, causing beams of light to travel in straight lines. Longer wave lengths, such as those of sound, travel around corners, and if light waves were of this length, a camera would be extremely difficult, if not impossible, to construct.

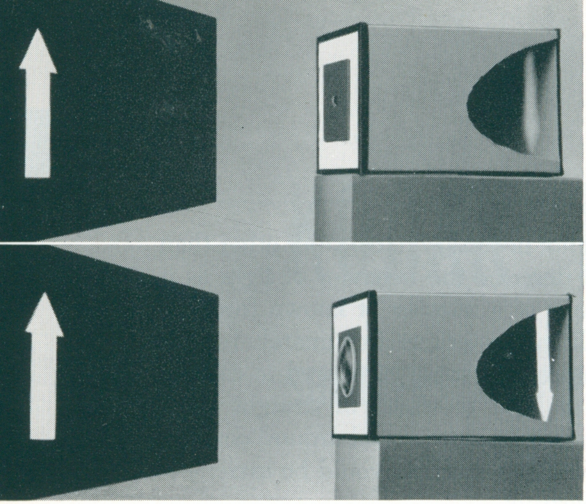
Light energy travels along these straight paths at the tremendous velocity of about 186,000 miles per second in air. When a light ray enters glass from the air, its speed is reduced; when it returns to the air, it resumes its original speed. If the ray enters or leaves the glass at any angle other than 90 degrees, it is bent, or "refracted," in a predictable manner, the extent of refraction being controlled by the nature of the glass and the angle at which the ray strikes the surfaces.

If the entering and emerging surfaces of the glass are parallel, light rays passing through will continue in the original line of travel. If the entering and exiting surfaces are not parallel, such as in a prism, the rays will emerge in a different direction from the original path.

Although the surfaces of a lens are usually spherical, a simple convex lens functions in a manner somewhat similar to the effect produced by placing two identical prisms base to base. All of the rays of

Light beams passing through glass blocks of various shapes. The light is traveling from left to right. Note surface reflections. *Left*—If the entering and exiting surfaces are parallel, the light continues in the same direction. *Center*—A prism causes deviation in the line of travel. *Right*—A lens also bends light rays; in the case illustrated, the rays will converge eventually at a point along the subject—lens axis.





Top—Actual photograph of the image formed of an illuminated arrow through a "pinhole." To admit sufficient light, the pinhole was made larger than normal; consequently, the image is considerably diffused. *Bottom*—The opening in the front of the box was enlarged and a lens inserted. The image is brighter and sharper.

light reflected from any one point on the subject being photographed and passing through the lens will be focused as a virtual point at the film plane of the camera. In both theory and practice, this "point" is never a true point, but instead, a circle small enough to appear as a point to the eye.

Actually, pictures can be made without using a lens. Many a youngster has built a pinhole camera capable of making quite presentable photographs. However, the scope of picture-taking possibilities is restricted to inanimate objects since the small opening (usually about 0.01 inch in diameter) admits very little light and average exposures must be in the range of several seconds to minutes.

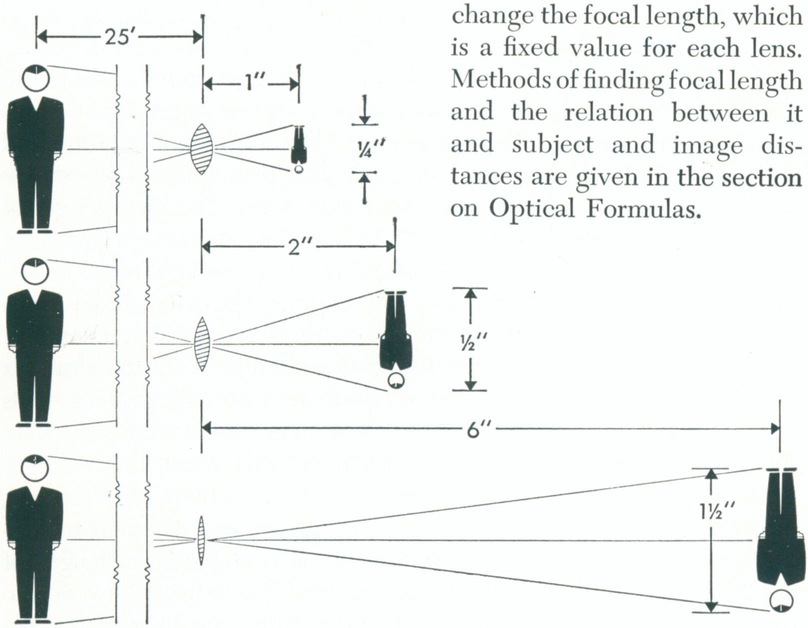
If the opening is made larger, the exposure time is reduced, but the image becomes objectionably soft long before any great advantage in exposure is obtained. When a lens of proper design is inserted, the opening can be enlarged to admit more than 50,000 times the amount of light passed by a pinhole, with the light rays refracted so that a point will once more image small enough so as to appear as a point. This, then, is the primary function of a lens—to focus the rays of light which are admitted through an opening large enough to obtain exposures in the desired range.

FOCAL LENGTH

A fundamental characteristic of any lens is the focal length. The focal length of the lens is the property which determines the size of the image of an object placed at a given distance from the lens. For all practical purposes, the light from a point in an infinitely distant scene may be said to enter the lens as parallel rays. The lens bends these rays so that they converge behind the lens to form an image of the point from which they originate. The distance from this image to the rear nodal point (see page 43) in the lens is the focal length of the lens.

The longer the focal length, the larger the image of an object at a given distance. For example, if a man six feet tall stands 25 feet away from a 1-inch lens, the lens forms an image of him about ¼ of an inch high. A 2-inch lens forms an image twice as high; a 6-inch lens, six times as high; and so on. It is important to stress that the focal length and not the type of lens determines how large an image is formed by the lens. A 6-inch telephoto lens for 16mm motion pictures gives an image the same size as a normal 6-inch lens for a 4 x 5-inch press camera or a 6-inch wide-angle lens used on an 8 x 10-inch view camera, when the object is at the same distance from the three lenses. All lenses of the same focal length form images of the same size, whether they are telephoto, wide-angle, or any other type of lens.

With any lens, as the subject distance decreases, the light from points in the subject enters the lens along increasingly divergent rays. *Since the light-bending power of a lens is fixed, as the subject distance decreases, the distance behind the lens at which the rays converge to a point increases.* Far objects will focus close to the lens, near objects farther behind. This does not change the focal length, which is a fixed value for each lens. Methods of finding focal length and the relation between it and subject and image distances are given in the section on Optical Formulas.



PHOTOGRAPHIC PERSPECTIVE

Human eyes see in three dimensions, but a lens reproduces a view in two dimensions only. The missing dimension, depth, is suggested mainly by the relative size and position of the various objects in the picture. The relation of these objects, or perspective, and therefore the naturalness of the picture, are determined by the position of the camera. A camera position too close to the subject results in an exaggerated magnification of the parts nearest the lens. Common examples are close-ups of people made with lenses of short focal length—hands, knees, feet, or features may be grotesquely enlarged in extreme cases.

Correct perspective in the final picture depends largely upon the distance at which it is viewed. Contact prints should be viewed at a distance equal to the focal length of the lens with which they were made, but frequently this distance is so short that the eye is unable to see the picture in focus. A roll-film camera using 620 film and producing 2¼ x 3¼-inch negatives normally has a lens of 4-inch focal length. Four inches is entirely too close for comfortable viewing of contact prints made from these negatives and the average observer will view such prints at 10 to 15 inches. At this distance, the rendering of perspective will not be accurate. Fortunately, excepting in extreme instances where very near and very distant objects of recognizable size appear in the same photograph, most individuals do not recognize this slight distortion and the results appear quite satisfactory.

If a magnifying lens having a focal length approximately equal to the focal length of the camera lens is used for viewing contact prints at the proper distance, the eye is relaxed in its accommodation and the photograph appears more natural. This principle is used extensively in hand viewers for miniature color slides. The focal length of the lens in most hand viewers is 2½ to 3 inches, and since most color slides are made with cameras having lenses of approximately 2 inches in focal length, slides viewed in this manner appear to have much better perspective than when viewed alone at greater distances.

Enlargements require a viewing distance equal to the camera-lens focal length times the number of diameters of enlargement. This usually results in a viewing distance more convenient to the eye than the one most desirable for contact prints, with the result that enlargements seem to convey an improvement in naturalness. For pictures projected on a screen, the correct viewing distance is equal to projector-screen distance multiplied by the ratio of the focal length of the taking lens to that of the projection lens. It is natural, however, to view any picture at a distance convenient to the eye when looking at the picture as a whole. Only if this results in a departure by more than a factor of 2 from the correct viewing distance is the rendering of perspective noticeably affected.

The best balance between normal perspective in the picture and compact still-camera design calls for a focal length slightly greater than the picture diagonal. Lenses with a focal length appreciably shorter than this are known as wide-angle or wide-field lenses. Long-focus lenses, such as the telephoto type, exceed the diagonal considerably in focal length.

To obtain large images at distances which are sufficient to render pleasing perspective and to provide a comfortable working distance, lenses used in portraiture should have a focal length of from one and one-half to two times the diagonal of the negative.

Lens Focal Length and Room Dimensions. In view of both the preference for a long-focus lens for portraiture, and the desirability of using the same lens for larger subjects, such as groups, the photographer is sometimes faced with the problem of selecting a studio or room of adequate size to permit the full utilization of his portrait lens. Sometimes the problem is one of selecting the longest practical lens focal length for the dimensions of a given room. The formulas and examples in the section on Optical Formulas are helpful in such cases.

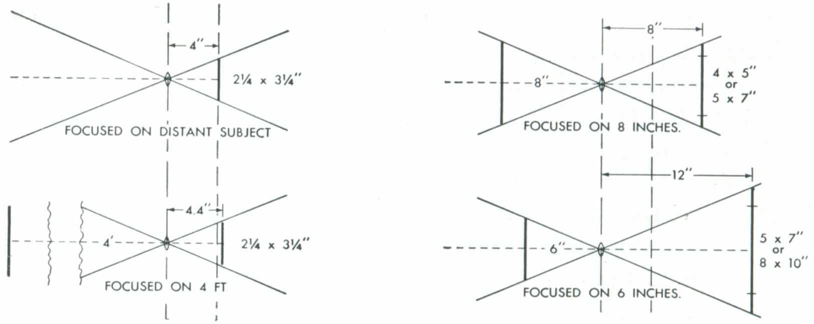
ANGULAR COVERAGE

A lens has a fixed angular covering power, which means that the area of good definition produced at the film plane is a circle described by a given angle subtended at the lens. This circle of good definition is seldom as large as the actual area of illumination projected by the lens. It is customary to state the field of a lens in terms of the area of acceptable sharpness, and not of the total area "seen."

Photographic lens systems cover a much wider angle of view than most other lens systems. Telescopes, microscopes, and similar objectives cover a field of view of from 5 to 10°; normal lenses for still photography, about 50°; and wide-field lenses, about 75°. Since in viewing motion pictures it is necessary to see the entire picture at a glance, most cine lenses have an angular field of about 30°.

The size of the circle of good definition produced by a lens depends on the image distance. When the image moves farther behind the lens, as it does when the subject approaches the lens, the circle of good definition increases, although the angular coverage does not change.

When the subject has moved up to twice the focal length away from the lens, then the image is two focal lengths behind the lens. In the



Although the angular coverage of a camera lens remains constant, the size of film which can be sharply covered changes with the lens-to-film distance.

case of a 4-inch lens as used for 2¼ x 3¼ cameras, when the subject is 8 inches in front of the lens, the image is 8 inches behind it. In such a case the lens will cover a 4½ x 6½-inch area, since this comes within the angle of good definition of the lens. When the subject is only 6 inches from this same lens, the image is 12 inches away and the angle of good definition would cover a 6¾ x 9¾-inch area.

An application of this property is the photography of objects taken actual size or greater than actual size. In practice, it is necessary to use a very small aperture to obtain sufficient depth of field. This incidentally reduces any aberrations which might be introduced when the lens is used in a manner for which it is not computed.

LENS DIAPHRAGM AND ITS MARKINGS—*f*-NUMBERS

While slower lenses have a fixed opening or a series of apertures in a movable slide or disk, faster lenses have an adjustable opening to vary the amount of light passed. The size of this opening as compared to the focal length is indicated by a diaphragm scale, generally marked in *f*-numbers. Each *f*-number is the focal length divided by the effective diameter of the diaphragm. The *f*-numbers 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, and 45 indicate successive *decreases* of one half in light intensity (an aperture of *f*/5.6 gives twice as bright a picture as *f*/8, *f*/4 twice as bright as *f*/5.6, and so on). Most lenses do not have a range of apertures this great, and often the largest will be less than one full increment from the next marked one. Some continental cameras use a different series of *f*-numbers, such as 2.3, 3.5, 4.5, 6.3, 9, 13, 18, 25, etc. Since settings can be made anywhere on the scale, no difficulty should be experienced in applying American Standard aperture settings to such a series of openings.

The modern practice of coating lenses increases light-transmission efficiency to the point where, at a given *f*-number, there is no practical difference in light transmission between coated, complex lenses and single lenses (see "Lumenized Lenses," page 18). The *f*-numbers of older, uncoated lenses, however, do not serve as a universal measurement of the actual amount of light transmitted, because different types of older lenses vary appreciably in their light-transmission efficiency. An uncoated lens having eight glass-air surfaces, for example, may transmit only about 60 percent as much light as a single lens, due to loss of light by reflection.

The U.S. (Uniform System) markings in which the numbers are proportional to the exposure required were formerly used on a number of lenses. The U.S. markings compare with the *f*-values as follows:

f	*f*/4	*f*/5.6	*f*/8	*f*/11	*f*/16	*f*/22	*f*/32	*f*/45
U.S.	—	—	4	8	16	32	64	128

Effective *f*-Number for Extreme Close-Ups. In extending the bellows to make extreme close-ups, the image distance becomes appreciably greater than the focal length; hence the *effective* f-*number* will be higher than indicated. This is especially important in color photography and in copying. The formula for computing the effective *f*-number is given in the Optical Formulas section. It also can be determined quickly and without calculation by using the Effective Aperture Computer in the Kodak Master Photoguide, sold by Kodak dealers (see page 30).

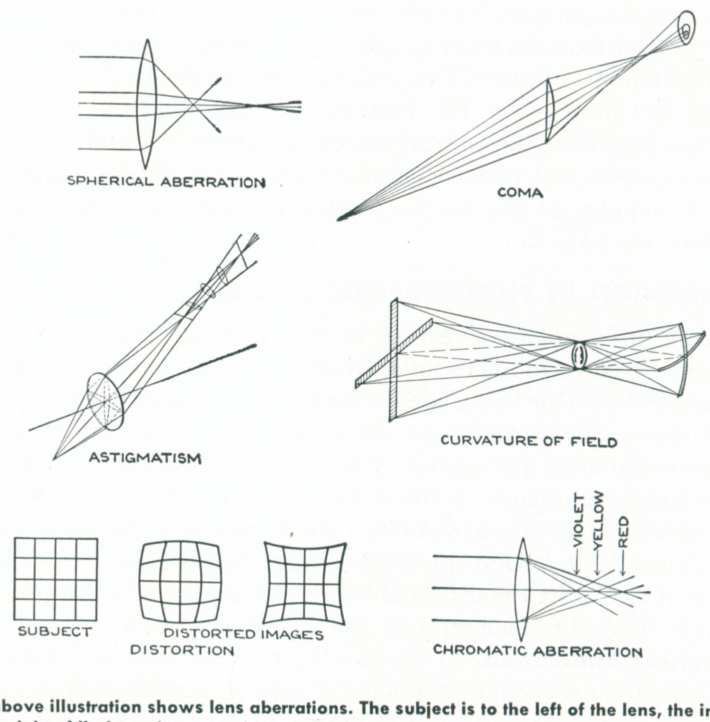
CORRECTION IN PHOTOGRAPHIC LENSES

A single convergent lens can be used to form an image. The image will, however, be found to suffer from defects due to lens aberrations, especially when the lens is used at large relative apertures. Kodak lens designers and lens makers use every means known to optical science to eliminate these aberrations or reduce them to a degree consistent with good performance. Some of the inherent shortcomings of lenses which are corrected in Kodak objectives to make them meet the exacting demands of modern photography are briefly listed. Readers interested in further details should consult a good textbook on optics, such as "Lenses in Photography" by Rudolf Kingslake.

Spherical Aberration. In the case of a simple lens with spherical surfaces, the rays coming through the central portion of the lens and the rays coming through an outer zone do not converge at the same distance from the lens. As a result, a point is imaged as a blur. The aberration is caused by the spherical lens surfaces and is therefore called "spherical aberration." The effect of a small amount of this aberration on the image of an extended subject is to cover it with a haze of light. Spherical aberration becomes progressively harder to eliminate as the speed of a lens is increased.

Coma. Coma is a kind of lateral spherical aberration. In spherical aberration itself, the various zones of a lens suffer from a longitudinal difference of focus for rays parallel to the lens axis. Coma affects the rays which enter at an angle to the axis. When coma is present, these oblique rays passing through the various zones converge at different distances from the center of the image so that the image of a single point in the subject roughly resembles an arrowhead pointing either toward or away from the center of the field.

Astigmatism. In this aberration, a single point in the subject is imaged, not as a point, but as two short, mutually perpendicular lines at different distances from the lens, the "best image" of the point lying



The above illustration shows lens aberrations. The subject is to the left of the lens, the image to the right. All aberrations are shown greatly exaggerated.

somewhere between them. The distance between the lines is a measure of the astigmatism present in the lens. Neither coma nor astigmatism exists at the center of the picture or, in other words, on the axis of the lens system.

Curvature of Field. The field of a lens is the imaginary surface where the image of the subject is brought to focus. The field of a simple lens is not flat, but concave, or saucer-shaped. As a result, a flat subject at right angles to the lens axis is brought to focus, not in a plane as would be desirable for recording the image on a flat film, but on a concave surface. In order to provide a satisfactorily sharp image over the entire picture area in cameras, such as box cameras, which have a simple lens, the film is placed at the distance for best average focus, and a small relative aperture is used to increase definition and depth of focus. In some simple-lens cameras, the film is held in a curved position, approximating the concavity of the lens field.

Distortion. In the case of distortion, the magnification varies from the center of the picture outward. This results in a distortion of the image and causes a square object to be imaged as either a barrel-shaped or a cushion-shaped figure. When distortion is present, a straight line running across the center of the picture remains straight, but straight lines lying in the outer parts of the image field are bowed. Distortion is not reduced by stopping down the lens aperture.

Chromatic Aberration. Because the amount of refraction, or bending, of a ray of light upon entering or leaving a polished glass surface varies with the color of the light, every property of a lens depends on color. Thus the position of the image itself changes slightly with the color, or wavelength, of light; this effect is known as axial, or longitudinal, chromatic aberration. This deficiency can be reduced by using the proper combination of two or more different kinds of glass.

Lateral Color. The varying degrees of refraction of different colors can result in another aberration, known as lateral color or chromatic difference of magnification. This can occur in a compound lens even though the lens may be corrected for the chromatic aberration as described above. In the case of lateral color, while all the color images may be focused in the same plane, the effective focal length of the lens varies slightly from one color to another; this results in differences in magnification of the respective color images. If present, this aberration results in colored fringes surrounding the images in the outer parts of the field. In black-and-white photography, they appear as a slight blur or fuzziness, but in color work, colored fringes may show up very badly. This aberration is not reduced by stopping down.

Lens Performance

• The term "definition" refers to the ability of a lens to form a clear image of fine detail. Not even a theoretically perfect lens would be capable of imaging a point source of light as a geometrical point. All practical lenses image such a point as a small blur which changes in character with the change of lens aperture.

DEFINITION AT VARIOUS APERTURES

In addition to reducing speed and increasing the depth of field, decreasing the lens aperture improves definition, as it removes the small amount of haze caused by residual aberrations. This also results in a slight increase in image contrast. As a general rule, the best compromise between optimum definition and speed is made by closing down the diaphragm from wide open about two stops for moderately fast lenses, such as *f*/4.5's, and about three stops for faster lenses.

The wave nature of light sets an ultimate limit to the increase in definition as the aperture is closed down. A beam of light passing through an aperture does not continue unchanged, but spreads slightly at the aperture edge in a manner similar to the spreading of water waves after passing through a small opening in a breakwater. The smaller the opening, the greater the spreading. Definition may be unfavorably affected by this spreading of light as the minimum aperture is approached. If best definition is desired, it may be advisable to use a diaphragm setting one to two stops away from the minimum.

Enlarger lenses used at their smaller lens apertures may limit print definition in extreme enlargements due to the diffraction effect mentioned. This limit is seldom reached in ordinary work.

Good lenses will perform satisfactorily at all stops provided. However, for extremely critical work, especially with ultrafast lenses and those of short focal length, it is well to take into consideration the above two factors influencing definition. In general photographic work, these small changes in performance are of little consequence.

DEFINITION AND CAMERA TECHNIQUE

Poor definition and lack of sharpness in negatives are more often due to faults in camera handling than to lack of lens quality.

Focusing for Visible Light. As the subject-to-lens distance is reduced, the lens-to-image distance must be increased. With lenses of comparatively short focal length and small aperture, as used on Brownie cameras and simple Kodak cameras, the depth of field is sufficiently great to cover the range of distance normally used for picture taking. When faster lenses are used at their greater apertures, the depth of field is more limited and focusing is necessary. With cameras provided with ground-glass or coupled-rangefinder focusing, this operation is simple and exact. Using cameras with scale focusing requires an ability to estimate distances rather closely. For all close-up work and when working at maximum lens apertures with fast lenses, the distance cannot ordinarily be estimated with sufficient accuracy, and should therefore be measured by a ruler or with the help of a rangefinder.

When focusing a camera by means of a ground glass, to obtain unit (1 to 1) magnification, it is necessary, after approximate focus and image size have been obtained, to move either the camera back (if this is possible) or the entire camera, in order to obtain sharp focus.

Focusing for Infrared. Focusing a lens by ground glass, rangefinder, or distance scale setting produces sharp pictures only with visible rays. Infrared rays, because of their longer wavelength, come to a focus slightly beyond the focal plane for visible rays. Some focusing scales provide a special index mark to be used when taking infrared pictures. The Data Sheets list corrections for some lenses.

For best definition, infrared photographs should be exposed with the smallest lens opening that conditions permit. This is particularly important since moving a lens corrects *only for longitudinal color aberration,* and ordinary photographic lenses are not corrected in other aberrations for the infrared part of the spectrum. If large apertures must be used, and the lens has no auxiliary infrared focusing mark, a focusing correction can be established by photographic focusing tests. A basis for trial is the extension of the lens by ¼ of 1 percent of its focal length. A tripod should be used whenever possible.

Camera Motion During Exposure. Small cameras are not held sufficiently steady by the average person for longer than 1/50 to 1/100 second. Large hand cameras cannot be held longer than 1/25 second without danger of blurring. To release a shutter properly, a slow "trigger-squeeze" finger movement should be used without moving the rest of the hand. A graphic test of a person's ability to release the shutter without moving the camera can be made by attaching a mirror to the front of the camera, directing the light beam of a projector or flashlight at the camera, and releasing the shutter while watching the reflected spot on a wall 10 to 20 feet away. With practice, the shutter can be released without moving the reflected spot.

CIRCLE OF CONFUSION AND DEPTH OF FIELD

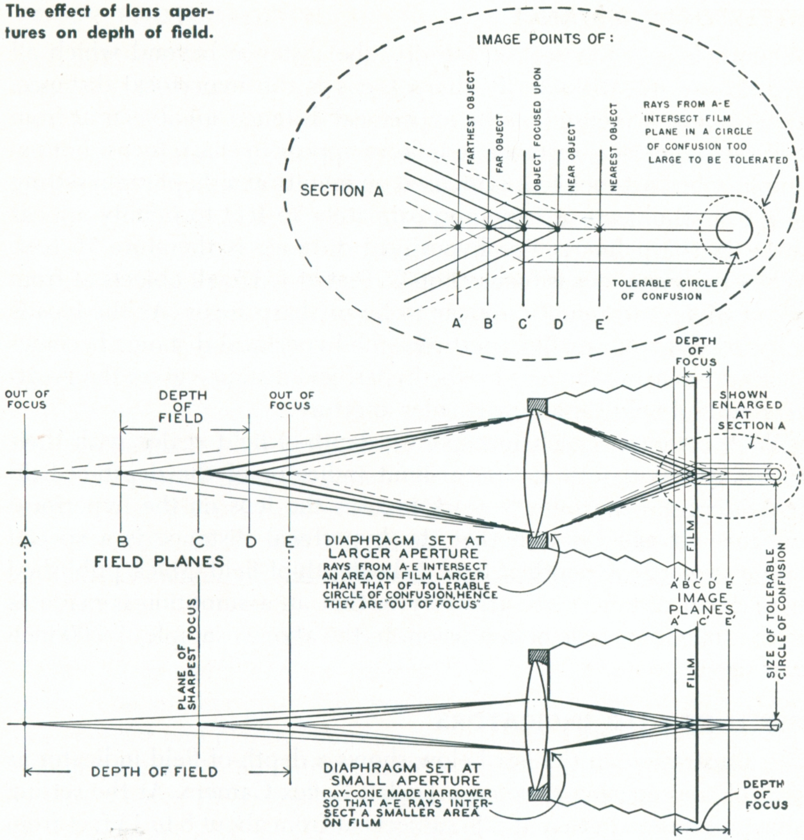
Theoretically, when a lens is focused for a certain distance, objects at that distance only are sharp. Objects at all other distances are more or less out of focus, and points outside of the plane focused upon are imaged as blurred circles which are referred to here as "circles of confusion." The farther the points are from the plane focused on, the larger the circles of confusion and the greater the out-of-focus effect.

For extremely critical definition, the circle of confusion *in the print* should approach 1/200 inch, if the print is to be viewed at an average distance of 10 inches. Greater viewing distances, such as those used for enlargements, permit proportionately larger circles of confusion without apparent loss of definition. Stated on an angular basis, the circle of confusion should not subtend more than two minutes of arc at the eye when the print is viewed for correct perspective (i.e., viewing distance equal to the focal length of the camera lens times the amount of enlargement, if any). For ordinary purposes, however, a circle of confusion of 1/100 inch in the print is acceptable. When the circles of confusion exceed this limit, they appear to the eye as small blurs rather than points, and detail within the image no longer appears sharp. The size of the circle of confusion which is accepted as tolerable is not a mark of lens quality, but is purely a mathematical value chosen for the purposes of computation.

"Depth of field" of a lens refers to the range of distances on the near and far sides of the plane focused upon, within which details are imaged with acceptable sharpness in the final print when observed from a normal viewing distance. Other things being equal, depth of field *increases* with increasing subject distance and with decreasing focal length; depth of field *decreases* with increasing relative aperture.

In addition to the factors previously mentioned, the depth of field for any lens is dependent upon the size of the circle of confusion which is considered as acceptable. In computing the depth of field for Kodak lenses, a circle of confusion of 1/200 inch is used for folding Kodak cameras, 1/500 inch for miniature Kodak cameras, 1/1000 inch for 16mm Cine-Kodak cameras, and 1/2000 inch for 8mm Cine-Kodak cameras. For Kodak lenses intended for commercial, press, portraiture, and studio work, a circle of confusion of 2 minutes of arc, which is equal to approximately 1/1720 of the focal length, is used in computing depth of field. This is a smaller circle than is ordinarily used in computing depth-of-field tables for such lenses and is for critical definition when the print is viewed for normal perspective. At the limits of the range of sharpness, the circles of confusion are of the above

The effect of lens apertures on depth of field.



dimensions, and between the limits, the circles are smaller. In the plane focused upon, these circles have a minimum diameter.

Since the eye, at 10 inches, accepts a circle of confusion of 1/100 inch as a point, it follows that the actual depth of field in a photograph also depends on the amount of enlargement in the print and the distance at which it is viewed. These affect the choice of diameter of the circle of confusion used in computing the depth of field for the camera lens. For this reason, the seemingly well-defined limits of sharpness given in depth-of-field tables should always be recognized as arbitrary mathematical values. The depth of field which is apparent in the photograph may be more or less, depending on the degree of reduction or enlargement in the final print, and on the distance at which the print is viewed. Also, the minuteness of detail in the scene is probably an important factor in determining the circle of confusion.

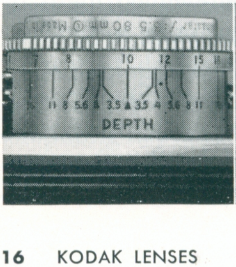
HYPERFOCAL DISTANCE

When a lens is focused on infinity, the distance beyond which all objects are in satisfactorily sharp focus is the hyperfocal distance. When a lens is focused on the hyperfocal distance, all objects at from half the hyperfocal distance to infinity appear in sharp focus. For example, when a 4-inch lens is focused on infinity at a diaphragm setting of *f*/3.5, all objects at from approximately 75 feet to infinity appear to be in sharp focus. The hyperfocal distance is therefore 75 feet. When the same lens is focused on 75 feet at *f*/3.5, all objects at from about 37 feet to infinity appear to be in sharp focus. As the lens is stopped down to smaller apertures, the hyperfocal distance becomes shorter. Focusing the lens on the hyperfocal distance gives the greatest depth of field for any particular aperture.

With cameras which incorporate depth-of-field scales with their focusing scales, setting the far-limit indicator of the depth-of-field scale opposite the infinity mark focuses the lens on the hyperfocal distance. It can be seen that the hyperfocal distance is a special application of the depth of field. Like depth-of-field tables, published hyperfocal distances are arbitrary in that an assumption is made as to the tolerable circle of confusion. In the above example, 1/200 inch was used.

DEPTH-OF-FIELD INDICATORS

The illustration on the left below shows a depth-of-field indicator as part of the focusing scale on a Kodak Reflex Camera. At the setting shown it indicates that at *f*/8, subjects at from about 8 to 13 feet from the camera will be acceptably sharp. The right-hand illustration shows the depth-of-field indicator used on the Kodak Medalist II Camera. The distance focused upon is automatically brought opposite the index mark. Controlled depth of field will help not only to emphasize or to subdue foreground or background selectively, but also to avoid "wasting" depth of field. The following example, using a 100mm lens and its depth-of-field scale, will illustrate this: The subject is 50 feet away; exposure conditions call for *f*/11. If, instead of focusing at 50 feet, the indicator dial is turned until "infinity" comes to the *f*/11 line, the index mark is at 22 feet, and the gain in foreground sharpness is 6 feet. The camera is therefore focused for 22, not 50 ft.



COLOR PHOTOGRAPHY

Kodak lenses of recent and present manufacture, according to their intended purposes, are adequately color corrected. The critical user can, however, test any lens for sufficient lateral color correction in the following manner: A test object of white threads should be arranged against a black-velvet drop. These threads should be well illuminated, placed to fill the picture area, and critically focused on the camera ground glass. An image of a thread, close to one edge of the ground glass and parallel to that edge, should be examined carefully. If color fringing is apparent, the lens is not satisfactory for exacting color work, although it may be suitable for color transparencies which are not intended as originals for color printing.

If a lens is to be used for extremely critical work, a more rigorous test can be made photographically with the same subject, as follows: Three separate exposures should be made on panchromatic plates, such as Kodak Tri-X Panchromatic Plates, Type B, with Kodak Wratten Filters No. 25, 58, and 47B. Plain gelatin filters are recommended; ordinary cemented or glass filters are not sufficiently accurate for this type of test.

These plates should be developed to low contrast, fixed, washed, and dried, as usual, and a contact positive should be made from one of them on another plate. The positive also should be developed to a low contrast and placed emulsion-to-emulsion with each of the other two negatives over an illuminator to see if the thread images coincide exactly. One of the test plates can be used to check the performance of the enlarger lens, if enlarged separation negatives are to be made, by focusing the enlarged image critically on the easel, then examining it for color fringing. If there is only a slight departure from register, definition may be satisfactory for many types of work, and the lens can be tried on a typical subject.

The critical color photographer can choose from a wide selection of Kodak lenses, available in focal lengths up to 14 inches. Kodak Ektar, Wide Field Ektar, and Commercial Ektar Lenses are color corrected to meet the most exacting demands.

Kodak Lenses

• The Eastman Kodak Company makes a complete line of lenses for still and amateur motion-picture cameras as well as for enlargers, projectors, and other photographic equipment. Here only Kodak still-camera lenses will be described in detail. Data for many lenses are given in the Data Sheets. Summaries of Kodak lenses for enlarging are given on page 56.

LUMENIZED LENSES

Most Kodak lenses now bear a thin, hard coating of magnesium fluoride to reduce surface reflections, and thereby reduce flare light and spots. Kodak lenses so coated are called "Lumenized" lenses. Picture quality is improved, with higher contrast and more detail in the shadows. In addition, the shadows in color pictures have greater color purity. Back- and cross-lighted scenes are easier to photograph, and less trouble from flare or internal reflections is encountered with the sun or bright lights in front of the camera.

Lumenizing slightly increases the speed of a lens having many glass-air surfaces. More of the light which forms the image is transmitted, but less flare light is produced, which has the effect of increasing the image illuminance in the highlights and decreasing the flare light in the shadows. In reversal processes the increase may amount to as much as a third of a full stop; in negative-positive processes no allowance should be made.

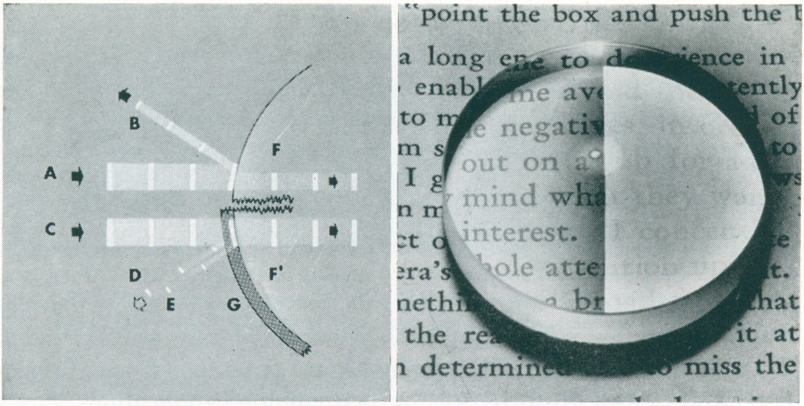
When all the elements including condensers of a projection system are Lumenized, screen brightness is increased—50 percent in the case of the Kodaslide Projector, Model 2A. The projected picture quality is also improved, mostly in the shadows.

Lumenized enlarger lenses tend to give improved highlight detail, especially from negatives of high contrast or large shadow areas.

Lumenized lenses, as currently made, bear a circled "L" engraved on the mount. Coated lenses can also be identified by the slight tint seen by reflected light. The lens is uncolored by transmitted light.

Dirt on Lumenized lenses tends to cancel the advantages of Lumenizing. Oil spots look like holes in the surface. Lumenized lenses should be cleaned in the usual way, as described on page 33.

The nature of the process used by the Eastman Kodak Company makes it practical to Lumenize lenses only during manufacture, and



Left—Action of Surface Treatment: Part of light beam A is reflected as B from untreated lens F. When light beam C reaches lens F' with coating G, reflected rays D from the surface of G and E from the surface of F' are out of step and cancel out. *Right*—Strong reflection from a lens of which the left half of both surfaces is Lumenized. In this case the stronger reflection came from the under surface.

before the lenses are assembled. Uncoated lenses therefore cannot be accepted for Lumenizing.

KODAK LENS MOUNTS

Precise centering and rigid support of lens elements is essential for good lens performance. The elements must be firmly mounted in alignment along a common optical axis, and must maintain the exact separation specified by the designer. Lens mounts often are highly-complicated lens control mechanisms, incorporating in some cases the rangefinding, focusing, and diaphragm adjustments.

Since metals differ in their characteristics, Kodak experts make use of the special capabilities of various metals, specifying that certain lens-mount parts be made of aluminum, others of hard brass, and still others of special bronze, or steel. These parts are machined on optical lathes of unusual precision. Kodak lens mounts are designed to minimize flare light; in many cases, knife-edge baffles are used.

Special attention is paid to finishes, such as anodizing and plating, for complete protection and smart appearance. Where lubricants are needed, they are chosen to allow smooth operation under all conditions. Diaphragm openings and focusing scales are carefully designed for accuracy and for convenience of operation. Click stops are provided on the diaphragm scales of most Kodak lenses. Lenses supplied in interchangeable mounts are prefocused on optical benches.

KODAK LENSES FOR STILL CAMERAS

• Superior photographs are made with superior lenses. Kodak has long enjoyed an enviable reputation for fine lens-making—whether for the simplest cameras requiring but a few dozen parts or for the precision Kodak Medalist II, requiring 796 separate pieces.

KODAK EKTAR LENSES

The name "Ektar" identifies Kodak's finest lenses for still photography, motion-picture photography, enlarging, and projection. The name "Kodak Ektar Lens" applies to taking lenses in general for normal still photography, while other series within the family are the Kodak Cine Ektar Lenses, Kodak Enlarging Ektar Lenses, and Kodak Projection Ektar Lenses. Unsurpassed for their intended applications, lenses bearing the Ektar name are popular among photographic workers who demand lenses that will meet the most exacting requirements.

Ektar Lenses are the result of the combined efforts of designers and lens makers in creating the best lenses that skill, care, and optical research can produce. For example, astigmatism, which is normally present to some extent in all lenses, has been reduced in Ektar Lenses to a new minimum. Lumenizing all Ektar Lenses reduces flare, and improves the clarity and brilliance of the image in black-and-white and in color negatives. Color purity in Kodachrome or Kodak Ektachrome transparencies also is improved. Color correction has been carried out to such a degree that color pictures made with Ektar Lenses not only satisfy the demands of the most critical color workers, but meet the far stricter requirements of photomechanical color reproduction.

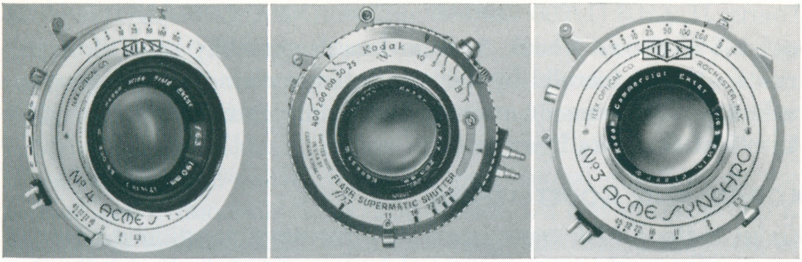
All Kodak Ektar Lenses focus as a unit. They are supplied on cameras, and separately in shutters and in barrels.

Kodak Ektar Lenses for Small and Medium-Size Cameras. Kodak Ektar Lenses, 101mm *f*/4.5, in Kodak Synchro-Rapid 800 Shutter, and 105mm *f*/3.7, 127mm *f*/4.7, and 152mm *f*/4.5, in Kodak Flash Supermatic Shutters are available for medium-size view and press cameras. The 127mm *f*/4.7 lens is also supplied in a Kodak Supermatic-X Shutter. The Kodak Medalist II Camera has a Kodak Ektar Lens, 100mm *f*/3.5; the Kodak Signet 35 Camera, a 44mm *f*/3.5 Ektar Lens.

Kodak Ektar and Commercial Ektar Lenses for Large Cameras. The following lenses are especially designed for view cameras:

Kodak Ektar Lenses—

7½-inch *f*/4.5, in barrel or Ilex Acme Synchro or Universal Shutter
8-inch *f*/7.7, in Kodak Flash Supermatic Shutter
12-inch *f*/4.5, in Ilex Universal Synchro Shutter



Lenses for portrait, press, commercial, and illustration photography. ***Left to right*****—Kodak Wide Field Ektar Lens, Kodak Ektar Lens, and Kodak Commercial Ektar Lens.**

Kodak Commercial Ektar Lenses—
- 8½-inch *f*/6.3, in barrel or Ilex Synchro Shutter
- 10-inch *f*/6.3, in barrel or Ilex Synchro Shutter
- 12-inch *f*/6.3, in barrel or Ilex Synchro Shutter
- 14-inch *f*/6.3, in barrel or Ilex Synchro Shutter

Kodak Wide Field Ektar Lenses *f*/6.3. Kodak Wide Field Ektar Lenses *f*/6.3, in focal lengths of 80, 100, 135, 190, and 250 mm, represent an exceptional advance in lens design and manufacture. They provide superb color correction, flatness of field, and freedom from distortion, and are applicable to all types of photography, including portraiture, and photography at unit magnification. In addition, they provide fine definition over more than twice the picture area covered by lenses of conventional design. This feature makes the Kodak Wide Field Ektar Lenses especially useful for such applications as architectural, press, group, or interior photography.

KODAK ANASTAR LENSES

Kodak Anastar Lenses are highly corrected lenses especially designed for use on amateur cameras, such as the Kodak Reflex II, Kodak Tourist II with Kodak Synchro Rapid 800 Shutter, and Kodak Flash Bantam Cameras. They employ the simple and convenient front-element focusing method. Usually consisting of four elements, the Kodak Anastar Lenses approach Ektar Lenses closely in definition and color correction at the generally used lens-to-subject distances. All Anastar Lenses are Lumenized.

KODAK ANASTON LENSES

Kodak Anaston Lenses are well-corrected lenses of the anastigmat type, designed for use on Kodak amateur cameras, such as the Kodak

Tourist II, $f/4.5$ (1/200 shutter) and $f/6.3$, and the Kodak Pony 828 and 135 Cameras. Kodak Anaston Lenses generally have three elements, and are focused by moving the front element. They give excellent performance in ordinary amateur picture taking. All $f/4.5$ Anaston Lenses are Lumenized.

KODAR AND KODET LENSES

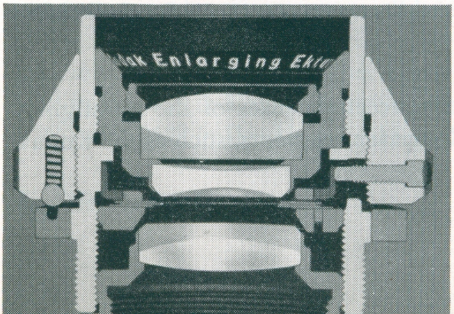
Kodar is the Kodak trade-mark for a focusing, anastigmat-type $f/8$ lens used on such cameras as the deluxe model of the Kodak Duaflex II. The Kodet Lens is a fixed-focus lens supplied at present on the lowest-priced Kodak Duaflex II and Kodak Tourist II Cameras. These lenses permit the taking of sharp, clear pictures in black-and-white or on Kodacolor Film with simple cameras, bringing good photography within the scope of the casual snap shooter.

KODAK ENLARGING LENSES

• A lens which gives excellent results in a camera may not perform equally well as an enlarger lens, especially at low degrees of magnification. Good enlarging lenses are especially corrected for the short working dimensions of the enlarger. They have to work between flat fields. Since the usual way of focusing an enlarger lens is by visual inspection of the projected image, the longitudinal chromatic aberrations must be exceptionally well corrected. Enlarger lenses used for the making of color-separation negatives must also be well corrected for lateral color to insure precise register. The Kodak lenses listed in the Data section are expressly designed to produce good enlargements. All Kodak Enlarging Lenses are Lumenized.

KODAK ENLARGING EKTAR LENSES

Kodak Enlarging Ektar Lenses, available in focal lengths of 2, 3, and 4 inches, are the darkroom counterparts of Kodak Ektar Lenses for still cameras. All corrections have been carried out to an exceptionally high degree for critical work in both black-and-white and color. They will give excellent definition through a wide magnification range of from 35mm to 2¼ x 3¼-inch negatives. Click stops are provided to facilitate identifying diaphragm stops in the dark.



Cutaway view of Kodak Enlarging Ektar Lens shows complex, precision-engineered mount.

KODAK ENLARGING EKTANON LENSES

Kodak Enlarging Ektanon Lenses in 2-, 3-, and 4-inch focal lengths are good-quality lenses of moderate price—ideally suited to the needs of the amateur working with negatives from 35mm to 2¼ x 3¼ inches in size. Enlarging Ektanon Lenses in focal lengths from 5⅜ inches to 10 inches are high-quality lenses for professional enlarging in the portrait and commercial fields. The 10-inch *f*/8 lens in this group is particularly recommended when maximum definition is required, as in graphic arts applications.

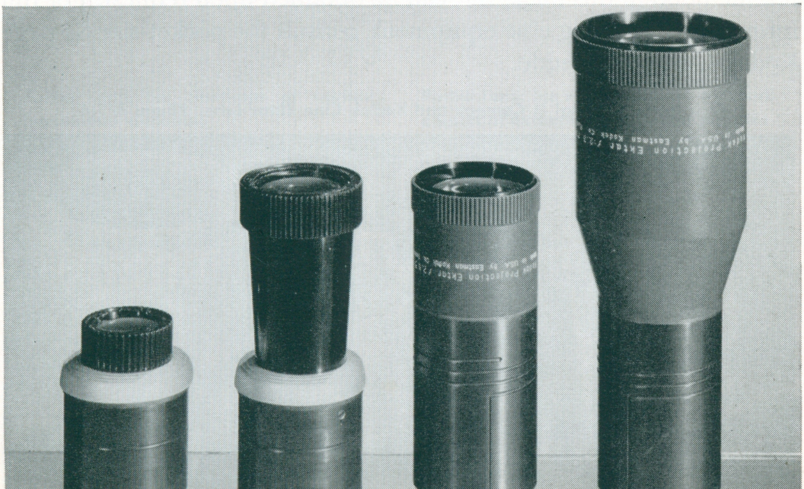
LENSES FOR KODASLIDE PROJECTORS

• In order to obtain satisfactory screen illumination, lenses for slide projectors must have relatively large apertures. Extremely fast projection lenses are simpler than camera lenses of comparable speed and focal length because the angle of view of projector lenses is smaller, and optical problems arising from angular coverage are less complicated. Besides requiring fine lens definition and flatness of field, the projection of 2 x 2-inch Kodachrome transparencies demands good visual color correction and efficient light transmission. Kodak projection lenses for Kodaslide Projectors are mounted in specially designed, antireflection barrels which contribute to superior screen brightness and image contrast. In addition, all glass-air surfaces, including those of the condenser lenses, are Lumenized.

KODAK PROJECTION EKTAR LENSES

Kodak Projection Ektar Lenses are available for the Kodaslide Projector, Master Model, in 5-inch and 7½-inch focal lengths, both with apertures of *f*/2.3. Five elements, exposing only six glass-air surfaces, carry out corrections—especially those for visible color—to an extremely high degree. Definition and flatness of field are unexcelled.

Kodak Projection and Projection Ektar Lenses for the Kodaslide Projector, Master Model.



The 7½-inch lens projects a 40-inch image of a 35mm transparency at a distance of 19 feet or a 20-foot image at 113 feet, while the 5-inch lens projects a 40-inch image at 13 feet or a 20-foot image at 75 feet.

KODAK PROJECTION EKTANON LENSES

Kodak Projection Ektanon Lenses are available in a 5-inch *f*/3.5 size for the Model 2A, Master Model, and Merit Projectors, and a 7½-inch *f*/4 size for the 2A and Master Model Projectors. These economical lenses, of somewhat smaller aperture and simpler construction than the Projection Ektar Lenses, are leaders in their field. They have contributed largely to the universal popularity of the dependable Kodaslide Projectors, Model 2A and Master Model, and the Kodaslide Merit Projector. All Kodak Projection Ektanon Lenses are Lumenized, and all are mounted in special antireflection lens tubes.

KODAK CINE LENSES

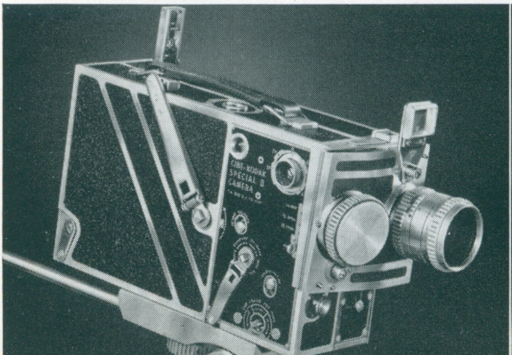
• Kodak Cine Lenses for 8mm and 16mm movie cameras are manufactured in focal lengths ranging from 9 mm to 152 mm, and are available with maximum apertures of from *f*/1.4 to *f*/4.5. All are skillfully designed and carefully manufactured. They are well hooded and baffled as a safeguard against reflections, and each lens is Lumenized.

Of special interest is the Kodak Cine Ektar Lens, 25mm *f*/1.4. This is the finest lens ever manufactured for professional and for advanced amateur movie makers. Designed for use with precision 16mm movie cameras, such as the Cine-Kodak Special II Camera, this lens combines very high speed and critical definition.

Flatness of field is unmatched and the image is brilliantly flare-free. The expertly designed diaphragm and focusing scales permit easy reading and fast adjustment of controls. The numbers on the diaphragm scale are uniformly spaced, eliminating crowding.

Optical data and detailed descriptions of Kodak Cine Lenses are not included in this book, but can be obtained upon request. For full information on using cine equipment, consult the pocket-size 34-page Kodak Cine Photoguide.

Cine-Kodak Special II Camera and Kodak Cine Ektar Lens, 25mm *f*/1.4.

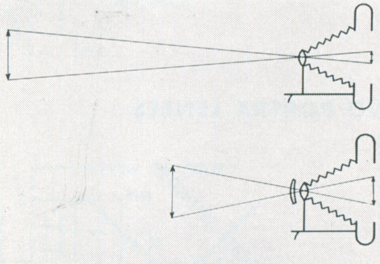


KODAK SUPPLEMENTARY LENSES

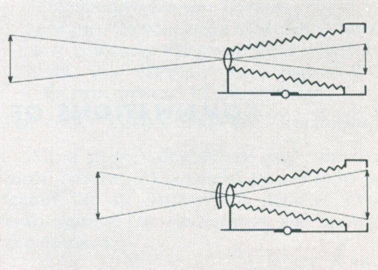
• Two kinds of Kodak supplementary lenses are available. They are the Kodak Portra Lenses 1+, 2+, and 3+, which can be used singly, or in combination to obtain powers higher than the 3+, and the Kodak Telek Lenses 1—, 2—, 3—, and 4—. Kodak Portra Lenses are positive meniscus lenses, and Kodak Telek Lenses are negative meniscus lenses. The numbers refer to power in diopters (explained later in this section).

APPLICATIONS OF PORTRA LENSES

1. When used with cameras which otherwise cannot focus for subjects closer than 3½ or 4 feet, the near focusing limit is brought closer to the camera, thus permitting copying and small-object photography.
2. With cameras having double-extension bellows, Portra Lenses yield larger images of small objects, in some cases greater than the object size. The Portra Lens 3+ provides the greatest magnification.
3. Portra Lenses can be used on view-type cameras for emergency wide-angle effects, since the focal length of the combined camera lens and Portra Lens is shorter than that of the camera lens alone.
4. The magnification range of an enlarger can be extended by the addition of a Portra Lens. Both lower and higher magnifications than are normally permitted by enlarger construction can be obtained. This assumes that the lower limit is set by the maximum bellows length, and the upper limit by the maximum height of the enlarger head. The 3+ lens has the greatest effect.

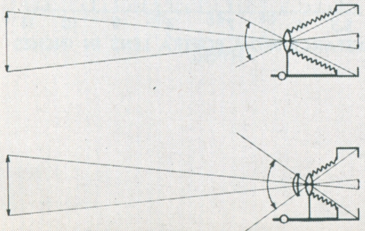


Portra Lens: for close-ups at normal lens-to-film distance.

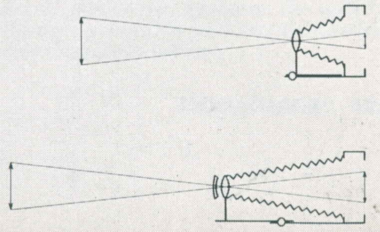


Portra Lens: for larger pictures of small objects at extended lens-to-film distance.

Portra Lens: for wide-angle work at shorter than normal lens-to-film distance.



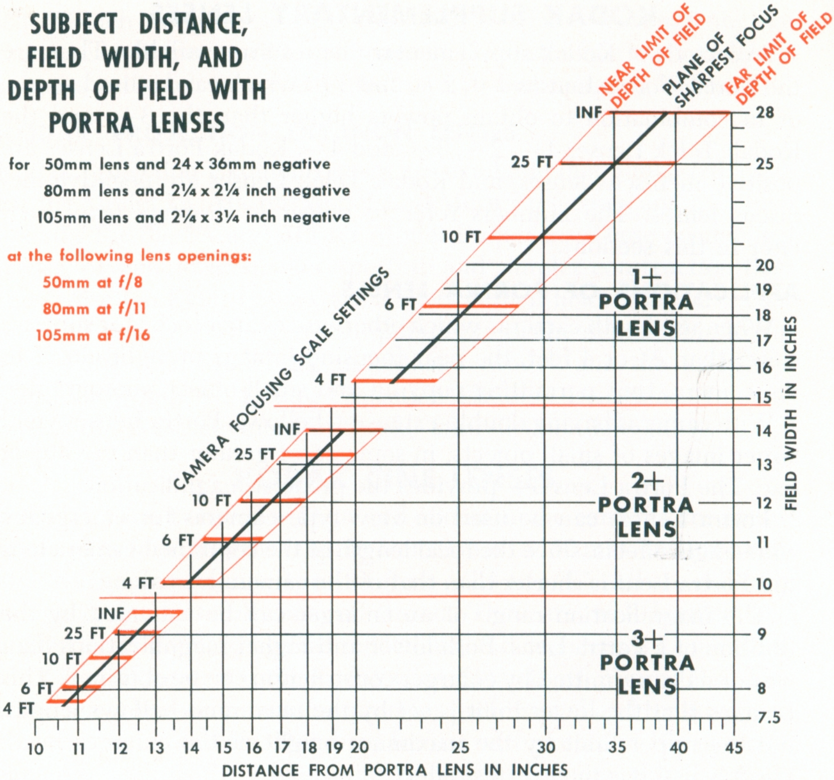
Telek Lens: for larger images of distant subjects with long bellows extension.



SUBJECT DISTANCE, FIELD WIDTH, AND DEPTH OF FIELD WITH PORTRA LENSES

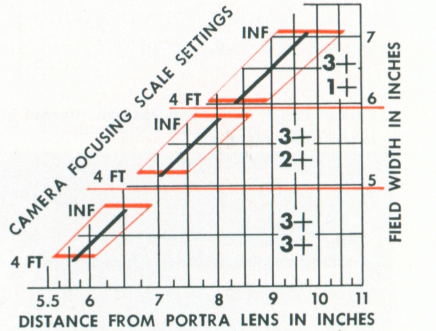
for 50mm lens and 24 x 36mm negative
80mm lens and 2¼ x 2¼ inch negative
105mm lens and 2¼ x 3¼ inch negative

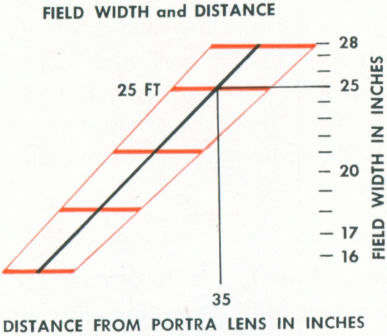
at the following lens openings:
50mm at *f*/8
80mm at *f*/11
105mm at *f*/16

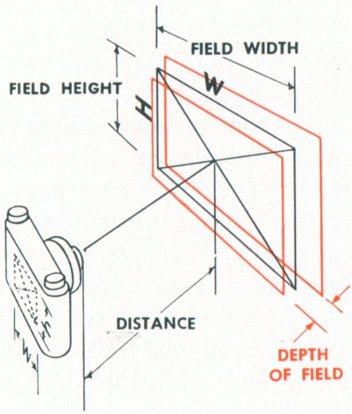


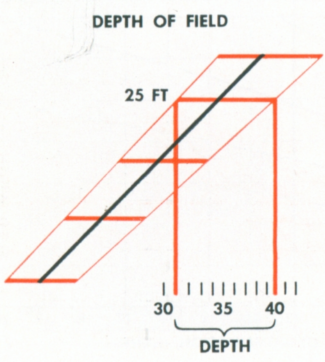
COMBINATIONS OF TWO PORTRA LENSES

at the following lens openings:
50mm at *f*/16
80mm at *f*/22
105mm at *f*/32









HOW TO USE THE GRAPHS

To Find Distance and Field Size

Distance (Portra Lens to subject): Note point on black line for focusing scale setting and Portra Lens concerned. Distance is given below this point. Applies to all cameras.

Field Width: From the same point, read sideways to the width scale.

Field Height: is equal to

$$\frac{h \times W}{w}$$

Field size data for new negative sizes and focal lengths (F) can be derived as follows, assuming a definite subject distance:

1. For the given negative size, but new focal length—

$$W(\text{new}) = \frac{W \times F}{F(\text{new})}$$

2. Both negative size and focal length differ from values given—

$$W(\text{new}) = \frac{W \times F \times w(\text{new})}{F(\text{new}) \times w}$$

3. *Transparencies in Kodak Ready-Mounts.* The Ready-Mount opening for a 24 x 36mm picture is 23 x 34mm. Therefore multiply the given field width by 0.94. For Bantam size, use 26.2 x 38.1mm instead of 28 x 40mm.

For other Portra Data see "Formulas."

All of these calculations give approximate results. Exact field size should be found by an improvised ground glass held against the opening in the back of the camera.

Depth of Field

Note the point on the black line for the focusing scale setting and Portra Lens concerned. The depth is given by the extent of the horizontal red line, read on the distance scale. Since the depth is shallow, measure the subject distance accurately and use the smallest practical lens aperture.

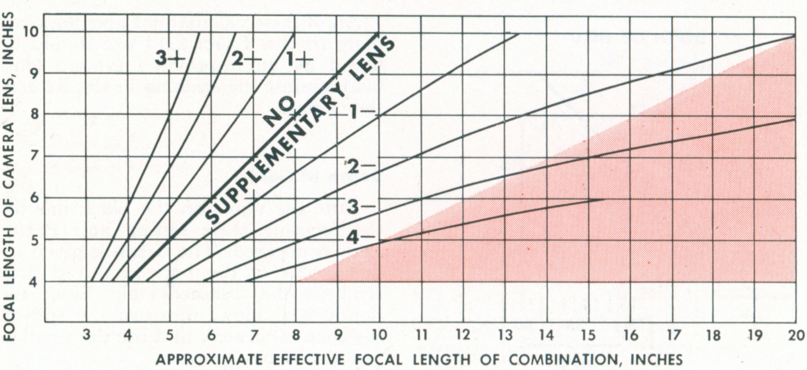
Kodak Telek Lenses can be used only with cameras having double-extension bellows or other means of greatly extending the lens-to-film distance. Focusing must be done on a ground glass. Telek Lenses have the effect of increasing the focal length, which gives more pleasing perspective in portraiture. The 4— lens gives the greatest effect. Telek Lenses cannot be used with roll-film or miniature cameras, since the image falls too far behind the film.

PROPERTIES

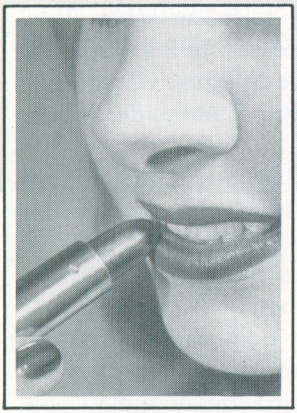
Power in Diopters. The rating of a Kodak supplementary lens (2+, 3+, 2—, 3—, etc.) indicates its power in diopters. The plus sign indicates a positive or converging lens. The minus sign indicates a negative or diverging lens. The power in diopters is the reciprocal of the focal length in meters. Thus, a 3-diopter lens has a focal length of ⅓ meter, or 39.3 inches divided by 3, or approximately 13 inches. When two such lenses are used together, their combined power in diopters is practically equal to the sum of both powers, that is, a 2+ and a 3+ used together are equivalent to a 5+; in this case the focal length is 39.3 divided by 5, or approximately 8 inches. The focal length of Portra Lenses is of interest because when the camera is focused at infinity, the supplementary lens refocuses the camera for a subject at a distance equal to the focal length of the supplementary lens regardless of the focal length of the camera lens. Thus, a 3-diopter lens will refocus a camera for a distance of about 13 inches.

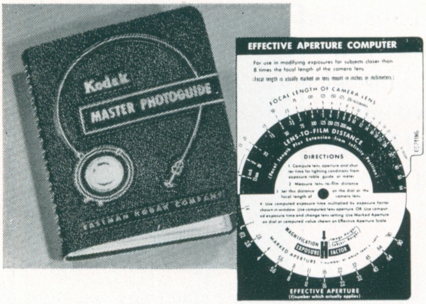
Combined Focal Length. When a supplementary lens is added to a camera lens, the combination of the two can be regarded as having a single focal length. With Portra Lenses, the combined focal length is always shorter than that of the camera lens alone, while the addition

Table of combined focal lengths. Combinations in red area require more than double bellows extension. Combined focal length should be shorter than bellows length.



The five photographs on this page demonstrate the effectiveness of the different Kodak Portra Lenses, individually and in combination, in permitting close-ups to be made at shorter distances than is possible with the camera lens alone. The photograph in the upper left corner was made with a 100-mm camera lens alone, focused at its near limit of 3½ feet. Portra Lenses used for the other photographs were, in clockwise order: 1+, 2+, 3+, and 3+ and 2+ in combination.





The Effective Aperture Computer, one of several convenient dial calculators in the Kodak Master Photoguide, solves lens aperture problems quickly.

of a Telek Lens increases the focal length. The combined focal length is a function of both focal lengths and the separation between the two lenses. Assuming this separation is short compared with either focal length, the approximate combined focal length can be obtained from the graph. Note that the combined focal lengths in the case of Telek Lenses increase rapidly with the camera-lens focal length, especially for the strongest Telek Lenses. It is impossible to use a combination whose focal length is longer than the maximum camera bellows extension. In fact, combined focal length should be somewhat shorter than bellows length to permit some focusing movement. If the focal length of the Telek Lens is equal to or less than that of the camera lens, the combination cannot be focused at all. For example, it is impossible to use a Telek Lens 4— with a 10-inch camera lens.

Effective f-Number. As long as the lens combination is used at the usual lens-to-film distances, the *f*-number indicated on the diaphragm scale applies. When the Portra Lens is used for wide-angle effects, the lens-to-film distance is shorter than usual, which increases the effective lens aperture. Conversely, when the Portra Lens is used for extreme close-ups with extension bellows or backs, or when Telek Lenses are employed, effective aperture decreases. In both cases the change must be allowed for. Use the Effective Aperture Computer, a convenient dial calculator in the Kodak Master Photoguide, or refer to the Formulas section.

Effects on Definition. A supplementary lens introduces slight aberrations which increase with aperture and focal length of the camera lens and with the power of the supplementary lens. For practical purposes, definition is restored by using small apertures. A supplementary lens should be shielded from side light by a lens hood.

Sizes Available. The Kodak Portra Lens 1+ is available to fit Series IV, V, VI, and VII Kodak Combination Lens attachments; the 2+, to fit Series V, VI, and VII; and the 3+, to fit Series V and VI only.

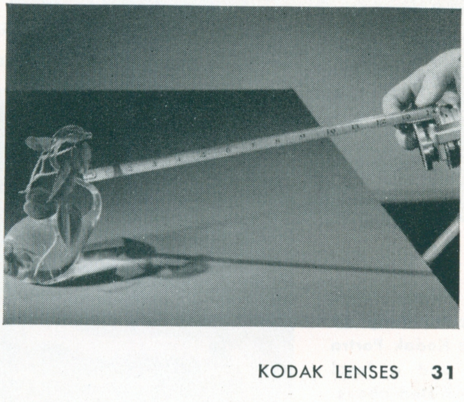
Kodak Telek Lenses 1–, 2–, 3–, and 4– are available to fit Series VI and VII. Portra Lenses 1¾+ and 3¾+ are also supplied in W Mounts to fit the Kodak Cine Ektanon Lens, 25mm *f*/1.9. Kodak Close-Up Attachments are low-power positive meniscus lenses (¾+), designed to focus fixed-focus cameras for 3½ feet. All Kodak supplementary lenses are ground and polished like fine camera lenses.

HOW TO USE KODAK PORTRA LENSES

Since the depth of field at close distances is very shallow, even at small apertures, hand operation of a camera equipped with one or more Portra Lenses is not usually practical. A tripod or other firm support should be used and the subject distance measured carefully from the front rim of the Portra Lens mount. The viewfinder can be used for approximate positioning of the subject, but at such close distances, it will not be accurate. The separation between the viewfinder axis and the lens axis introduces an error, the effect of which is that the picture is cut off on the side corresponding to the position of the viewfinder relative to the camera lens.

The normal working distance for the strongest of the Portra Lenses is 13 inches, and the field size is about 6 x 9 inches with 35mm cameras, such as the Kodak Retina IIa. This field size is too large for many small objects. By combining Portra Lenses, it is possible to obtain field sizes down to about 3¼ x 4¾ inches. This small size is appropriate for some flowers, large insects, small mechanical parts, etc., but requires a "focal frame" to locate the subject accurately and insure proper focus.

In order to use Portra Lenses in combination, the following items are needed: the appropriate Kodak Adapter Ring with its Insert Ring, a Kodak Retaining Ring, and the two Kodak Portra Lenses concerned. The stronger one should be placed next to the camera lens.



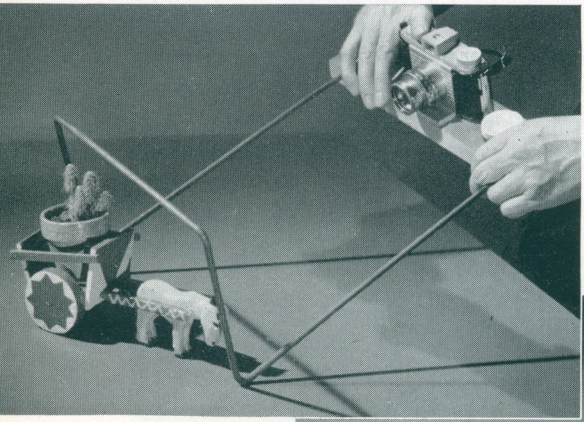
When supplementary lenses are used for close-up photography, subject distance must be measured carefully, since the depth of field is very shallow.

FOCAL FRAMES

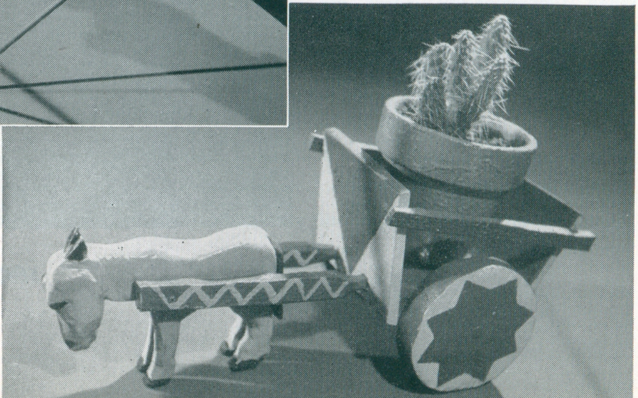
A device for each Portra Lens or combination can be improvised by the photographer to permit hand-held operation of the camera. A rectangular frame of wire can be made a trifle larger than the field size, and connected by a supporting block to the camera, using the tripod socket. The frame is positioned at the plane of sharp focus, or slightly on the camera side of it. Since the frame is a trifle larger than the field photographed, and placed to surround it, the frame does not show in the picture. Subject positioning is automatic and exact.

Making the Setup. Reference to the field-size graph is the starting point in building the required setup. The size of the subject matter will, of course, dictate the size of the field required.

The procedure for finding exact field size and distance consists of visual examination followed by a photographic test. The camera back is opened, and a strip of ground glass is held in the film track. The supplementary lenses are added, the shutter is opened as for a time exposure, and the diaphragm is set at the widest aperture. While the camera is held stationary, a strongly illuminated ruler is moved in front of it until the image of the ruler on the ground glass appears sharpest. The ruler must, of course, be kept parallel to the film plane. The width of the field, as shown by the portion of the ruler, is seen in the ground glass. The field height can be shown in the same way. While the ruler is still in the position for the sharpest image, its dis-



***Left*—A focal frame insures accurate focus and positioning of the subject. It also adds stability; the careful worker can expose at 1/10 or 1/25 second without fear of movement.**



***Right* — Photographed with a Kodak Pony 35 Camera, a Kodak Portra Lens 3+ and a focal frame, illustrated above.**

tance should be measured from the rim of the supplementary lens. From these measurements, the frame can be made and put tentatively in position. This position can be checked with the same improvised ground-glass focusing. The frame position is then checked by photographing a ruler, and adjusting it in conformity with the result.

DIFFUSION ATTACHMENTS

Kodak Pictorial Diffusion Disk for cameras is a device which, by means of concentric circles and radial lines polished into its surface, produces a picture made up of a combination of sharp and soft images. The softness produced is desirable in many pictures, such as landscapes and similar scenics.

Kodak Close-Up Diffusion Disk is similar in its diffusion. In addition it has ¾+ power, which focuses fixed-focus cameras for 3½ feet.

Kodak Optical Diffusing Plate, a 2 x 2-inch diffusing glass designed for enlargers, fits the 2-inch Kodak Gelatin Filter Frame Holder. It is held on the lens by a Kodak Adapter Ring of proper size. With this plate, soft-focus prints can be made from sharp negatives.

CARE OF LENSES

For lenses to perform satisfactorily they must be properly aligned with the film, plate, etc. Rough handling or the application of undue force in the use of a camera may upset such alignment.

All optical-glass surfaces should be protected as much as possible from dust, dirt, and fingerprints. Lenses should also be protected from jars and jolts, and from extreme and sudden changes in temperature. They should not be stored in hot or humid places.

An occasional cleaning of both rear and front lens surfaces is necessary. Care should be used not to scratch these lens surfaces while cleaning. Any dust or grit should be removed first by gently brushing the surface with wadded Kodak Lens Cleaning Paper or a fine camel's-hair brush. If this brushing action fails to clean the lens, wipe it gently with a wad made from one or several sheets of Kodak Lens Cleaning Paper or a clean, soft, lint-free cloth, such as well-washed linen. In the case of fingerprints or scum formation, the use of a drop of Kodak Lens Cleaner on the cleaning paper or cloth, or breathing on the lens, is suggested. Do not use acid, alcohol, or other solvents, or harsh, linty cloth. Avoid excessive cleaning and excessive pressure, as this may do more harm than good. Important: No attempt should be made to take a lens apart. If the lens or mounting requires attention, it should be returned to the manufacturer.

Kodak Shutters

• In accuracy, convenience, and versatility, Kodak shutters have consistently anticipated the requirements of photographers. For example, the growing popularity of synchronized flash photography has been given greater impetus by the incorporation of built-in flash synchronization in almost all recent Kodak shutters.

The quality of a shutter is not measured by the number and range of indicated speeds alone. It is of equal importance that the exposure be sufficiently accurate and consistent at every speed indicated.

Wholehearted co-operation between designer and craftsman, modern precision manufacturing methods, and more than 55 years' experience in making shutters have created a line of Kodak shutters unsurpassed by any shutters of similar type and price.

While various means, such as rotating disks, dropping slides, etc., can be used as shutters for still cameras, the most commonly encountered today are between-the-lens and focal-plane shutters. All Kodak shutters of current manufacture are of the between-the-lens type.

HOW A SHUTTER OPERATES

Between-the-lens, or central, shutters are of two types—the automatic or self-setting, and the presetting shutter. In the former, pressing the release lever sets up the spring tension and then trips the shutter. Such a design is generally employed on shutters with fewer and slower shutter speeds. In the presetting type of shutter, the necessary spring tension is produced by the separate action of setting, or cocking, before an exposure can be made. This construction permits not only a greater number of shutter speeds but also faster and more accurate ones. On most cameras, cocking the shutter is a separate operation, but on some, such as the Kodak Retina IIa and the Kodak Medalist II Cameras, advancing the film sets the shutter.

In most presetting shutters, the blades start opening at the center of the lens aperture, and move outward far enough to clear the maximum lens aperture. After dwelling in the open position for a controlled period, the shutter closes toward the center. One notable exception is the Kodak Synchro-Rapid 800 Shutter. In this shutter, double-ended blades rotate about fixed pivots, the opening and closing cycle being made by one continuous action.

The perfect shutter (a mechanical impossibility) would consume zero time in opening and in closing, being fully open for the desired interval. The practical central shutter, however, requires a little time to open and close. The use in Kodak shutters of highly efficient actuating mechanisms and the thinnest metal blades consistent with durable construction has reduced this lag to a very short interval.

SHUTTER-SPEED MARKINGS AND EFFICIENCY

Shutter-Speed Markings engraved on the face of the shutter are based on the *effective exposure time* obtained at each setting. This is the time during which the "perfect" shutter previously described would be open to admit the same amount of light as is actually admitted during the cycle of the central shutter's operation. By this system of marking speeds, a definite amount of light at a given lens aperture is specified. The total time consumed by the shutter operating cycle is not an accurate means of expressing exposure because of the constantly changing size of the useful aperture while the shutter is opening and closing. At the present time, effective exposure times (the marked shutter speeds) are calculated at the maximum shutter opening. Using smaller lens openings results in slightly longer effective exposure times at a given speed, as shown on the next page.

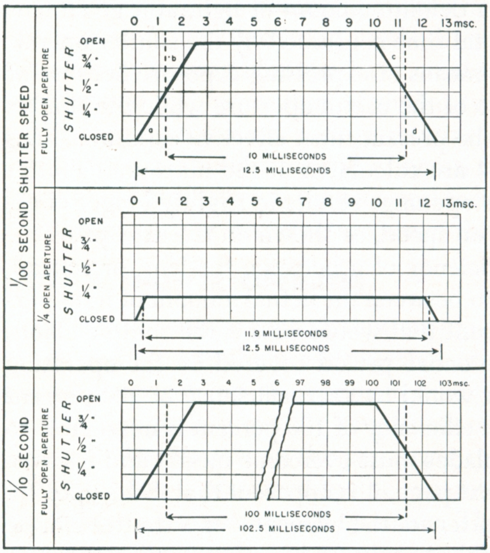
Shutter Efficiency. The efficiency of a between-the-lens, or central, shutter is expressed as a ratio between the actual amount of light permitted to pass and the amount that would pass if the shutter blades were fully open during the entire period covered by the operating cycle. The "perfect" shutter would have an efficiency of 100 percent at all speeds. In practice, an efficiency of 100 percent is impossible to achieve, since the moving blades must overcome inertia and friction. From the diagram on the next page, it is apparent that if the opening and closing time can be shortened, the efficiency of a shutter can be increased. Kodak shutters of the presetting type open to the maximum diaphragm setting within about two to three milliseconds from the time the blades permit the first ray of light to pass. They close in approximately the same time. Kodak shutters of the self-setting type are somewhat slower and require a total of about six to nine milliseconds for opening and closing. These figures may vary from one type to another. They also depend on the care the shutter has received.

As smaller diaphragm openings are used, less time is required for the shutter blades to clear the lens opening, with the result that shutter efficiency increases markedly with smaller lens apertures. Shutter efficiency is also greater with longer exposures, since the time for opening and closing represents a smaller percentage of the total time.

Shutter Testing. All Kodak shutters are carefully tested for both effective and total time on electronic testing machines of the highest precision, and must work within strictly held tolerances before they are permitted to leave the factory. While it may be possible to use simple testers, such as rotating disks, falling weights, or other devices, to check the performance of shutters, these tests reveal only the approximate total open time of the shutter. They do not measure effective exposure time nor do they take into consideration shutter efficiency.

EFFICIENCY OF A BETWEEN-THE-LENS SHUTTER AT VARIOUS SPEEDS AND LENS OPENINGS

The top figure shows that out of 12.5 milliseconds, about 2.5 are used for the blades to open fully. About the same time is needed for the blades to close. The shutter permits light to pass the moment the blades begin to open. Light begins to be cut off the moment the blades start to close. Taking a half-open position as a basis for measuring shutter efficiency compensates for this action, since area (a) is equal to area (b), and area (c) to (d). On this basis the efficiency of the hypothetical shutter illustrated is about 78 percent.



The middle figure demonstrates that shutter efficiency increases with smaller diaphragm openings. Shutter blades clear a small lens stop in less time than a fully opened one. The shutter efficiency in this case is 93 percent.

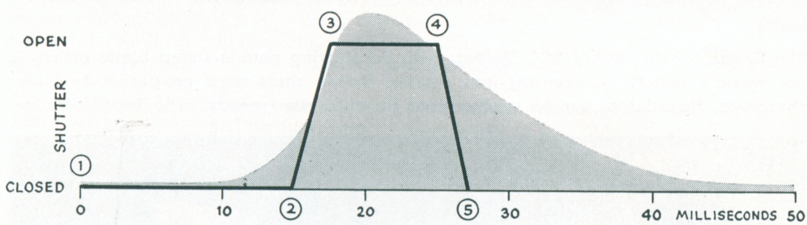
The lower figure shows that shutter efficiency (about 97 percent) is greater with slower shutter speeds, since the time required to open and close the blades to the half-open position is a smaller percentage of the total time than with faster shutter speeds.

The camera owner's natural interest in the performance of his shutter is usually in terms of exposure, rather than total time; he wants to know the appropriate lens aperture to use for a marked shutter speed and picture situation. It is a simple matter to test the combination of aperture and shutter time. For example, a series of pictures taken of the same sunlighted subject (clear blue sky is good) should produce negatives of the same density when these combinations are used: *f*/16 and 1/25 second, *f*/11 and 1/50 second, *f*/8 and 1/100 second, *f*/5.6 and 1/200 second, etc. Negatives should receive uniform development; a comparison of the central areas will then show whether the exposures were the same, within practical limits.

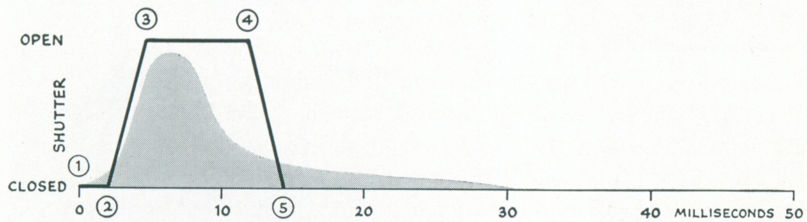
FLASH SYNCHRONIZATION

• To assure good synchronization, the time lag of the flash lamp as well as the lag of the shutter must be considered. In flash lamps, this lag represents the time between the instant the current is applied and the instant the peak or plateau of light intensity is approached. The two most popular classes of flash lamps in general use are the Class F (such as the SM or SF) which have a nominal time lag of 5 milliseconds to peak of flash, and Class M (such as the No. 5 or 25) which have a time lag of 20 milliseconds. The lag in central shutters is the time between the pressing of the shutter release and the instant the shutter blades start to open, plus the blade opening time. In Kodak between-the-lens shutters of the presetting types, the average total lag is about 4 to 6 milliseconds, and in those of the self-setting types, 8 to 15 milliseconds.

In the illustration below, the heavy black lines represent the action of a hypothetical flash shutter, and the shaded areas represent nominal performance of flash lamps. The exact times may differ from one shutter type to another, or may vary slightly in similar shutters. The same is true of flash lamps. Upper figure: Shutter is released and electrical contacts are closed at (1). Built-in synchronizer delays opening of shutter until flash starts to build up (2). Shutter is open from (3) to (4) during peak of flash, and closes at (5) as flash starts to die out. Lower figure: The interval from (1) to (2) is shortened (and in some shutters eliminated entirely), permitting the shutter to synchronize with the Class F flash lamp.



SHUTTER SPEED—1/100 SECOND
CLASS M FLASH LAMP



SHUTTER SPEED—1/100 SECOND
CLASS F FLASH LAMP

KODAK FLASH SHUTTERS

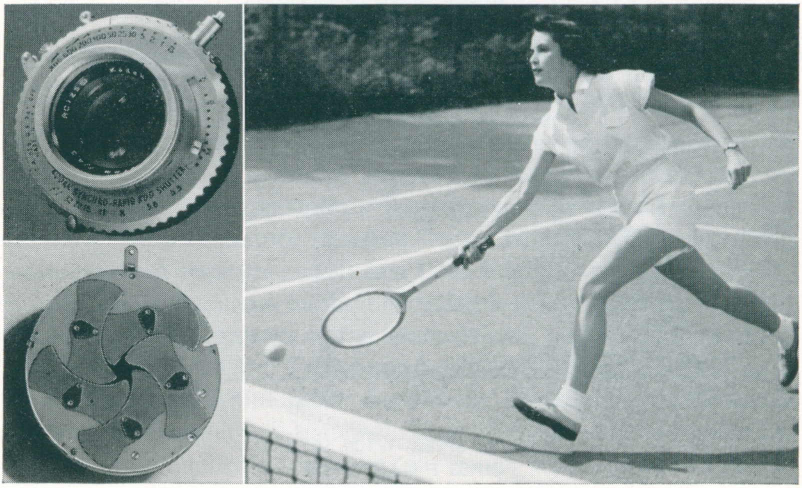
The word "Flash" in the name of a Kodak shutter indicates that the shutter is equipped with a built-in mechanism which can be engaged to close an electrical circuit for firing flash lamps in synchronization with the opening of the shutter. Such an arrangement obviates the need for an external synchronizer; the only additional equipment needed for synchronized flash photography is an inexpensive Kodak Flasholder, a Kodak Ektalux Flasholder, or a similar electrically-powered flash-lamp holder with both reflector and electrical connections to fit the shutter.

The Kodak Synchro-Rapid 800 Shutter is the world's fastest and most versatile between-the-lens shutter. Five double-ended blades rotate about fixed pivots as the shutter is tripped, the opening and closing cycle being made by one continuous action. Unlike ordinary shutters where the blades must open, stop, and then close, in the Synchro-Rapid 800, the opening edge of each blade uncovers the aperture, and the trailing edge closes it. This type of action gives extremely high accuracy and speed.

When the shutter is cocked, the five blades move in the reverse direction. During this operation, a pair of cover blades is in position to prevent light from reaching the film.

The Synchro-Rapid 800 Shutter will synchronize with Class M

The Kodak Synchro-Rapid 800 Shutter, with its pivoting double-ended blade action, is the world's fastest between-the-lens shutter. Action shots need no posing to insure sharpness. Flash lamps can be synchronized for all shutter speeds, including 1/800 sec.



(No. 5 or 25) lamps at any speed, including 1/800 second; with Class F (SM or SF) lamps, up to 1/400 second; and for electronic flash synchronization, there is an "X" setting. Shutter lags and compensations for variation between lamps of different manufacture can be adjusted by means of a graduated scale.

Kodak Flash Supermatic Shutters have a two-position scale, engraved with the letters "F" and "M" to correspond with the two popular classes of flash lamps. In addition, the Kodak Flash Supermatic Shutter on the Kodak Medalist II Camera can be synchronized with the Kodatron Studio Speedlamp, or similar equipment, with no lag in the trip circuit. The operation of the Kodak Flash Supermatic Shutter is shown below. Kodak Supermatic (X) Shutters have built-in flash synchronization for electronic flash tubes only.

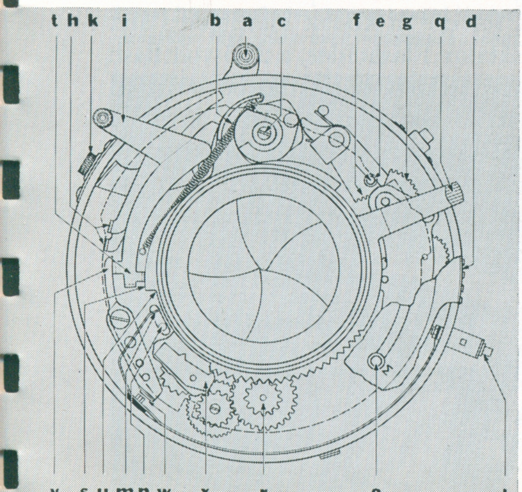
A blade arrester on the Kodak Flash Supermatic and Supermatic (X) Shutters for press- and view-type cameras permits the opening of the shutter blades for focusing at any speed selected, without the necessity of moving the speed selecting dial to "T" or "B."

HOW THE KODAK FLASH SUPERMATIC SHUTTER OPERATES

Presetting the shutter by moving lever (a) to the right sets up tension in spring (b); at 1/400 second, additional spring located under eccentric member (c) is brought into action. Shutter speeds are changed by turning speed selecting ring (d) which, by means of cams shown as dashed line, actuates controls. The step-shaped cam at (e) controls extent of engagement of gear sector (f) with one member of gear-train retard mechanism (g), and a cam, not shown, controls position of an oscillating pallet relative to a ratchet wheel. "T" and "B" are determined by positions of levers (h), also controlled by a cam. The release lever is marked (i) and the socket for the cable release, (k).

Flash discharges with no time lag are synchronized with shutter blade action by an electric circuit formed through post (l) and closing at (m) through post (n) which moves upward as blades open.

Flash lamps with a time lag of 5 milliseconds are synchronized by sliding the limiting stop (o) to end of slot marked "F" (not shown). Clockwise movement of lever (q) sets up spring tension through gear train (r) and moves cam (s) upwards. Downward pressure on lever (i) now allows its extension (t) to move sideways to cam (u). Lever (v) follows and opposite end closes contacts (w). This releases gear train which, through downward movement of step between cams (s and u), actuates lever (t) and releases shutter in synchronization with flash peak.



Synchronizing flash lamps with a 20-millisecond time lag is accomplished similarly. Limiting stop (o) at "M" permits extended movement of lever (q) which, in addition to the action described above, engages oscillating pallet (x). The pallet's action slows down counterclockwise travel of "step," delaying opening of shutter for synchronization with the peak of the flash output.

Flash Kodamatic Shutters have provision for synchronizing the shutter operation with the firing of both Class F and Class M flash lamps. When Class M lamps are used, the synchronizer lever on the shutter is cocked, setting up a retard mechanism which, when the shutter release lever is pressed, delays the opening of the shutter long enough after the flash contacts are closed to permit the lamp flash to approach peak intensity. The synchronizer is not cocked for Class F lamps; the contacts are closed as the shutter blades start to open.
Kodak Flash 200 Shutters can be used for internally synchronized flash photography with Class F (SM or SF) flash lamps at speeds of 1/25, 1/50, and 1/100 second. For picture-taking situations requiring a greater amount of light, Class M (No. 5) flash lamps can be synchronized at 1/25 second.
The Kodak Synchro 300 Shutter is accurately timed at all shutter settings for all Class M lamps. The novel design of this rugged 2-blade shutter gives high efficiency—it opens wide in 2½ milliseconds, and closes at the same rate. The electrical circuit is completed through self-cleaning "wipe" contacts.

POWER SOURCES FOR FLASH UNITS

Flash equipment powered with ordinary dry cells should be checked at regular and frequent intervals as insurance against disappointing and costly flash failures. Batteries can be tested with special equipment meant for the purpose or momentarily with a pocket-type ammeter. They should be replaced when their individual short-circuit current falls below the following values: AA Penlite cells, 2.5 amperes; C cells, 5 amperes; and D cells, 5 amperes.

Battery-condenser units are far more dependable power sources for flash units than batteries alone and should be used where possible. Temperature changes and the condition of battery and contacts are not so critical and the peaking time of flash lamps is more consistent. In the Kodak B-C Flashpack for use in Kodak Flasholders and similar units, and in the Kodak Ektalux Flasholder, a 22.5-volt flash battery feeds power to a condenser which stores the power until needed. The condenser, fully charged between each shot, fires the lamp in a single surge 15 times as strong as the force of the usual 1.5-volt flashlight battery. With average use, batteries will last 1 to 2 years. Failure of synchronization is virtually nonexistent.

The Kodak B-C Flashpack can be used in any flash unit now using two C batteries placed end to end.

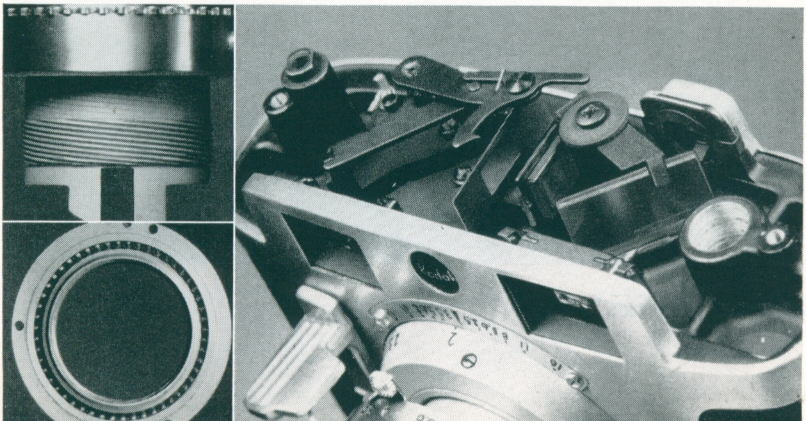
Kodak Focusing Aids

KODAK RANGEFINDERS

As an aid to accurate focusing, Kodak Medalist II, Retina IIa, and Signet 35 Cameras have rangefinders coupled to the camera lens. For cameras not so equipped, the Kodak Service Range Finder is available. Basically, rangefinders measure the angle of convergence between two beams of light coming from the same subject point and separated at the camera by the distance between the two apertures of the rangefinder. The rangefinder operates by moving a mirror or prism so that the two beams are brought into alignment in the eyepiece. In coupled rangefinders, the movable mirror or other means for deflecting the one beam of light is linked with the focusing mechanism in such a manner that the lens is focused, at all times, for the point of convergence of the two beams forming the aligned image. The Kodak Service Range Finder contains a scale which translates angle of convergence to linear distance directly. The camera focusing scale is then set to correspond with the figure appearing in the rangefinder eyepiece.

Coupled rangefinders for cameras are of two types. In the split-field rangefinder used on the Kodak Medalist II Camera and the Kodak Service Range Finder, the field is divided into two equal parts. The

The rangefinder on the Kodak Signet 35 Camera is the most rugged and reliable rangefinder ever supplied on a miniature camera. Three features not found in other rangefinders are responsible for its outstanding performance. *Upper left*—The precision focusing helix on the lens tube is machined for .001-inch or less lateral play. Results are repeatable, no matter which way the focusing ring is rotated. *Lower left*—The lens mount is supported by 50 ball bearings. It works smoothly at all seasonal temperatures and the parallelism is perfect at any setting. *Right*—Cut-away view shows the complexity of the Signet 35 rangefinder. Spring-loaded V-block bearings eliminate all of the tiny bearing variations that cause most rangefinder errors.



halves of the image are magnified so that alignment is quick and accurate. Kodak Signet 35 and Retina IIa Cameras have superimposed image-type rangefinders combined with viewfinders for rapid focusing and framing through a single window.

Rangefinders are an aid to more accurate focusing, and consequently to sharper and crisper pictures. They are especially useful when focusing distances must be determined accurately, for example, in close-up work and when high-speed lenses are used at wide apertures.

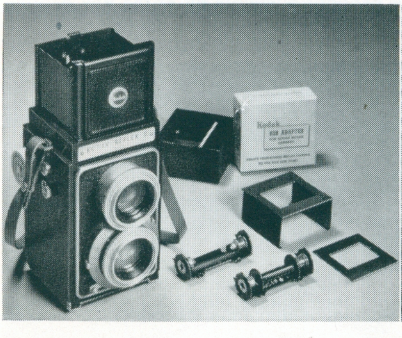
In addition, rangefinders are useful for measuring distances when exactness contributes toward better pictures. For example, a rangefinder can be used in some cases to measure the lamp-to-subject distance in picture taking with artificial light. They can also be used to determine whether near and far objects in the picture are within the depth of field given by indicator or table for a given lens setting.

Good rangefinders are precision instruments and should be treated as such. All outside glass surfaces should be kept clean. A rangefinder should never be tampered with. If it is in need of adjustment, only a competent repairman or the factory should be allowed to do the work. Precision tools are needed to insure accurate alignment.

FOCUSING WITH THE KODAK REFLEX II CAMERA

Positive, accurate focusing is possible with the Kodak Reflex II Camera which utilizes the twin-lens reflex principle. The Kodak Anastar, 80mm $f/3.5$ viewing lens is identical with the taking lens. The mounts of the viewing and taking lenses are gear-coupled, assuring accurate coincidence of focus. Because the viewing lens is separate from the taking lens, the subject image can be seen in the ground-glass screen before, during, and after exposure.

Left—Kodak Reflex II Camera, shown with Kodak 828 Adapter for using 828 Kodachrome, Kodacolor, and black-and-white film in Kodak Reflex Cameras. _Right_—Kodak Service Range Finder in use on a Kodak Tourist II Camera.



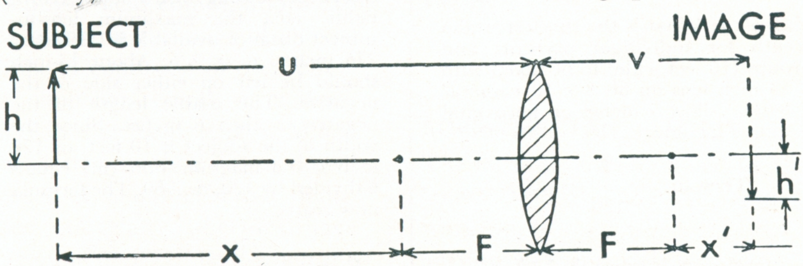
Useful Optical Formulas

• In relationship between studio size and focal length, in special work with supplementary lenses, and with various projection arrangements, the photographer may need to compute the subject and image positions or sizes, field size, depth of field, etc. A few basic optical formulas are given here to assist in making such calculations.

The usual diagram of the formation of an image by a lens shows rays proceeding in straight lines from points in the subject to corresponding points in the image, as though they passed through a pinhole at the center of the lens. In an actual lens this group of rays may not proceed in straight lines through the center of the lens. Usually, these rays from the subject converge toward one point or apparent pinhole, but after passing through the lens, they diverge apparently from another pinhole or point at a different position on the lens axis. For theoretical accuracy, the subject distance and image distance should be measured from these two points, known as the first and second nodal points. With normal photographic lenses, however, these points are not unduly separated, and the following formulas will apply with practical accuracy if distances are measured to the center of the lens. This approximation does not apply to telephoto lenses.

To Find the Focal Length of a Lens. The focal length of camera lenses not of the telephoto type is roughly equal to the distance from the center of the lens to the image plane when the lens is focused for a very distant object. The focal length of any lens can be found more accurately by focusing first on a distant object, then on an object to obtain a full-size image (unit magnification). The difference between the two focusing positions of the lens is the focal length.

To Find the Back Focus of a Lens. Focus for a very distant object (infinity) and measure from rear lens surface to image plane.



Lens-subject-image positions. For key to symbols, see next page.

APPROXIMATE POSITION OF SUBJECT AND IMAGE

F = focal length   u = subject distance   h = height of subject
m = magnification   v = image distance   h′ = height of image
x′ = distance of image from focal point, or distance lens is moved from infinity setting.

The fundamental relation between focal length and image and object distances is: $\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$

More directly useful relations and some examples of their use follow:

Magnification:

$$m = \frac{h'}{h} = \frac{v}{u} = \frac{v-F}{F} = \frac{F}{u-F}$$

Lens movement from infinity position:

$$x' = \frac{F^2}{u-F}$$

Lens to Image:

$$v = \frac{Fu}{u-F} = mu = (m+1)F$$

Subject to Image:

$$u + v = \frac{(m+1)^2}{m}F$$

Lens to Subject:

$$u = \frac{Fv}{v-F} = \frac{v}{m} = \left\{\frac{1}{m} + 1\right\}F$$

Example 1: What is the shortest studio length for individual portraits and groups (10 feet wide) to be taken with a 14-inch lens on an 8 x 10 camera? *Solution:* Allow 9 inches on horizontal negative for image.

$$\text{Then } m = \frac{9}{120} = .075$$

$$\text{and } u = \left\{\frac{1}{.075} + 1\right\}F =$$

All distances must be expressed in the same unit of measure.

To convert dimension in	*divide by*
mm to meters	1000
cm to meters	100
inches to meters	39.4
feet to meters	3.28
mm to inches	25.4

$$(13.3 + 1)F = 14.3 \times 14 = 200 \text{ in.} = 16+ \text{ ft}$$

This answer gives the lens-to-subject distance, to which must be added at least 7 feet to allow room for the camera, operator, background separation, etc. The minimum room length is therefore 23 feet. The room width must be at least 15 feet in order to accommodate the group and lights.

Focal length:

$$F = \frac{u}{\left\{\frac{1}{m} + 1\right\}} = \frac{v}{m+1}$$

Example 2: For a studio 20 x 30 feet, and a 5 x 7 camera, what is longest focal length feasible for groups 10 feet wide?

Solution: Since about 7 feet of the room length is needed for the camera and operator, background separation, lights, etc., the maximum lens-to-subject distance available is 23 feet or 276 inches. u = 276. About ½-inch should be left on either side of the negative. The usable length of the negative is then 6 inches. Since the width of the subject is 10 feet, or 120 inches, the magnification (m) equals 6 divided by 120, or .050. The formula now reads,

$$F = \frac{276}{1/.050 + 1} = \frac{276}{20 + 1} =$$

$$\frac{276}{21} = 13+$$

Answer: 13 inches is the maximum usable focal length. The nearest available focal length is 12 inches.

Field Size (front-element focusing lenses):

$$\text{Field width} = \text{negative width} \times \frac{u}{F}$$

The above relations hold strictly if the measurements are made from the first and second nodal points. With a normal (not telephoto) lens, practical accuracy results if u and v are measured from the lens center.

Effective Aperture for Extended Bellows differs from the indicated aperture because of the increased image distance. This is especially important in work with color films and in copying.

Effective f- (unmber for any subject distance)

$$= \frac{v \times f}{F} = f\,(m + 1) \text{ where } v =$$

lens-to-film distance, or focal length plus lens extension from infinity focus, f = f-number indicated on aperture scale, and F = focal length. For close-ups, allow this aperture correction, or increase exposure time by v^2/F^2. Both aperture and time corrections are given directly by the Effective Aperture Computer for all lenses 1 to 30 inches in focal length.

DEPTH OF FIELD

Depth-of-field computations can be made on the basis of a fixed circle of confusion or on a circle of confusion equal to a fraction of the focal length. When the latter method is used, all lenses of equal effective diameter (not relative aperture) have the same depth of field when the image is viewed at the distance for normal perspective. See the discussion of depth of field on page 14 of the text.

Method A, fixed circle of confusion:

F = focal length of lens
f = f-number of relative aperture
H = hyperfocal distance
u = distance for which camera is focused
d = diameter of circle of confusion

Near limit of depth of field (measured from camera lens)

$$= \frac{H \times u}{H + (u - F)}$$

Far limit of depth of field (measured from camera lens)

$$= \frac{H \times u}{H - (u - F)}$$

Method B, circle of confusion a fraction of the focal length of the lens:

u = distance focused upon
Θ = angular size of circle of confusion (for critical definition, Θ is 2 minutes of arc [tan 2′ = .00058], or approximately F/1720)

$$L = \textit{effective diameter of lens} = \frac{F}{f}$$

Near limit of depth of field (measured from plane focused upon)

$$= \frac{u^2 \tan \Theta}{L + u \tan \Theta}$$

Far limit of depth of field (measured from plane focused upon)

$$= \frac{u^2 \tan \Theta}{L - u \tan \Theta}$$

Hyperfocal Distance (near limit of depth of field when lens is set at infinity)

$$H = \frac{F \times F}{f \times d}$$

SUPPLEMENTARY LENSES

The formulas for combined focal length, field size, and wide-angle work apply only when the separation between supplementary lens and camera lens is very small, compared to camera-lens focal length. For this reason, they do not apply closely to 35mm cameras, and never apply to movie cameras.

The following quantities, except s, must all be expressed in meters. Answer will be in meters.

F_s = focal length of supplementary lens = $\frac{1}{D}$

D = power in diopters (1+, 2+, etc.)

u = distance from supplementary lens to subject

s = focusing scale setting *in feet*

F_c = combined focal length of camera and supplementary lens

F = focal length of camera lens

W = Field Width

w = negative width

Portra Lenses

Subject Distance

Distance for Infinity Setting

$u = F_s = \frac{1}{D}$, for two Portra Lenses = $\frac{1}{D_1 + D_2}$

Distance for Focusing Scale Set at s Feet

$\left\{\frac{3.28}{s} \text{ is “power of focusing scale”*}\right\}$

$$u = \frac{1}{D + \frac{3.28}{s}}$$

*"Power of focusing scale" is equivalent to the power of a supplementary lens which would cause the same change of focus. For example, changing the focusing scale setting from infinity to 3½ feet is equivalent to adding slightly more than one diopter to the power of the supplementary lens used.

To find s and D for given u:

$$\frac{1}{u} - D = \frac{3.28}{s}$$

Take highest whole number of D (1, 2, 3, etc.) that is not larger than $\frac{1}{u}$. Solve for s.

Combined Focal Length

$$\frac{1}{F_c} = \frac{1}{F} + D$$

Field Size

For Infinity Setting:

$$W = \frac{w\ F_s}{F}$$

For Front-Element Focusing at s feet:

$$W\left\{D + \frac{3.28}{s}\right\} = \frac{w}{F}$$

Field height is proportional to negative height.
See also text on Portra Lenses.

Wide-Angle Formula—for camera lens behind infinity position:

$$\frac{\text{Width of field with Portra Lens}}{\text{Width of field without Portra Lens}} = \frac{1}{1 + FD}$$

Telek Lenses

(D is negative for Telek Lenses.)

Combined Focal Length

$$\frac{1}{F_c} = \frac{1}{F} + D$$

Required bellows length = F_c for distant subjects, longer for nearer subjects.

Increase in Image Size

$$\frac{\text{Width of image with Telek Lens}}{\text{Width of image without Telek Lens}} = \frac{1}{1 + FD}$$

Lens and Shutter Data

• The following pages contain useful data on Kodak lenses and shutters. Lenses of the same basic design are grouped together, except in the case of lenses supplied as part of Kodak cameras.

Lens Diagrams: These drawings are schematic presentations of the basic design for each lens or group of lenses. They show the number and approximate arrangement of the various elements. Cemented pairs of elements can be distinguished by the contrasting pattern of the diagonal lines in the drawings. The arrow indicates the direction in which light normally passes through the lens to the light-sensitive material. The two vertical lines indicate the position of the lens diaphragm.

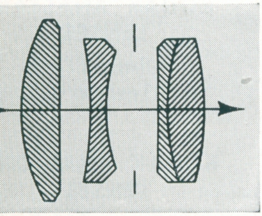
Depth-of-Field Tables: Where lack of space does not permit the listing of the depth of field for all lens stops, the depth of field for the missing *f*-numbers can be estimated by comparing the depth for the next larger and smaller stops.

Back Focus: For lenses supplied separately for use in studio, view, press, and reflex cameras, the distance between the rear glass surface of the lens and the focal plane when the lens is focused on infinity, is given. This distance is referred to as the "back focus" of the lens.

Attachment Size: The Series number (VI, VII, etc.) of Kodak Combination Lens Attachments accepted by each lens, as well as the size of the Kodak Adapter Ring required, is listed. Kodak Adapter Rings listed by inches and millimeters are of the slip-on type, and those listed by number are of the screw-in type.

Shutter Data: Shutter speeds and flash synchronization data are given for the shutter in which each lens is supplied. "Class F" and "Class M" refer to photoflash lamps having nominal times-to-peak of 5 and 20 milliseconds, respectively. A separate table summarizes the data for all Kodak shutters.

LENSES SUPPLIED ON KODAK AMATEUR CAMERAS



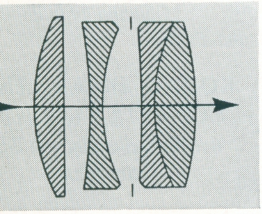
Kodak Anastar, 48mm *f*/4.5

The lenses for which data are given below are supplied on current Kodak cameras. For the convenience of owners of Kodak cameras bearing the older lens names, the following name equivalents are given:

Old Name	*Present Name*
Kodak Anastigmat	Kodak Anaston
Kodak Anastigmat Special	Kodak Anastar

KODAK ANASTAR, 48mm *f*/4.5

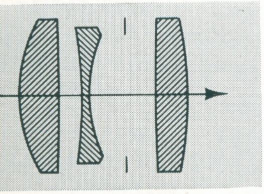
Camera: Kodak Flash Bantam.
Marked Apertures: *f*/4.5, *f*/5.6, *f*/8, *f*/11, and *f*/16.
Shutter Speeds: 1/25, 1/50, 1/100, 1/200 sec, T, and B. Built-in synchronization for Classes F and M flash lamps.
Negative Size: 28 x 40 mm.
Kodak Combination Lens Attachments: 15/16 in., 24 mm, Series V.



Kodak Anastar, 101mm *f*/4.5

KODAK ANASTAR, 101mm *f*/4.5

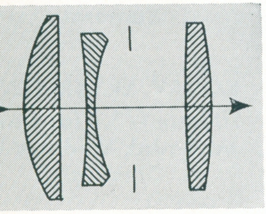
Camera: Kodak Tourist II (with Synchro-Rapid 800 Shutter).
Marked Apertures: *f*/4.5, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32.
Shutter Speeds: 1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, 1/400, 1/800 sec, and B. Built-in synchronization for Classes F, M, and X.
Negative Size: 2¼ x 3¼ in.
Kodak Combination Lens Attachments: $1\frac{5}{16}$ in., 33 mm, Series VI.



Kodak Anaston, 51mm *f*/4.5

KODAK ANASTON, 51mm *f*/4.5

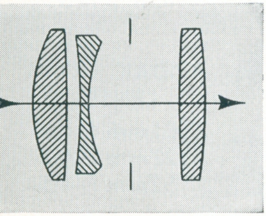
Cameras: Kodak Pony 135*; Kodak Pony 828.
Marked Apertures: *f*/4.5, *f*/5.6, *f*/8, *f*/11, *f*/16, and *f*/22.
Shutter Speeds: 1/25, 1/50, 1/100, 1/200 sec, and B. Built-in synchronization for Classes F and M flash lamps.
Negative Sizes: 24 x 36 mm and 28 x 40 mm.
Kodak Combination Lens Attachments: 1¼ in., 31.5 mm, Series VI.



Kodak Anaston, 105mm *f*/4.5

KODAK ANASTON, 105mm *f*/4.5

Camera: Kodak Tourist II (with Flash Kodamatic Shutter).
Marked Apertures: *f*/4.5, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32.
Shutter Speeds: 1/10, 1/25, 1/50, 1/100, 1/200 sec, T, and B. Built-in synchronization for Classes F and M flash lamps.
Negative Size: 2¼ x 3¼ in.
Kodak Combination Lens Attachments: 1¼ in., 31.5 mm, Series VI.



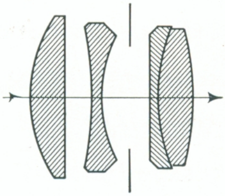
Kodak Anaston, 105mm *f*/6.3

KODAK ANASTON, 105mm *f*/6.3

Camera: Kodak Tourist II (with Flash 200 Shutter).
Marked Apertures: *f*/6.3, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32.
Shutter Speeds: 1/25, 1/50, 1/100, 1/200 sec, and B. Built-in synchronization for Classes F and M flash lamps.
Negative Size: 2¼ x 3¼ in.
Kodak Combination Lens Attachments: 1¼ in., 31.5 mm, Series VI.

*For infrared focusing, turn focusing scale counterclockwise by 0.17 in.

Lens and Shutter Data:



KODAK EKTAR LENS, 44mm f/3.5

(as used on the Kodak Signet 35 Camera)

This four-element completely Lumenized Ektar lens, especially designed for the Kodak Signet 35 Camera, is one of the finest lenses ever produced for a miniature camera, regardless of price. Black-and-white negatives are crisp and needle-sharp, capable of being enlarged many diameters without loss of detail. Kodachrome transparencies have greater color purity and saturation than ever before. Focusing is consistently accurate throughout the entire focusing range from 2 feet to infinity. The lens mount is supported by 50 ball bearings, working smoothly and accurately at all seasonal temperatures. The coupled superimposed-image rangefinder is combined with the viewfinder for rapid focusing and framing through a single window.

Marked Apertures: *f*/3.5, *f*/4, *f*/5.6, *f*/8, *f*/11, and *f*/22. Click stops.

Focal Length: 44 mm.

Negative Size: 24 x 36 mm.

Angle of View: With lens focused at infinity, 29° x 43°.

Focusing Range: Infinity to 2 feet, with coupled rangefinder. Marked distances: Inf, 50, 25, 15, 10, 8, 6, 5, 4, 3.5, 3, 2.5, 2 ft.

Infrared Focusing: Turn focusing scale counterclockwise $\frac{3}{32}$ in. from the visual focus (equivalent to the distance from the "I" in INF to the 50 ft setting mark).

Shutter: Kodak Synchro 300. Speeds—1/25, 1/50, 1/100, 1/300 sec, and B. Built-in synchronization for all Class M lamps. For time exposures, use the Kodak TBI Cable Release No. 2.

Size of Kodak Combination Lens Attachments: Series V with No. 22 Screw-in Adapter Ring or 1⅛ in. (28.5 mm) Slip-on Adapter Ring.

Hyperfocal Distance: Same as near limit of depth of field at infinity. See below.

Depth of Field: Kodak Ektar Lens, 44 mm f/3.5.

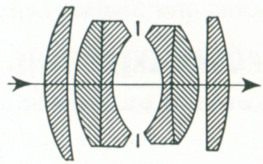
Distance* Focused On—Ft	Approximate Field Size**	DEPTH OF FIELD*** Circle of confusion = 1/500 inch				
		f/3.5	*f*/5.6	*f*/8	*f*/11	*f*/16
INF	29° x 43°	36′ to inf	23′ to inf	16′ to inf	11′9″ to inf	8′ to inf
50	26′ x 39′	21′ to inf	16′ to inf	12′ to inf	9′7″ to inf	7′ to inf
25	13′ x 19′	15′ to 79′	12′ to inf	10′ to inf	8′ to inf	6′3″ to inf
15	8′ x 11′	10′9″ to 25′	9′3″ to 43′	8′ to 230′	6′9″ to inf	5′5″ to inf
10	5′ x 7′4″	8′ to 13′6″	7′ to 17′4″	6′3″ to 25′6″	5′6″ to 63′	4′8″ to inf
8	4′ x 6′	6′7″ to 10′	6′ to 12′	5′6″ to 15′5″	4′10″ to 23′9″	4′2″ to inf
6	3′ x 4′6″	5′3″ to 7′	4′10″ to 7′10″	4′6″ to 9′3″	4′ to 11′7″	3′7″ to 21′
5	2′6″ x 3′8″	4′6″ to 5′8″	4′2″ to 6′3″	3′11″ to 7′	3′8″ to 8′3″	3′3″ to 12′
4	2′ x 3′	3′8″ to 4′5″	3′6″ to 4′9″	3′4″ to 5′2″	3′ to 5′9	2′10″ to 7′4″
3½	1′8″ x 2′6″	3′3″ to 3′10″	3′1″ to 4′	3′ to 4′4″	2′9″ to 4′9″	2′7″ to 5′8″
3	1′5″ x 2′	2′10″ to 3′3″	2′9″ to 3′4″	2′7″ to 3′6″	2′6″ to 3′10″	2′4″ to 4′5″
2½	1′2″ x 1′9″	2′4″ to 2′8″	2′4″ to 2′9″	2′3″ to 2′10″	2′2″ to 3′	2′ to 3′4″
2	11″ x 1′3″	1′11″ to 2′1″	1′11″ to 2′2″	1′10″ to 2′3″	1′9″ to 2′4″	1′8″ to 2′6″

* All distances measured from film plane
** Based on Kodak Readymount opening
*** The depth is not given for *f*/4.0 or *f*/22. It can be estimated by comparison

Lens and Shutter Data:

SCHNEIDER RETINA-XENON LENS, 50mm *f*/2.0

(as used on the Kodak Retina IIa Camera)



This lens, with extra speed for picture taking under poor lighting conditions, is well-corrected and precisely mounted in a Synchro-Compur shutter. Since the lens is unit-focusing, it maintains critical sharpness throughout the entire focusing range. Focusing is accomplished by means of the engraved focus scale or the built-in coupled rangefinder. The lens is surface-treated.

Marked Apertures: *f*/2.0, *f*/2.8, *f*/4, *f*/5.6, *f*/8, *f*/11, and *f*/16

Focal Length: 50 mm (2 in.)

Negative Size: 24 x 36 mm

Angle of View: With lens focused at infinity, 27° x 40°

Focusing Range: Infinity to 3½ feet, with coupled rangefinder or with focus scale. Marked distances: Inf, 50, 25, 15, 12, 10, 8, 7, 6, 5, 4½, 4, and 3½ feet. Red circles on focusing scale indicate two universal-focus positions at *f*/8. For subjects from 7 to 15 feet, set focus at circle near 10; for scenes from 15 feet to infinity, set focus at circle near 25.

Shutter: Synchro-Compur. Speeds: 1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/250, 1/500 sec, and B. Built-in synchronization for Class F, M, and X. Camera-body socket accepts the Kodak TBI Cable Release No. 2 or the Kodak Metal Cable Release No. 5.

Size of Kodak Combination Lens Attachments: 1¼-inch Series VI Kodak Adapter Ring and Series VI-A Kodak Lens Hood.

Hyperfocal Distance: Same as near limit of depth of field at infinity. See below.

Depth of Field: Schneider Retina-Xenon Lens, 50mm *f*/2.0

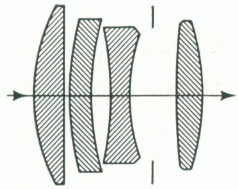
Distance* Focused On—Ft	Approximate Field Size**	DEPTH OF FIELD*** Circle of Confusion = 1/500 inch			
		f/2.0	*f*/4.0	*f*/8	*f*/16
INF	26° x 37°	80′ to Inf	40′ to Inf	20′ to Inf	10′ to Inf
50	22′ x 33′	31′ to 132′	22′ to Inf	14′ to Inf	8′6″ to Inf
25	11′ x 17′	19′ to 36′	15′ to 66′	11′ to Inf	7′ to Inf
15	6′9″ x 10′	12′8″ to 18′6″	11′ to 24′	8′7″ to 59′	6′ to Inf
12	5′4″ x 8′	10′5″ to 14′	9′3″ to 17′	7′6″ to 30′	5′6″ to Inf
10	4′6″ x 6′7″	8′11″ to 11′5″	8′ to 13′4″	6′8″ to 20′	5′ to Inf
8	3′6″ x 5′3″	7′3″ to 8′10″	6′8″ to 10′	5′9″ to 13′3″	4′6″ to 39′
7	3′ x 4′7″	6′5″ to 7′8″	6′ to 8′5″	5′2″ to 10′9″	4′1″ to 23′
6	2′8″ x 3′11″	5′7″ to 6′6″	5′3″ to 7′	4′7″ to 8′6″	3′9″ to 14′9″
5	2′2″ x 3′3″	4′9″ to 5′4″	4′6″ to 5′8″	4′ to 6′7″	3′4″ to 9′8″
4½	2′ x 2′11″	4′3″ to 4′9″	4′1″ to 5′	3′8″ to 5′9″	3′3″ to 7′11″
4	1′9″ x 2′6″	3′10″ to 4′3″	3′8″ to 4′5″	3′4″ to 4′11″	2′11″ to 6′6″
3½	1′6″ x 2′3″	3′4″ to 3′8″	3′3″ to 3′9″	3′ to 4′3″	2′8″ to 5′3″

* All Distances measured to front of shutter.
** Based on Kodak Readymount opening.
***The depth of field for *f*/2.8, *f*/5.6, and *f*/11 can be estimated by comparison.

Lens and Shutter Data:

KODAK ANASTAR LENSES, 80mm *f*/3.5

(as used on the Kodak Reflex II Camera)



The lenses of the Kodak Reflex II Camera are truly "twin" lenses; optically identical, they form a superior team for viewing and taking pictures. Unique in their field, each of these lenses has four elements to carry out corrections to a high degree, and each is Lumenized. Ground-glass image brightness is unexcelled, due to the Lumenizing and the fixed *f*/3.5 aperture of the viewfinder lens in addition to the Kodak Ektalite Field Lens positioned just under the ground glass. The equally fast, adjustable-aperture taking lens permits a wide range of picture taking even under poor lighting conditions. Sharp focus is assured throughout the focusing range by the positive, geared coupling of the viewfinder lens and the taking lens. Rotating the front mount of either automatically rotates the other and keeps the focus of the lenses identical.

Lens Speed: Finder lens, *f*/3.5. Taking lens, *f*/3.5, marked apertures—*f*/3.5, *f*/4, *f*/5.6, *f*/8, *f*/11, *f*/16, and *f*/22. Click stops.

Focal Length: 80 mm.

Lens Separation: 1.875 in. between centers of finder and taking lenses.

Focusing Range: Infinity to 3½ feet. Marked distances—Inf, 50, 25, 18, 15, 12, 10, 8, 7, 6, 5, 4, 3½ feet.

Shutter: Flash Kodamatic. Speeds—1/300, 1/100, 1/50, 1/25, 1/10, 1/5, 1/2 sec, B, and T. Built-in synchronization for Class F and M lamps. Accepts the Kodak Metal Cable Release No. 5.

Negative Size: 2¼ x 2¼ inches.

Angle of View: With lens focused at infinity, 39° x 39°.

Size of Kodak Combination Lens Attachments: 1½ in., 38 mm, Series VI.

Hyperfocal Distance: Same as near limit of depth of field at infinity. See below.

Depth of Field: Kodak Anastar Lens, 80mm *f*/3.5, on Kodak Reflex II Camera.

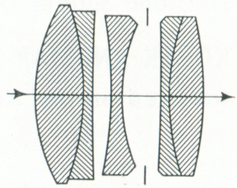
Distance* Focused On—Ft	DEPTH OF FIELD. ** Circle of Confusion = 1/350 Inch.																							
	f/3.5				*f*/5.6				*f*/8				*f*/11				*f*/16				*f*/22			
	ft	in.	to ft	in.	ft	in	to ft	in.	ft	in.	to ft	in.	ft	in.	to ft	in.	ft	in.	to ft	in.	ft	in.	to ft	in.
INF	84	6	Inf		52	9	Inf		37	—	Inf		27	—	Inf		18	6	Inf		13	6	Inf	
50	31	6	122	—	25	9	Inf		21	3	Inf		17	6	Inf		13	6	Inf		10	6	Inf	
25	19	3	35	6	17	—	47	6	15	—	77	—	13	—	350	—	10	9	Inf		8	9	Inf	
18	14	9	22	9	13	6	27	3	12	—	35	—	10	9	54	6	9	—	Inf		7	9	Inf	
15	12	9	18	3	11	9	21	—	10	6	25	3	9	6	34	—	8	3	79	3	7	—	Inf	
12	10	6	14	—	9	9	15	6	9	—	17	9	8	3	21	6	7	3	34	3	6	3	110	—
10	9	—	11	3	8	3	12	3	7	9	13	9	7	3	16	—	6	6	21	9	5	9	39	—
8	7	3	8	9	7	—	9	6	6	9	10	6	6	6	11	6	5	6	14	—	5	—	22	—
7	6	6	7	6	6	3	8	—	6	—	8	9	5	6	9	6	5	—	11	3	4	6	14	6
6	5	8	6	6	5	4	6	9	5	3	7	3	5	—	7	9	4	6	9	—	4	3	10	9
5	4	9	5	3	4	6	5	6	4	4	5	9	4	3	6	3	4	—	7	—	3	9	8	—
4	3	10	4	2	3	9	4	4	3	8	4	6	3	6	4	9	3	3	5	—	3	—	5	9
3½	3	4	3	8	3	3	3	9	3	3	3	10	3	2	4	—	3	—	4	4	2	9	4	9

*All distances measured to front of shutter.
**The depth is not given for *f*/4. It can be estimated by comparison.

Lens and Shutter Data:

KODAK EKTAR LENS, 100mm *f*/3.5

(as used on Kodak Medalist II Camera)



With its fast maximum aperture of *f*/3.5, this lens brings to photographic workers preferring larger negative sizes many of the picture-taking possibilities otherwise restricted to miniature cameras. A carefully worked out formula, excellent quality of the optical glass from which each one of the five elements is made, precision grinding, polishing, and mounting, all contribute to make it a really outstanding lens. Aberrations, especially those in any way affecting excellent color reproduction, are virtually nonexistent. To assure greater clarity and brilliance of black-and-white negatives and color purity in full-color pictures, the lens has been Lumenized. A coupled rangefinder and an automatic depth-of-field indicator aid in exact focusing. An auxiliary infrared focusing mark is provided.

Marked Apertures: *f*/3.5, *f*/4, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32. Click Stops.

Focal Length: 100 mm (4 in.)

Negative Sizes: 2¼ x 3¼ in. and 6.5 x 9 cm

Angle of View: With lens focused at infinity, 32° x 45° for 2¼ x 3¼ in. roll film, 36° x 49° for 6.5 x 9-cm sheet film, and 29° x 42° for 2¼ x 3¼ in. sheet film.

Focusing Range: Infinity to 3½ ft, with coupled rangefinder. Marked distances: Infinity, 50, 25, 15, 10, 8, 6, 5, 4, 3½ ft.

Shutter: Kodak Flash Supermatic. Speeds— 1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, 1/400 sec, and B. Built-in synchronization for Class F, M, and X. For time exposures, use the Kodak TBI Cable Release No. 2.

Size of Kodak Combination Lens Attachments: Series VI. No Adapter Ring needed.

Hyperfocal Distance: Same as near limit of depth of field at infinity. See below.

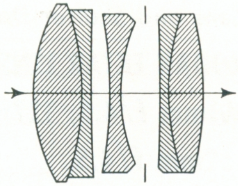
Depth of Field: Kodak Ektar Lens, 100mm *f*/3.5

Distance* Focused On—Ft	Approximate Field Size with 2¼ x 3¼″ Roll Film	DEPTH OF FIELD—IN FEET. Circle of Confusion, 1/200 in. *f*/3.5	*f*/4	*f*/5.6	*f*/8
INF	32° x 45°	74 to inf	65 to inf	46 to inf	32 to inf
50	28′ x 41′	30 to 155	28¼ to inf	24 to inf	19½ to inf
25	14′ x 20′	19 to 38	18 to 40	16 to 55	14 to 110
15	8⅓′ x 12¼′	12½ to 19	12¼ to 19½	11 to 22	10 to 28
10	5½′ x 8′	8¾ to 11½	8⅔ to 11¾	8⅙ to 12¾	7⅔ to 14½
8	4⅓′ x 6⅓′	7⅙ to 9	7⅙ to 9⅓	6¾ to 9⅔	6⅓ to 10½
6	3¼′ x 4⅔′	5½ to 6½	5½ to 6¾	5⅓ to 7	5 to 7½
5	2⅔′ x 3⅚′	4⅔ to 5⅓	4⅔ to 5½	4½ to 5⅔	4⅓ to 6
4	2′ x 3′	3⅚ to 4¼	3¾ to 4⅓	3⅔ to 4½	3½ to 4⅔
3½	1⅚′ x 2⅔′	3⅓ to 3⅔	3⅓ to 3¾	3¼ to 3⅚	3⅙ to 4
	Approximate Field Size with 6½x9-cm Sheet Film	***f*/11**	***f*/16**	***f*/22**	***f*/32**
INF	36° x 49°	23 to inf	16 to inf	11¾ to inf	8 to inf
50	32′ x 45′	16 to inf	12 to inf	9½ to inf	7 to inf
25	16′ x 22′	12 to inf	10 to inf	8 to inf	6 to inf
15	9½′ x 13¼′	9 to 42	7¾ to inf	6½ to inf	5¼ to inf
10	6½′ x 9′	7 to 17	6⅙ to 26	5⅓ to 69	4½ to inf
8	5′ x 7′	6 to 12	5⅓ to 16	4¾ to 25	4 to inf
6	3⅔′ x 5′	4¾ to 8⅙	4½ to 10	4 to 13	3½ to 23
5	3′ x 4⅙′	4⅙ to 6½	3⅚ to 7½	3½ to 9⅙	3 to 13⅙
4	2⅓′ x 3⅓′	3½ to 4⅚	3¼ to 5½	3 to 6⅓	2⅔ to 8
3½	2′ x 2⅚′	3⅙ to 4⅙	3 to 4⅔	2¾ to 5¼	2½ to 6⅓

*All distances measured from front of shutter.

Lens and Shutter Data:

KODAK EKTAR LENS, 105mm *f*/3.7



This lens has been designed for use on small press and view cameras or on the Kodak Flurolite Enlarger A when used as a camera, where excellence of performance and high speed are desired. It has been corrected for all the usual lens aberrations and works equally well at all distance settings from infinity to 3½ feet from the lens. When a shorter lens-to-subject distance is used, it is advisable to stop the lens below maximum aperture, particularly for work demanding critical definition. It is especially suitable for use with Kodak color sheet films. The performance of this lens, like that of other Ektar Lenses, is unsurpassed by any lens of similar type. Like all other Ektar Lenses, this lens is Lumenized. It is supplied in a Kodak Flash Supermatic Shutter.

Marked Apertures: *f*/3.7, *f*/4, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32

Focal Length: 105 mm (4⅛ in.)

Back Focus: 87.5 mm (3 7/16 in.)

Maximum Recommended Negative Size: 2¼ x 3¼ in.

Angle of View: With lens focused at infinity, 31° x 43°

Infrared Focusing: Lens should be extended .004 in. (.1 mm) from visual focus.

Shutter: Kodak Flash Supermatic. Speeds—1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, 1/400 sec, T, and B. Built-in synchronization for Class F, M, and X. Blade arrester. Accepts the Kodak Metal Cable Release No. 5.

Diameter of Lens-Board Mounting Hole: 38 mm, 1½ in.

Size of Kodak Combination Lens Attachments: 38 mm, 1½ in., Series VI

Hyperfocal Distance: Same as near limit of depth of field at infinity. See below.

Depth of Field: Kodak Ektar Lens, 105mm *f*/3.7

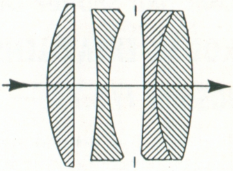
Distance* Focused On—Ft	Approximate Field Size with 2¼ x 3¼″ Neg	DEPTH OF FIELD—IN FEET.** Circle of Confusion, 2 min arc. This equals approximately 1/1720 of the focal length, and is for critical definition, and when extreme enlargements are to be made from the negatives. For normal work the depth of field is greater.					
		f/3.7	*f*/5.6	*f*/8	*f*/11	*f*/16	*f*/32
INF	31° x 43°	160 to inf	105 to inf	74 to inf	54 to inf	37 to inf	18½ to inf
100	54′ x 78′	62 to 266	51 to inf	43 to inf	35 to inf	27 to inf	15⅔ to inf
50	27′ x 39′	38 to 73	34 to 96	30 to 154	26 to inf	21 to inf	13½ to inf
25	13⅓′ x 19⅓′	22 to 30	20 to 33	18⅔ to 38	17 to 46	15 to 77	10½ to inf
15	8′ x 11½′	13⅔ to 16½	13 to 17½	12⅛ to 18⅚	11⅔ to 21	10⅔ to 25	8⅓ to 79
10	5¼′ x 7⅔′	9½ to 10⅔	9⅙ to 11	8⅚ to 11½	8½ to 12⅓	7⅚ to 13⅔	6½ to 22
8	4⅙′ x 6′	7⅔ to 8⅓	7½ to 8½	7¼ to 9	7 to 9⅓	6¾ to 10⅙	5⅔ to 14
6	3¼′ x 4¾′	5⅚ to 6¼	5⅔ to 6⅓	5½ to 6½	5⅓ to 6¾	5 to 7	4⅔ to 8⅔
5	2½′ x 3⅔′	4⅚ to 5⅙	4¾ to 5¼	4⅔ to 5⅓	4½ to 5½	4⅓ to 5¾	4 to 6⅔
4	2′ x 2⅚′	4 to 4	3⅚ to 4⅙	3⅚ to 4¼	3¾ to 4⅓	3⅔ to 4½	3⅓ to 5
3½	1¾′ x 2′	3½ to 3½	3⅓ to 3⅔	3⅓ to 3⅔	3¼ to 3¾	3¼ to 3⅚	3 to 4¼

*All distances measured to front of lens.
**The depth is not given for *f*/4.5 or *f*/22. For these openings depth can be estimated by comparison.

Lens and Shutter Data:

KODAK EKTAR LENSES

101mm f/4.5; 127mm f/4.7; 152mm f/4.5



These lenses make available to users of small and medium-size press and similar cameras the optical pre-eminence represented by Kodak Ektar Lenses. Their ability to meet most exacting requirements in black-and-white and color photography is well known. All of these lenses are Lumenized.

They produce definition of exceptional quality over the areas they are designed to cover at all apertures and all working distances from infinity to about 3½ feet from the lens. When a shorter lens-to-subject distance is used, it is advisable to stop the lens below maximum aperture, particularly for work demanding critical definition. The 101mm and 127mm lenses are also supplied with metal lens boards for use with the Kodak Flurolite Camera Combination.

Marked Apertures:

101mm lens: *f*/4.5, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32
127mm lens: *f*/4.7, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, and *f*/32
152mm lens: *f*/4.5, *f*/5.6, *f*/8, *f*/11, *f*/16, *f*/22, *f*/32, and *f*/45

Focal Length, Back Focus, Maximum Recommended Negative Size, and Angle of View (Lens Focused at Infinity):

Focal Length		*Back Focus*	*Maximum Recommended Negative Size*	*Angle of View (Lens Focused at Infinity)*
101mm	4 in.	90 mm	2¼ x 3¼ in.	32° x 45°
127mm	5 in.	113 mm	3¼ x 4¼ in.	36° x 46°
152mm	6 in.	135.2 mm	4 x 5 in.	37° x 45°

Infrared Focusing: Lens should be extended from visual focus as follows:

.004 in. (.1 mm) for 101mm lens
.004 in. (.1 mm) for 127mm lens
.03 in. (.76 mm) for 152mm lens

Shutters: Kodak Synchro-Rapid 800 (101mm lens): Speeds—1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, 1/400, 1/800 sec, and B. Built-in synchronization for Class F, M, and X. Kodak Flash Supermatic (127mm and 152mm lenses): Speeds—1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, 1/400 sec, T, and B. (No 1/400 sec for 152mm lens). Built-in synchronization for Class F, M, and X. Blade arrester. Kodak Supermatic X (127mm lens): Same features as Flash Supermatic Shutter except synchronized for Class X only.

Diameter of Lens-Board Mounting Hole:

101mm lens—35 mm, 1⅜ in.
127mm lens—38 mm, 1½ in.
152mm lens—47 mm, 1⅞ in.

Size of Kodak Combination Lens Attachments:

101mm lens—Series V, no Adapter Ring needed
127mm lens—38 mm, 1½ in., Series VI
152mm lens—44.5 mm, 1¾ in., Series VII

Hyperfocal Distance: Same as near limit of depth of field at infinity. See next page.

Depth of Field: Kodak Ektar Lens, 101mm *f*/4.5

Distance Focused On—Ft	Approximate Field Size with 2¼ x 3¼″ Neg	DEPTH OF FIELD—IN FEET. Circle of Confusion, 2 min arc. This equals approximately 1/1720 of the lens focal length, and is for critical definition, and when extreme enlargements are to be made from the negatives. For normal work the depth of field is greater.					
		f/4.5	*f*/5.6	*f*/8	*f*/11	*f*/16	*f*/32
INF	32° x 45°	127 to inf	102 to inf	72 to inf	52 to inf	36 to inf	18 to inf
100	56′ x 82′	56 to inf	51 to inf	42 to inf	34 to inf	26 to inf	15 to inf
50	28′ x 41′	36 to 82	34 to 98	29 to 165	25 to inf	21 to inf	13¼ to inf
25	14′ x 20′	21 to 31	20 to 33	18½ to 38	17 to 48	15 to 83	10½ to inf
15	8⅓′ x 12¼′	13½ to 17	13 to 17½	12½ to 19	11¾ to 21	10½ to 26	8⅙ to 92
10	5½′ x 8′	9¼ to 11⅓	9⅙ to 11	8¾ to 11½	8⅓ to 12½	7¾ to 14	6½ to 23
8	4⅓′ x 6⅓′	7½ to 8½	7⅓ to 8⅔	7⅙ to 9	7 to 9½	6½ to 10¼	5½ to 14½
6	3¼′ x 4⅔′	5¾ to 6⅓	5⅔ to 6⅓	5½ to 6½	5⅓ to 6¾	5⅙ to 6⅚	4½ to 8¾
5	2⅔′ x 3⅚′	4¾ to 5¼	4⅚ to 5¼	4⅔ to 5⅓	4⅔ to 5½	4½ to 5¾	4 to 6¾
4	2′ x 3′	3⅚ to 4⅙	3⅚ to 4⅙	3⅚ to 4¼	3¾ to 4⅓	3⅔ to 4½	3⅓ to 5
3½	1⅚′ x 2⅔′	3⅓ to 3⅔	3⅓ to 3⅔	3⅓ to 3⅔	3¼ to 3¾	3⅙ to 3⅚	3 to 4¼

The depth is not given for *f*/22. For this opening depth can be estimated by comparison.

Depth of Field: Kodak Ektar Lens, 127mm *f*/4.7

Distance Focused On—Ft	Approximate Field Size with 3¼ x 4¼″ Neg	DEPTH OF FIELD—IN FEET. Circle of Confusion, 2 min arc. This equals approximately 1/1720 of the lens focal length, and is for critical definition, and when extreme enlargements are to be made from the negatives. For normal work the depth of field is greater.					
		f/4.7	*f*/5.6	*f*/8	*f*/11	*f*/16	*f*/32
INF	36° x 46°	152 to inf	128 to inf	90 to inf	65 to inf	45 to inf	22 to inf
100	65′ x 85′	60 to 292	56 to inf	47 to inf	39 to inf	31 to inf	18 to inf
50	32′ x 42′	37 to 74	36 to 82	32 to 113	28 to inf	24 to inf	15½ to inf
25	16′ x 21′	22 to 30	21 to 31	19½ to 35	18 to 41	16 to 57	11¾ to inf
15	9½′ x 12⅓′	13⅔ to 16½	13⅓ to 17	12¾ to 18	12¼ to 19½	11¼ to 23	9 to 45
10	6¼′ x 8¼′	9½ to 10¾	9¼ to 10⅚	9 to 11⅙	8⅔ to 11¾	8¼ to 13	7 to 18
8	5′ x 6½′	7⅔ to 8⅓	7½ to 8½	7⅓ to 8¾	7⅙ to 9⅙	6⅚ to 9¾	6 to 12¼
6	3⅔′ x 4¾′	5¾ to 6¼	5¾ to 6¼	5⅔ to 6½	5½ to 6⅔	5⅓ to 6⅚	4⅚ to 8
5	3′ x 3⅚′	4⅚ to 5⅙	4⅚ to 5⅙	4¾ to 5¼	4⅔ to 5⅓	4½ to 5½	4⅙ to 6⅓
4	2⅓′ x 3′	3⅚ to 4⅙	3⅚ to 4⅙	3⅚ to 4⅙	3¾ to 4¼	3⅔ to 4⅓	3½ to 4¾
3½	2′ x 2⅔′	3½ to 3½	3½ to 3½	3⅓ to 3⅔	3⅓ to 3⅔	3¼ to 3¾	3 to 4

The depth is not given for *f*/22. For this opening depth can be estimated by comparison.

Depth of Field: Kodak Ektar Lens, 152mm *f*/4.5

Distance Focused On—Ft	Approximate Field Size with 4 x 5″ Neg	DEPTH OF FIELD—IN FEET. Circle of Confusion, 2 min arc. This equals approximately 1/1720 of the lens focal length, and is for critical definition, and when extreme enlargements are to be made from the negatives. For normal work the depth of field is greater.					
		f/4.5	*f*/8	*f*/11	*f*/16	*f*/32	*f*/45
INF	37° x 45°	190 to inf	107 to inf	78 to inf	54 to inf	27 to inf	19 to inf
100	66′ x 83′	66 to 209	52 to inf	44 to inf	35 to inf	21 to inf	16 to inf
50	33′ x 41′	40 to 67	34 to 95	30 to 137	26 to inf	18 to inf	13¾ to inf
25	16′ x 20′	22 to 29	20 to 33	19 to 37	17 to 47	13 to inf	10⅚ to inf
15	9⅔′ x 12⅙′	14 to 16¼	13 to 17½	12½ to 18½	11¾ to 21	9¾ to 33	9 to 69
10	6⅓′ x 7⅚′	9½ to 10¾	9¼ to 11	8¾ to 11½	8½ to 12½	7⅓ to 15½	6½ to 21
8	5′ x 6¼′	7¾ to 8⅓	7½ to 8⅔	7¼ to 8⅚	7 to 9⅓	6¼ to 11⅓	5¾ to 13¾
6	3⅔′ x 4½′	5¾ to 6¼	5¾ to 6½	5⅔ to 6½	5⅓ to 7⅓	4⅚ to 7¾	4½ to 8¾
5	3′ x 3½′	4⅚ to 5⅙	4¾ to 5¼	4¾ to 5⅓	4¾ to 5⅓	4⅓ to 6	4 to 6½
4	2⅓′ x 2⅚′	3⅚ to 4⅙	3⅚ to 4⅙	3¾ to 4¼	3¾ to 4¼	3⅔ to 4¾	3⅓ to 5
3½	1⅚′ x 2⅓′	3½ to 3½	3½ to 3½	3⅓ to 3⅔	3⅓ to 3⅔	3 to 4⅙	3 to 4¼

The depth is not given for *f*/5.6 or *f*/22. For these openings depth can be estimated by comparison.

KODAK SHUTTER DATA (Presetting Type—Current Models)

Kodak Shutter	Speeds	Synchronized for	Connector
Synchro-Rapid 800	1 to 1/800 sec, and B	Class F to 1/400 sec Class M and X, all speeds	Bayonet
Flash Supermatic	1 to 1/400 sec, T and B (B only on some models)	Class F, M, and X, all speeds	Bayonet 2-Prong
Flash Supermatic	1 to 1/200 sec, T and B	Class M and X, all speeds	Bayonet
Supermatic (X)	1 to 1/400 sec (1/200 on some), T and B	Class X, all speeds	2-Prong
Flash Kodamatic	1/10 to 1/200 sec, T and B	Class F and M, all speeds	Bayonet
Flash Kodamatic for Kodak Reflex II Camera	1/2 to 1/300 sec, T and B	Class F and M, all speeds	Bayonet
Synchro 300	1/25 to 1/300 sec, and B	Class M, all speeds	Bayonet
Flash 200	1/25 to 1/200 sec, and B	Class F, to 1/200 sec Class M at 1/25 sec	Bayonet

KODAK ENLARGING EKTANON LENSES

Lens	Aperture Range	For Negatives up to	Adapter Ring Size		Lens Attachment Series	Supplied in
			in.	mm		
50mm $f/4.5$	$f/4.5$ to $f/22$	$1\frac{3}{16} \times 1\frac{9}{16}$ in.	$\frac{15}{16}$	24	V	$2\frac{5}{8} \times 2\frac{5}{8}$-in. lens board
3 in. $f/4.5$	$f/4.5$ to $f/22$	$2\frac{1}{4} \times 2\frac{1}{4}$ in.	$1\frac{3}{16}$	30	V	
89mm $f/6.3$*	$f/6.3$ to $f/22$	$2\frac{1}{4} \times 3\frac{1}{4}$ in.	2	50.5	VII	
4 in. $f/4.5$	$f/4.5$ to $f/22$	$2\frac{1}{4} \times 3\frac{1}{4}$ in.	$1\frac{9}{16}$	39.5	VI	$2\frac{5}{8} \times 2\frac{5}{8}$-in. lens board
$5\frac{3}{8}$ in. $f/4.5$	$f/4.5$ to $f/22$	$3\frac{1}{4} \times 4\frac{1}{4}$ in.	$1\frac{3}{4}$	44.5	VII	
$6\frac{3}{8}$ in. $f/4.5$	$f/4.5$ to $f/22$	4 x 5 in.	2	50.5	VII	
$7\frac{1}{2}$ in. $f/4.5$	$f/4.5$ to $f/32$	5 x 7 in.	2	50.5	VII	Mounting flange
10 in. $f/8$	$f/8$ to $f/45$	8 x 10 in.	$1\frac{3}{4}$	44.5	VII	
10 in. $f/4.5$	$f/4.5$ to $f/32$	8 x 10 in.	$2\frac{5}{8}$	67	VIII	

*Supplied on Kodak Hobbyist Enlarger only

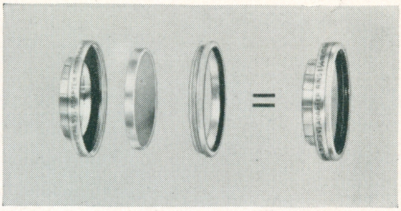
KODAK ENLARGING EKTAR LENSES

Lens	Aperture Range	For Negatives up to	Adapter Ring Size		Lens Attachment Series	Supplied in
			in.	mm		
2 in. $f/4.5$	$f/4.5$ to $f/22$	$1\frac{3}{16} \times 1\frac{9}{16}$ in.	$\frac{15}{16}$	24	V	$2\frac{5}{8} \times 2\frac{5}{8}$-in. lens board
3 in. $f/4.5$	$f/4.5$ to $f/22$	$2\frac{1}{4} \times 2\frac{1}{4}$ in.	$1\frac{3}{16}$	30	V	
4 in. $f/4.5$	$f/4.5$ to $f/22$	$2\frac{1}{4} \times 3\frac{1}{4}$ in.	$1\frac{9}{16}$	39.5	VI	

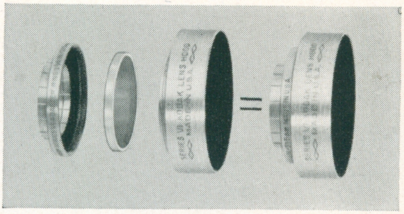
KODAK COMBINATION LENS ATTACHMENTS

KODAK Portra Lenses and Kodak Telek Lenses, described in this Data Book, are part of the system of matched lens accessories provided by Kodak Combination Lens Attachments. This system permits the interchange or combination of the various unmounted units, such as Kodak Wratten Filters, Kodak Pola-Screen, Kodak Lens Hood, and other attachments.

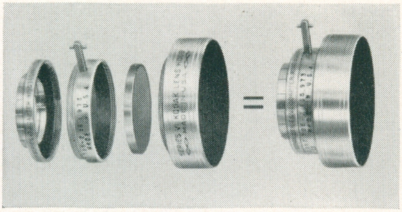
Kodak Adapter Ring is a basic attachment which is provided in a variety of sizes to fit lens mounts measuring from ⅝ to 2⅝ inches in outside diameter. Each Kodak Adapter Ring is supplied complete with its Kodak Adapter Ring Insert, to hold the filter or supplementary lens in place. Threaded lens mounts take screw-in Kodak Adapter Rings.



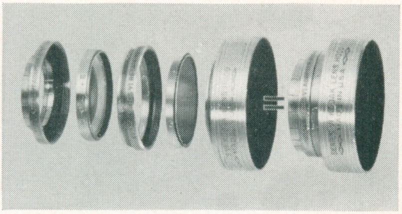
Kodak Lens Hood can be substituted for the Kodak Adapter Ring Insert. **Kodak Step-Up Ring** (not illustrated) permits the use of one set of accessories with two lenses which would normally require two different series of attachments. Kodak Step-Up Rings are supplied in Series IV-V, Series V-VI, Series VI-VII, and Series VII-VIII.



Kodak Pola-Screen can be substituted for the Kodak Adapter Ring Insert. If desired, a color filter can be added to the assembly and held in place either by the Kodak Adapter Ring Insert or by the Kodak Lens Hood, as shown in the illustration at right. **Kodak Pola-Screen Viewer,** which fits the handle of the Kodak Pola-Screen, is also available.



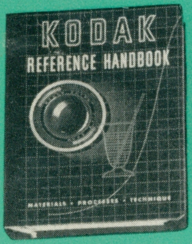
Kodak Retaining Ring makes it possible to assemble two filters, or a filter with a supplementary lens. The Kodak Retaining Ring holds one disk in the Kodak Adapter Ring, and either the Kodak Adapter Ring Insert or Kodak Lens Hood holds the second disk. Kodak Combination Lens Attachments can be purchased separately, as needed.



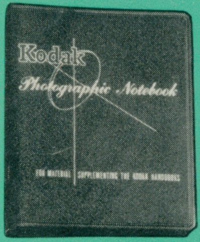
AUTHORITATIVE REFERENCE BOOKS

Kodak Master Photoguide. A pocket library of photo data with many computing aids. Contains exposure data for most types of situations encountered in the studio, at home, or in the field.

Kodak Color Handbook. A complete guide to taking still pictures in color. Four Kodak Color Data Books in a Mult-O Ring binder describe theory, data, and the use of color materials.



Kodak Reference Handbook. A comprehensive Mult-O Ring binder containing several complete Kodak Data Books. Discusses materials, processes, and photographic techniques.



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