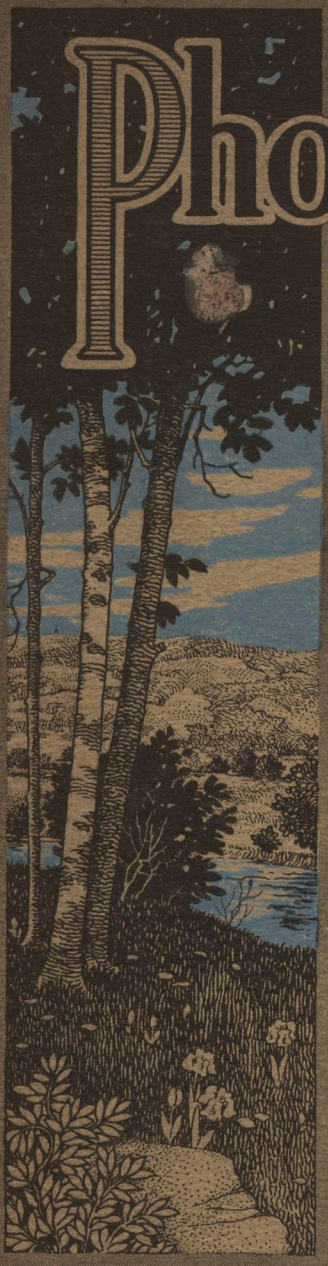
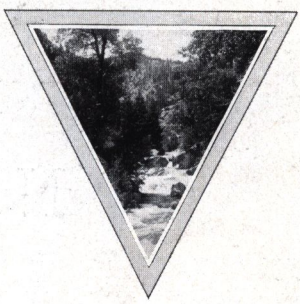
Photographic Lenses

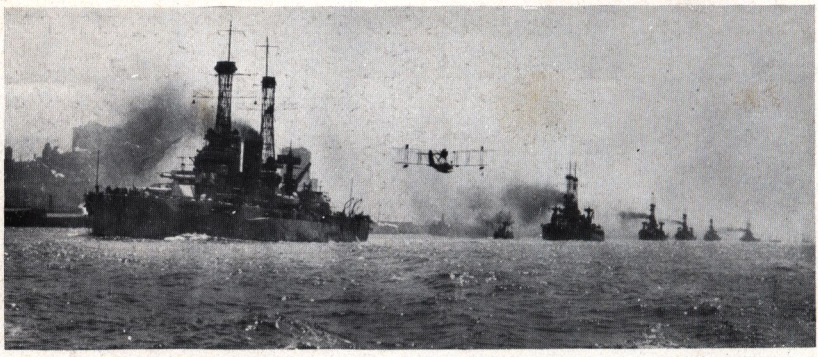


BAUSCH & LOMB OPTICAL COMPANY

Capitol at Night

PHOTOGRAPHIC LENSES





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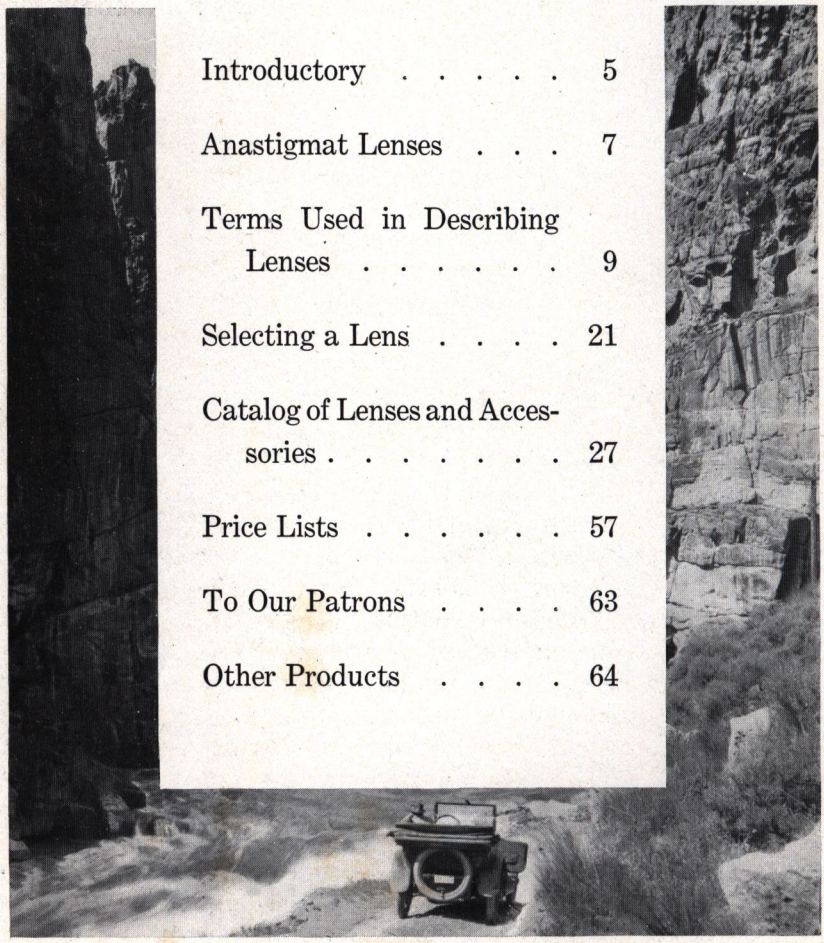
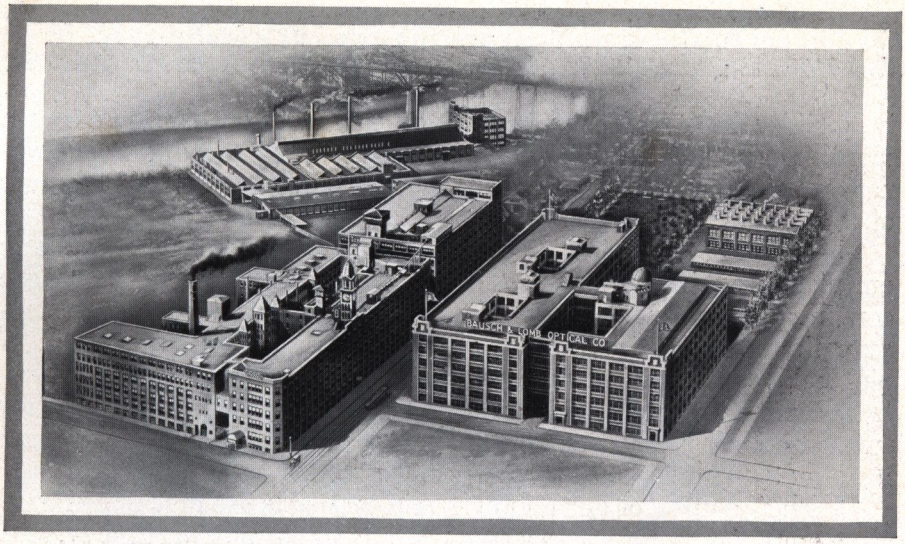




Bausch & Lomb Plant—Aerial Photograph by J. G. McNett with Tessar Ic

INTRODUCTORY

BACK of the products presented herein lies a heritage of nearly seventy years of optical research and manufacturing experience, of which more than forty years have seen us in the photographic field. Devoted to optical endeavor of varied forms since the establishment of our business in 1853, we naturally became a pioneer agency in the development and popularizing of photography in America.

It was in 1878 that we produced our first photographic lenses, although they were only of the simplest form designed for small cameras. Our manufacture of double-system, or so-called Rapid Rectilinear lenses, was begun in 1885 and marked the approximate beginning of our serious endeavor along this line.

Prior to that time most of the photographic lenses used in this country were of European manufacture and high in price. The problem confronting us, then, was to equal the quality of the foreign product, at the same time reducing the cost to the user. How well we have met both counts of that issue is attested by the millions of our lenses which have since met every photographic requirement most successfully—on every type of camera, from the inexpensive vest pocket size to the modern aerial camera and the most elaborate professional equipment.

Our most significant contribution to American photography was the introduction of the Anastigmat lens in this country, shortly after its invention by the scientists of Carl Zeiss, Jena. This culminated in the production of the Tessar and Protar series, unexcelled representatives of that superior type, which it is our purpose to present in the following pages. The manner in which Anastigmats helped solve photography's most perplexing problems is indicated in the next chapter.

Pioneers also in the development of optical glass manufacture in America, we now control our own supply of this basic raw material. It

is possible, therefore, for us to work out our glass problem in our own plant, in advance of our lens and instrument problems and in co-ordination with them—a condition of no slight advantage in manufacture of this exacting character.

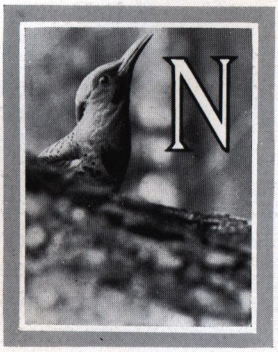
The work of our Scientific Bureau is also of special significance in our photographic production. The formulae for our different lenses are computed by our own staff of scientists—the same scientists who compute the formulae for practically every type of lens, from that of pinhead size for use in our high-power microscope objectives, to large searchlight mirrors five feet or more in diameter. Furthermore, they supervise both production and testing, to insure the finished product meeting the standard set by their computations.

This new edition of our photographic catalog is the first to be issued since our department was released from its important wartime service. It purposes to afford brief information on the wide range of our products in this field. For those who may desire more complete or detailed information on lenses for portraiture, in studio or home, for photo-engraving, enlarging or any special work, we are always pleased to take up such questions by correspondence. Do not hesitate to refer your photographic problems to us. (For terms, etc., see page 63.)

Landscape Study

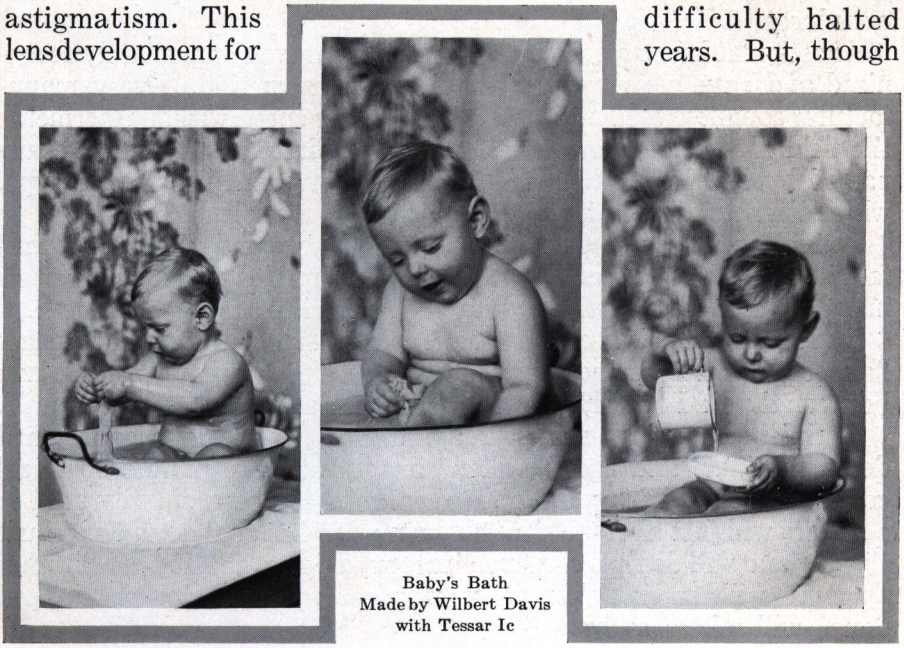
ANASTIGMAT LENSES

WHAT THEY HAVE MEANT TO PHOTOGRAPHY



O camera can give better results than its lens will permit; hence, the importance of lens manufacture to the enthusiastic photographer. In the early days of photography the lenses available were exceedingly slow and difficult to work with. Many experimenters, interested in the new science, tried to find a way to better them, but few met with any appreciable success. When faster lenses finally were invented, they had, from a modern viewpoint, a narrow field and other serious defects.

Numerous optical scientists undertook to produce a lens of greater versatility, which would overcome these defects, but it was more than twenty years before a lens was produced which represented a real forward step. This type, known as Rectilinear, was the first that proved its fitness to survive by combining spherical correction for a comparatively large aperture with freedom from distortion over a large field. Even this lens, which is still widely used in the simpler outfits, has one serious drawback, as it cannot be corrected for both astigmatism and curvature of field. If free from astigmatism, it has a curved field; or, if made to give a flat field, the margins show the blur of the uncorrected astigmatism. This difficulty halted lens development for years. But, though



Baby's Bath
Made by Wilbert Davis
with Tessar Ic

mathematics was baffled, science finally found a remedy—a *new glass.*

For this new glass modern optical science is indebted to the collaboration of Professor Abbe and Dr. Schott, of Jena. In 1881, Dr. Schott, at the suggestion of Professor Abbe, began his experimental effort to produce a glass with new optical properties. Up to this time the optical qualities of ordinary glass had changed in proportion to its specific gravity. The heavier the glass, the higher the refractive power and the greater the dispersive power.

Abbe, the mathematician, had advanced the theory that it was possible to produce glasses which, though they had refractive indices as high as heavy flint glass, should show no more dispersion than ordinary crown glass. Dr. Schott worked to produce such a glass, and after three years was so successful that a plant making this new glass was put into regular operation. It was glass manufacture of this character which we successfully developed during the European War and which we are now carrying on in our own plant at Rochester, N. Y.

The first man to utilize the possibilities of the new glasses for the purpose of photography was Dr. P. Rudolph, of Jena, who in 1890, made the first anastigmat. This lens had astigmatic correction over a large flat field and at the same time spherical correction for a large opening, covering a large plate well and with a short exposure. The first lens of this type was a "universal," with a moderate speed and angle of view. There soon followed lenses of higher speed, as well as wide angle lenses, and in 1895 came the Convertible Protar Series VIIa, which has since become famed for its wide range of efficient usefulness.

Anastigmat lens superiority over Rectilinear was immediately recognized and gave a great stimulus to lens construction. Every manufacturer sought persistently to acquire greater speed without sacrificing the field of view. All other efforts in this direction were finally surpassed by Dr. Rudolph in 1903, when he invented the Tessar type, which is unequalled in its perfection by any other lens.

As indicated in our introductory statement, we undertook the manufacture of both Protar and Tessar lenses in America shortly after their inception and have carried it on with increasing success ever since.

To summarize this chapter, the progress in lens optics during the last half century can be most vividly shown, perhaps, by a comparison between the old Petzval type of Portrait Lens and the present Tessar Ic.

Both lenses have the same speed, if the Portrait lens is diaphragmed down to F:4.5, and their brilliant images indicate perfect spherical correction. But, while one of these early lenses, as ordinarily used in a studio, will just about cover field enough to image the head and bust sharply and will do no more, even if stopped down, the Tessar, with full aperture, will cover a field more than twice as great, and, when stopped down, will take a group.

TERMS USED IN DESCRIBING LENSES

TECHNICAL terms used in photography are often puzzling to the amateur, particularly, perhaps, those terms which relate to the science of optics. The following glossary of optical terms has been prepared with a view to giving general information as to the descriptive words and phrases in ordinary use.

EQUIVALENT FOCAL LENGTH. **Focal Plane** is the plane in which a far distant object is imaged by the lens. The line drawn perpendicularly through the center of the lens is its Optical Axis; the point at which the Focal Plane intersects the Optical Axis, the Focal Point of the lens.

The **Focal Length** of a lens is the value upon which depends the size of the images produced by that lens. Its magnitude can be determined only by comparing the size of a given object with its image as formed by the lens. The distance of the object, unless very great, must also be considered.

For far distant objects the size of the image is in direct proportion to the focal length. A lens of 12-inch focal length will produce an image of a distant steeple twice as large as the image formed by a lens of 6-inch focal length.

Back Focus is the distance from the focal point to the rear surface of the lens. In the case of very thin lenses, this back focus is equal to the focal length, while in the case of lenses of considerable thickness and in combinations of lenses, the back focus cannot be relied upon as any indication

Columbia River Highway, Snowclad—Made by G. M. Davidson with Tessar IIb

Cloud Effects—Made by F. M. Locke with Tessar Ic and Ray Filter

of the value of the focal length. The focal length of such a lens is equal to the focal length of a thin lens, which gives an image equivalent in size to the one formed by the combination lens, hence the term "**Equivalent Focal Length.**"

In the majority of photographic lenses the equivalent focal length is greater than the back focus, an exception being found in the Series VII, where the back focus is the longer.

By measuring back from the focal point a distance equal to the equivalent focal length, we find the position of the cardinal point of the lens.

ANGLE OF VIEW is the angle under which the diameter of the circular area covered sharply by the lens appears from the center of the lens (the point where the rays cross). If the largest plate, which the lens covers sharply, is used, the angle of view is equal to the angle under which the diagonal of the plate appears from the center of the lens. The angle of view **increases** with the **decrease** of the focus of the lens for the **same size plate.** Lenses for general purposes are calculated for an angle of about 60°. Lenses covering from 75° to over 100° are termed **Wide Angle Lenses.** Wide angle lenses have necessarily shorter foci than other lenses rated for the same plate. The diagram on page 55 enables one to determine the angle of view in any given case.

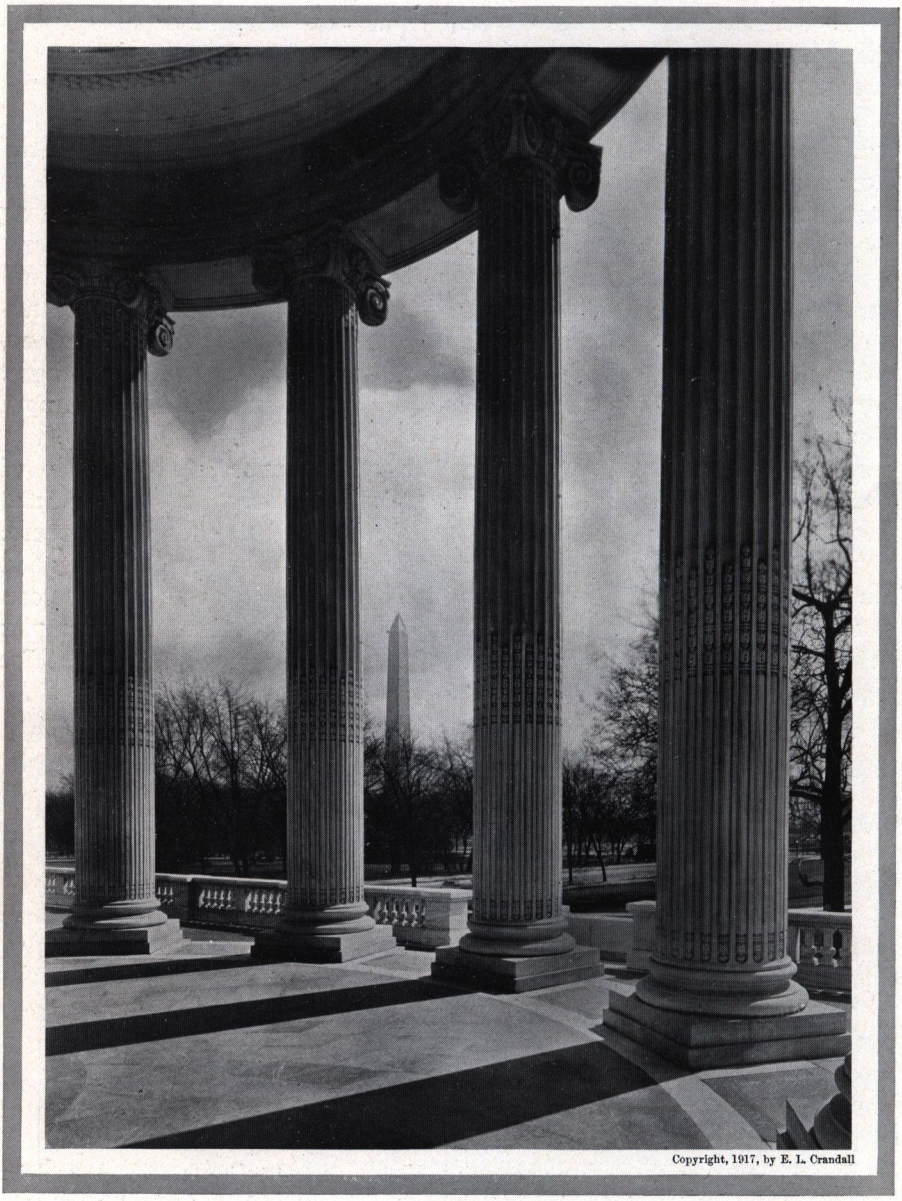
The circular area which is covered by the lens on the ground glass is called its **Image Circle,** and its diameter is expressed in linear measure (inches or centimeters).

Effective Aperture is measured by the diameter of the beam of light transmitted by the lens. The effective aperture is not, as often thought, equal to the diameter of the front lens, nor is it equal to the linear diameter of the diaphragm opening used. It equals the diameter of the diaphragm as it appears when observed through the front lens; therefore, the effective aperture cannot be found by unscrewing the front lens and measuring the actual diameter of the diaphragm. Only in the case of a landscape lens, like Series VII, where the diaphragm is placed in front of the lens, is the effective aperture expressed by the linear diameter of the diaphragm.

The effective aperture varies, of course, with the size of the diaphragm opening.

Relative Aperture is a fraction which expresses the ratio of effective aperture to focal length; for instance, relative aperture of 1:6.3 means that the focal length is 6.3 times greater than the effective aperture. The denominator of the fraction, in this instance the figure 6.3, is called the **F value.** If the relative aperture is known, the effective aperture can be found by multiplying the relative aperture by the focus. For example: F:160; relative aperture=1:8; effective aperture=160 x 1:8=20. The relative aperture is a term of greatest value and convenience in judging the

Park Scene—Made by Otto Stenzel



Through the Pillars

time of exposure. All lenses of the same relative aperture, no matter what their focus may be, require the same exposure under the same conditions. An exception will be mentioned under the heading, "Depth of Focus."

The exposures necessary for different relative apertures can easily be found because they are proportionate to the square of the F values. For instance, if two lenses are compared with the relative apertures of 1:4 and

1:8 respectively, the squares of the F values are 16 and 64 respectively, which means that the 1:8 requires four times as long exposure as the 1:4 lens, since $^{64}/_{16}=4$. This, of course, also holds true in comparing the different stops.

SPEED. The relative aperture is very commonly called the speed of the lens, although the speed of two lenses is not proportionate to their relative apertures but to their squares. In other words, a lens with the speed of 1:4 is not twice as fast as a lens with the speed of 1:8, but four times so, as the comparison of the squares of their relative apertures $^1/_{16}$ and $^1/_{64}$ shows.

There are two methods of designating lens stops, viz.: the so-called **F System** of the Royal Photographic Society, wherein the stop is expressed by fractions of the focal length, and the **U. S. (Uniform System)**, in which every following stop requires a doubling of the exposure or represents half the speed of the foregoing, the exposure required with F:4 being taken as the unit.

Comparison Between the F System and the U. S. (Uniform System) of Stops

F. System	F:4	F:4.5	F:5.6	F:6.3	F:7.7	F:8	F:9	F:10	F:11.3	F:12.5	F:16	F:22.6	F:25	F:32	F:45.25	F:50	F:64
U. S. . .	1	1.2	2	2.5	3.7	4	5	6.25	8	9.8	16	32	39	64	128	156	256

The above table gives the comparative stops in the two systems and shows at the same time the exposure values of the different stops in the F System. For instance, F:11.3 requires four times as long an exposure as F:5.6; and F:32, an exposure sixteen times longer than F:8, since $^8/_2=4$ and $^{64}/_4=16$.

DEPTH OF FOCUS. Very closely connected with the speed of a lens is its depth of focus. All well-corrected lenses image only one plane of the object space sharply. The reason why a lens focused at a house images also with sufficient sharpness, say a horse in front and a tree back of it, lies in the fact that a slight racking out of focus will not cause an indistinctness great enough to be noticeable to the eye. The range of sharpness forward and back of the object is called "depth of focus" or "depth of field." It depends on several factors, viz.: the focal length of the lens, the aperture used (consequently its speed), the distance of the object, and the amount of lack of sharpness which seems permissible to the operator. Of these factors, focal length, aperture and distance are definite numerical values. That the amount of indistinctness permissible in the picture is susceptible of numerical expression is easily seen from the following: if an object at a given distance is in sharp focus, the light issuing from a point of that object is converged to a point on the plate. Light issuing from a point forward or back of the object will also be converged to a point, but not on the plate, the cone of light showing in either case a circular patch on the plate. This circle of light is known as the "circle of confusion."

Facing a Climb—Made with Tessar Ic

Its diameter can be used to express the amount of indistinctness existing in a picture. If the circle of confusion is not greater than 1/10 mm or 1/250 inch, it would appear as a point to an eye 10 inches away, hence, an object no point of which is imaged by a circle larger than 1/10 mm would appear sharp.

No matter what their type of construction may be, **all lenses of the same equivalent focus and the same relative aperture require the same exposure,** that is, have the **same speed,** other conditions

being equal. They will also have the **same depth.** The depth of focus decreases:

1. With increase of focal length.
2. With increase of relative aperture (speed).
3. With increasing nearness of objects.

Of two lenses of the same equivalent focus, the one with the lower relative aperture (speed) has the greater depth of field. On the other hand:

Country Road near Boulder, Colo.—Made by T. C. Black, Jr., with Protar VIIa

if the focal length of the lens is very short, a speed as high as F:4.5 will allow bringing every object from 10 feet to infinity to a sharp focus, while a studio lens of long focus and the same speed may not even image an object of the depth of a head sharply within the range of the length of a studio. Speed, great focal length and depth of focus cannot be combined in the same lens. **This is an unalterable law of optics.** If speed be the most desirable quality, depth of focus must be sacrificed; if depth of focus, speed. This does not detract from the value of fast lenses, because with a given lens the depth of focus can be increased by diaphragming down the lens which means reduction of speed. If a short exposure demands the use of the lens wide open, one must not expect great depth of focus. Under ordinary conditions of light and distance, with fair judgment, and with lenses not too long in focus, these opposing qualities may be happily combined, so that lack of depth is hardly perceptible.

Some apparent exceptions may be stated, for instance, a lens which

produces images of general "softness," i. e., a lens in which the aberrations are not corrected to the utmost perfection. Such lenses, which lack snap and brilliancy, may show greater depth of focus than a first-class lens. There is less difference between the "sharpest" focus and the image of objects forward and back of it, simply because the "sharpest" focus itself is not really sharp. Thus the statement that one lens has a greater depth of focus than others of the same aperture and focus, must be regarded as a rather doubtful compliment to the lens, for as stated above, **depth of focus cannot be made subject to special correction.**

Another case may be mentioned in which one lens may **really** have an advantage over another one, in regard to depth of focus. In some constructions, correction of astigmatism is obtained at a great sacrifice of simplicity by employing an unusual number of lenses separated by air spaces. There is a certain loss of light by reflection on a lens surface and it is easily intelligible that the fewer reflecting surfaces in a lens, the smaller the loss of light. In some constructions the number of the lens surfaces runs up as high as ten, while the Tessar contains only six. The consequence is that the lens with the greater number of reflecting surfaces requires a longer exposure than a lens of simple construction, although both may have the same relative aperture. Or to express it differently: the lens with the greater number of reflections requires an aperture of F:6.3 with a certain time of exposure, while the other lens will give a negative of equal density with its aperture stopped down to F:7.2 or F:7.5, which means a **gain in depth of focus** for the **lens** with the **smaller number of reflecting surfaces.** This is especially important with lenses used on folding cameras where the focusing is done without ground glass by means of a scale, and where the photographer has to depend on his unaided judgment and experience for getting the necessary depth of focus.

Spherical Aberration. Owing to the fact that lenses are made with spherical curves, all single collective lenses have the defect of imaging an object through their marginal zone at a shorter focus than through their central zone. Such a lens may give a sharp image with a small central diaphragm, and a sharp image as well if the center is covered with a round opaque stop so that only an annular zone around the margin comes into action. But both images will not lie in the same plane, nor will they be of the same size. Even if a lens is spherically corrected, so that the parallel rays penetrating the lens near the optical axis and those going through the lens near the margin come to exactly the same focus, there may be a slight remnant of spherical aberration in the zone between center and margin. Small remnants of this kind (so-called **Zonal Errors**) are found in almost all photographic lenses, especially of the cemented symmetrical type. The unsymmetrical combination upon which the Tessar construction is based, allows a better correction of the zonal errors than any other known construction. The greater the relative aperture (speed of the lens), the greater the task to correct the spherical aberration for all zones of the lens.

Big Thompson Cañon, Colo.—Made by T. C. Black, Jr., with Protar VIIa

Unsatisfactory spherical correction is indicated either by a general indistinctness of the image or by a fairly sharp image, which is entirely covered by halo (fog). Stopping down the aperture may improve the performance of a badly corrected objective.

Coma. The spherical aberration of pencils of light going through the lens in oblique direction is called **coma.** This manifests itself in the fact that although objects in the center of the field appear perfectly defined, objects outside of the center show a one-sided indistinctness which increases towards the margin of the field, and in the image of a point-shaped object assumes the form of a tail like a comet, wherefrom this aberration takes its name. Stopping down reduces the amount of coma.

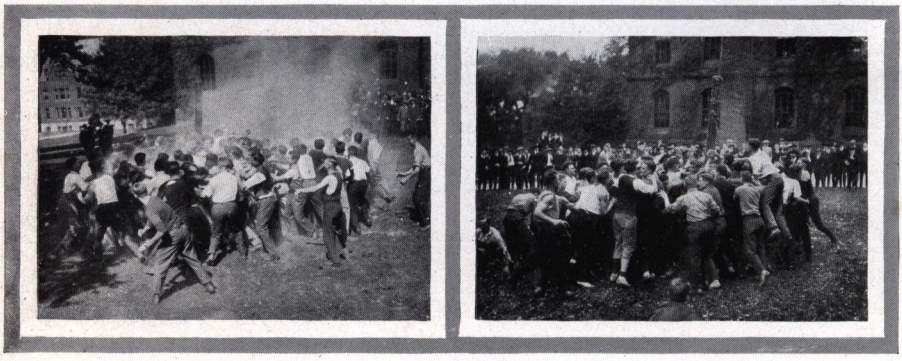
Astigmatism. Astigmatism is that aberration which withstood longest the efforts of the opticians. A lens which is not corrected for astigmatism will not image sharply horizontal and vertical lines at the same time near the margin of the plate, although the center of the image may be perfect. This aberration is inherent in narrow pencils of light, so that stopping down the lens will not decrease the amount of astigmatism to the same degree that it decreases other uncorrected aberrations.

In the absence of a test chart a very simple test for astigmatism may be made by focusing on the joints of a brick wall. No matter how much the lens may be racked in or out, both horizontal and vertical lines will never be sharply defined at the same time near the margin of the plate.

CURVATURE OF FIELD. The ordinary lens images a flat object, not in a plane, but in a spheroidal surface, so that when the center of the image is focused sharp, the ground glass has to be brought nearer to the lens to obtain a sharp image of an object point near the margin of the plate.

Lenses which are free from spherical aberration for a large aperture and produce a flat image free from astigmatism, are called "Anastigmats," the prefix "an" meaning without, hence, without astigmatism.

DISTORTION is that fault of a lens which prevents the rendering of straight lines as such. The straight lines are reproduced as curves. All single lenses used with a diaphragm in front (landscape lenses) are subject to this defect in some degree. The distortion is called **cushion**



Class Rush beneath Flour Screen, University of Rochester—Made by A. R. Stone with Tessar Ic

shaped, when the curves are concave, and **barrel shaped,** when the curves are convex toward the margin of the plate.

Lenses which are free from distortion are called **rectilinear.**

The performance of a lens which distorts cannot be improved by using smaller stops.

Distortion has nothing to do with curvature of field. The image can be properly flat and the definition perfect, and yet straight lines may be distorted into curves.

CHROMATIC ABERRATION is due to the fact that in a lens, unless corrected for chromatic aberration, the visual rays which form the image seen on the ground glass do not form the images at the same position as the actinic or chemical rays, which affect the sensitive plate. Since the image is focused with rays for which the **eye** is most sensitive, the image formed by the rays for which the **plate** is most sensitive will fall outside of the visual focus (focal point), and therefore must be blurred on the plate. Of course all photographic lenses which claim to be of any value at all must, first of all, be corrected for chromatic aberration. An objective which has chromatic aberration is sometimes said to have chemical focus.

DEFINITION is that quality which enables a lens to produce sharp and crisp images, and its presence in an objective is a proof of exact workmanship as well as careful computation. The best workmanship will be wasted in a lens not well designed, and bad workmanship will annihilate the best computer's skill. If all the various defects and aberrations are corrected and the workman has done everything to carry out the designer's ideas, the lens will give at full aperture a flat and sharply cut image over the entire area covered. Among the few constructions which permit such perfection the Tessar type stands foremost. The area covered with perfection is sometimes called **area of critical definition.** Since most of the aberrations depend upon the opening of the lens, the definition may be improved in some cases by reducing the opening at the sacrifice of speed.

ILLUMINATION. We speak of even illumination when the margin of the plate receives as much light as the center, and the negative shows an even density all over. A perfectly even illumination is only possible with small stops, especially when a larger plate is used than the lens is rated for. All speed lenses show more or less drop in the illumination (vignetting) toward the margin of the field covered when used with full aperture.

COVERING POWER is expressed by the area which the evenly illuminated flat field covers with perfect definition. It depends upon the diameter of the lenses and on the degree to which the different aberrations are corrected and may, in some cases, be increased by using smaller stops.

The greater the relative aperture and the greater the covering power, the more valuable the lens.

FLARE SPOTS. Occasionally a negative will show a nebulous patch of light covering shadows and highlights alike. Such patches are called **flare spots or ghosts.** They are formed by light reflected within the lens, at the lens surfaces bounding air spaces, and as a general proposition, it may be stated that every lens having an air space will show a flare spot under some conditions. Although it is possible to so adjust the curvature and direction of the lens surfaces that the flare spot is spread over nearly the whole plate, therefore, not noticeable, this generally could be accomplished only by sacrificing more important corrections.

Before it can be said that one lens is superior to another with respect to flare spot formation, the two lenses must be thoroughly tried out under a great variety of conditions of illumination. It will generally be found that if under certain conditions one lens shows a flare spot and another of different construction does not, by changing conditions the second lens will show a flare spot and the first will not.

Very small stops may show flare spots when larger stops do not.

Flare spots are most apt to appear when photographing an object against a strong light and least apt to appear when the light is coming from back of the camera.

"Everybody In !"—Seneca Park Lake, Rochester, N. Y.—Made by A. R. Stone with Tessar Ic

SELECTING A LENS

HELP TOWARD ANSWERING "WHAT LENS SHALL I BUY?"

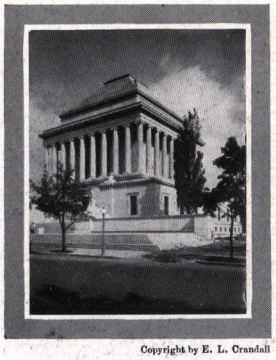
THE present catalog gives specific descriptions, prices and shutter fittings of our various series of lenses, but it will be of aid to the intending purchaser to review the appended sketch of lens requirements and first decide upon the specific purposes for which his lens is to be used. Having so decided he may turn to the fuller statement of the lens or lenses recommended under this heading.

AERIAL PHOTOGRAPHY

Recent experience has shown the usefulness of the Tessar Ic for both oblique and vertical photographs made from aircraft. Here speed is essential to overcome the motor vibration, and flatness of field is important, as the object in a vertical "shot" is practically a plane, and the photograph to be successful must reproduce it as such. Covering power and even illumination should commend the Tessar Ic to Engineers and others concerned with the use of aerial photography in connection with surveying and general problems of topography and map making.

ARCHITECTURAL WORK

Protar Series VIIa is the first choice on account of its superb corrections and reserve covering power. For details of architecture at some distance from the observer, where the series VIIa images would be too small, the Series VII elements of the VIIa are useful as the image increases in size as the focal length of lens is increased. In restricted spaces, Protar Series V Wide Angle lenses are almost necessities. For the inaccessible details, such as cornices, gargoyles, etc., the Bausch & Lomb telephoto attachment will be found to be invaluable.



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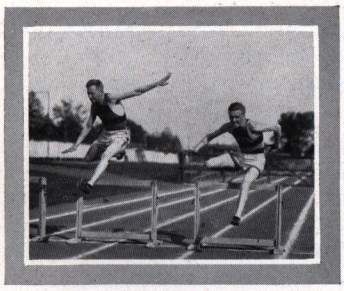
ATHLETIC SPORTS



The Tessar Ic, F:4.5, should be selected on account of its great speed. The motion of the object must be arrested by the shutter in order to obtain sharp images, no matter what the light conditions may be at time of exposure. By working at a greater distance, smaller images are produced with greater depth, which images, therefore, can be enlarged successfully.

The Tessar IIb, F:6.3, will also do very satisfactory work along these lines, if the pictures are made at moderate distances. The Tessar Ic should always be selected in preference to the Tessar IIb if a reflecting type of camera is available, as the Tessar Ic stopped down will duplicate the Tessar IIb; but the Tessar Ic cannot be recommended for compact hand cameras as it is necessarily more bulky than the Tessar IIb and some cameras do not have room enough to permit its use.

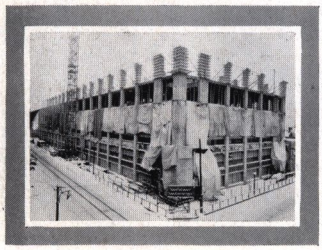
BUTTON AND STAMP PICTURES

For this work the required image is so small that the lens works practically at a universal focus. A short focus lens will probably be demanded on account of the restricted operating space. The Tessar Ic, F:4.5, such as No. 13, 14 or 15, is the proper selection.

CHILDREN'S PHOTOGRAPHS

For this fascinating branch of photography, we need speed—therefore the Tessar Ic, F:4.5, is the best lens. With reflecting type of camera and the Tessar Ic, one can catch the fleeting expression of the child, make pictures of him at play, or a snap-shot in the house. The Tessar Ic is of necessity more bulky than the IIb, which is generally fitted to the folding type of hand camera. There are some types of cameras with ground glasses for focusing which also have front board room enough to take Tessars Ic, but in general these cameras will take only the Tessar IIb, F:6.3. The latter lens will do excellent work, for it has about twice the speed of the ordinary camera lens.

CONSTRUCTION WORK



A Tessar IIb, F:6.3, on a light hand camera should be used for reconnoitering and preliminary surveys. For all-round work by a resident photographer for large engineering projects a Protar VIIa, supplemented by Series V Wide Angle Protar, is the best equipment on account of the convertible features which are so advantageous for photographs of this nature.

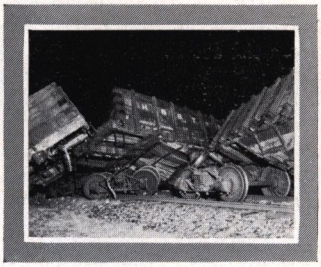
COPYING

All of our lenses can be used with good success for this work. The Tessar IIb is excellent in this line and for an inexpensive copying lens the Series V Wide Angle Protar is recommended. Specially corrected copying lenses are made for photo-engravers.

ENLARGING

The Tessar IIb, F:6.3, should be selected on account of its excellent optical corrections. In enlarging a flat object (the negative) is projected on another flat surface (the bromide paper) and the necessity of a perfectly flat field lens is, of course, obvious. If the Tessar is intended primarily for enlarging, we recommend a specially adjusted lens for the purpose. When such an adjustment is made, the lens can be used at much larger openings, thus gaining speed. (Special literature on condensers and enlarging sent on request.)

FLASHLIGHT PHOTOGRAPHY



For flashlight work, banquets, interiors, etc., the most useful lens is one which has a large available image circle. Series VIIa or Tessar IIb allow focusing at large apertures, and save flashlight powder, expense and smoke. Series IV, in the larger sizes, is an excellent lens for flashlight groups. Series V may also be used if greater angle is desired.

FLOWER PHOTOGRAPHY

In this work there is no great necessity for speed, so that a Convertible Protar Series VIIa, F:6.3, with several focal lengths can be selected, gaining the advantage of better proportions of parts, resulting from the use of long focus lenses. Our Ray Filter is a necessity if the photograph is to show the differences in color values. Adjustment and utility of Ray Filter are described in accessories division of this catalog.

GROUPS

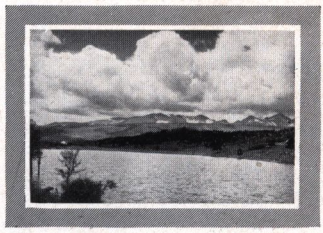
In no line of photographic work is the anastigmat more essential for good results. The best investment is the Protar VIIa. The reserve covering power of this type makes it possible to use a shorter focus lens and have definition from corner to corner—an obvious advantage where work must be done in a limited space. The speed is ample and the single lenses are useful as longer focus lenses for distant objects.

The Protar VIIa may also be used for commercial work, such as photography of landscape gardening, buildings in construction, machinery and automobile photographs, as well as groups.

If conditions do not justify expense, the Tessar IIb may be employed or the Tessar Ic. These lenses may be worked at moderate apertures for groups and when used at full openings are, on account of their speed, useful lenses for studio work or for portraiture in the home.

The longer focus lenses are preferable, as the front rows will be more in proportion to the back rows, but the focus of a lens, for a group, is governed by restrictions of operating space—an important fact which can never be neglected.

LANDSCAPES



For this work the Convertible Protar Series VIIa, F:6.3 should be chosen. The speed is ample and the convertible features of the lens, containing in one lens barrel or shutter fitting, the possibility of using two or three focal lengths according to the lens purchased, makes the selection an ideal one. If the Series VII lenses which make up the VIIa lens are equal in focus, a speed of F:6.3, equal to the Tessar IIb, is obtained; if the combinations are unequal, an extra focal length is gained, with a slight loss of speed. By adding one or more Series VII elements, a set of Protars is built up, for full details of which see catalog under C or D sets.

Convertibility means convenience in photography. If the image size is too small with the VIIa, a single element can be used at the same tripod location and larger image secured. You simply find the proper viewpoint and can always pick some combination from the set to give you the size and perspective which you desire.

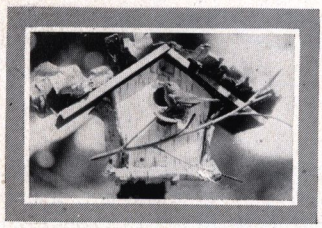
LANTERN-SLIDE MAKING

For the reduction method, a Tessar IIb, F:6.3, should be employed with the cap end of lens facing negative and flange end of lens facing lanternslide plate. Tessar Ic or Protar VIIa of suitable foci may also be used.

METALLOGRAPHY

The Micro Tessars will be found very satisfactory for photographing a comparatively large area of a specimen at a low magnification. For especially low power work and large areas we recommend some of the regular Tessars, and will make recommendations upon being advised regarding the requirements. (Special literature sent on request covering complete Metallographic Equipment.)

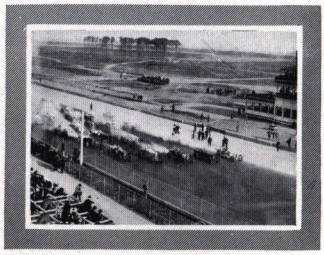
NATURALIST PHOTOGRAPHY



For work from "blinds" with shutter operated from a distance, the Tessar Ic should be selected.

At a distance from the animal, the apparent motion of image on plate is not so great as when nearer, for in the latter case he may be startled and away before exposure is made. The Convertible Protar Series VIIa is, therefore, useful and combines in one lens a speed lens and a long focus lens.

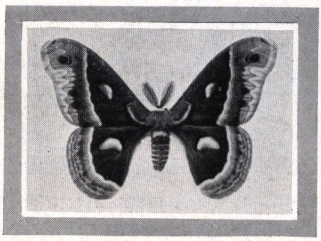
NEWSPAPER PHOTOGRAPHY



The Tessar Ic will appeal to the newspaper photographer. Its speed, F:4.5, will satisfy the requirements for exposures under difficult conditions. Since it can be stopped down and used at small apertures without suffering in definition, it serves also as a universal lens. The Tessar Ic, F:4.5, covers focus for focus a larger plate than competing lenses, a most important fact. Moreover the Tessar Ic can always be used as a portrait lens when desired, for emergency photographs of celebrities in hotel rooms, etc., where the light conditions are usually unfavorable for picture making.

Every newspaper man has use also for a Series V Wide Angle lens, when forced to work in restricted spaces.

PHOTOMICROGRAPHY



The Micro Tessars are useful for direct enlarged photographs from small objects such as insects or seeds and plant life where the magnification does not exceed 25 times. (Special literature will be sent on request covering Micro-Tessars, Photomicrography, Microscopes and accessories.)

PORTRAITURE

As the reduction of exposure is of the greatest importance, speed such as is possessed by our Tessar Ic, F:4.5, is essential. This lens has a flat field which makes it adaptable for standing figures and groups. For home portraiture the shorter focus members of the series are unequalled as they can be fitted to portable cameras.

No. 18 is particularly adapted for compact home portrait outfits.

No. 18a is the standard lens for the ordinary studio. No. 19 is intended for large heads and 11 x 14 work.

This is the ideal lens for the professional who wishes one truly universal lens.

PROJECTION WORK

The Tessar IIb, on account of its flat field, is the finest projection lens made, and the Micro Tessar has special properties which fit it for the projection of microscope slides. Tessars IIb for projection are furnished in special rack and pinion mounts with steel iris diaphragm leaves.

(Special catalogs on projection lenses and apparatus for lantern-slides and opaque projection will be sent if requested.)

REFLECTING CAMERA WORK

The Tessar Ic, F:4.5, is here supreme. The speed, F:4.5, is maintained in all sizes of the Tessar Ic, and the angle of sharp field in proportion to focal length is much greater in this lens than in competing lenses. As the Tessar Ic does not shift focus when stopped down, the lens can be used at smaller apertures when full opening is not needed, a very important point.

SCIENCE WORK

Teachers will be interested to correspond with us regarding their special requirements, and for all around work on science outfits we recommend the Protar VIIa or a set of Protars on account of the several focal lengths. Tessar IIb also makes an excellent selection, if a somewhat lower price lens is desired.

STANDING FIGURES

Any of our Tessar series or Protar VIIa members may be selected for standing figures in the studio. They excel the old portrait types of lenses because of their ability to make a large standing figure without stopping down. This is of great importance as the standing position is the hardest for a person to maintain, and when slow lenses are used many plates are spoiled by the movement of the subjects. Tessar Ic No. 18 or 18a is a good selection for an all around studio lens, on account of its speed, F:4.5, combined with perfectly flat field. Tessar IIb No. 7, 8, 9 or 9a can also be used with good success, up to the limits of their speed, F:6.3.

STEREOSCOPIC PHOTOGRAPHY

The Tessar IIb, F:6.3, is recommended. The lenses must be accurately matched in focus. For stereoscopic work on reflecting cameras the Tessars are used in barrels.

TELEPHOTOGRAPHY

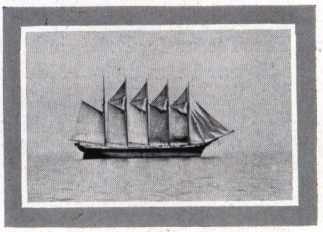
Since the telephoto magnifies the image produced by the regular photo lens, it is necessary to have as perfect a lens as possible for the basis of the telephoto outfit. The Tessars and the Protar VIIa are suitable selections, but they must be very carefully adjusted to the telephoto attachment. We cannot fit satisfactorily without having the regular photo lenses at hand. TELEPHOTO ATTACHMENTS CANNOT BE SENT ON APPROVAL. Statistics regarding magnifications possible with various camera extensions, with pictorial illustrations of telephoto work, are given in lens catalog section.

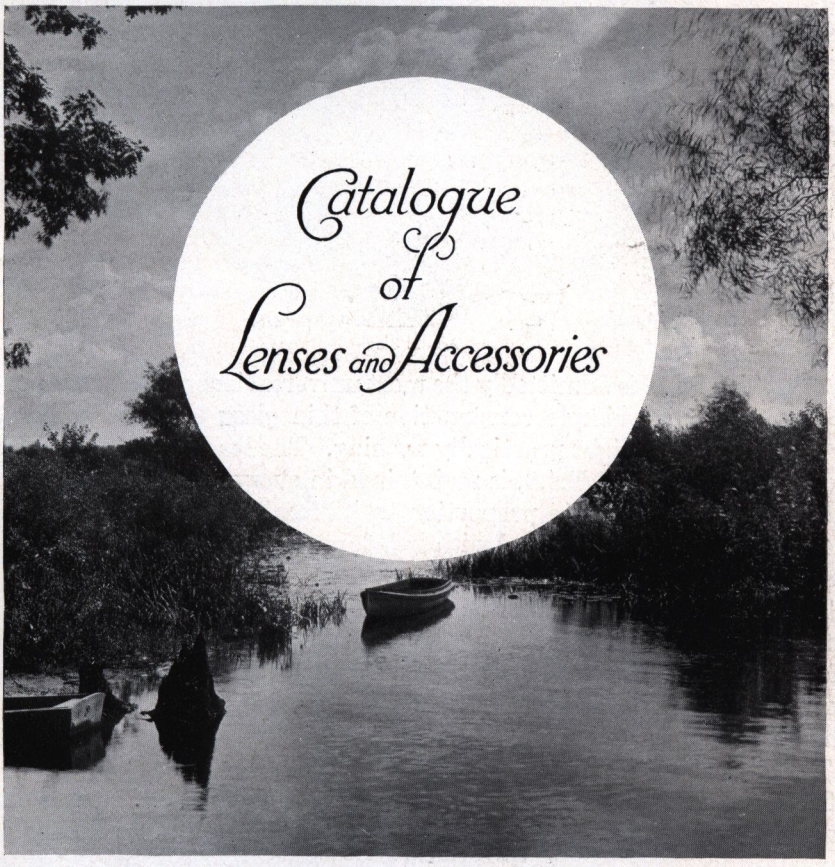
WIDE ANGLE WORK

Series V covers the demand for extreme angle and can be used for snap shots in good lights. Its speed is F:18. It is also good for flashlight work. Those who own Convertible Protar VIIa lenses can also use them as wide-angle lenses when stopped down on account of their reserve covering power. When stopped down the circle of sharp definition is increased. IT SHOULD BE NOTED THAT SERIES V LENSES CANNOT BE FITTED WITH SHUTTERS LIKE COMPOUND OR AUTOMAT, but demand a shutter such as VOLUTE in which diaphragm blades and shutter blades are identical.

WATER PICTURES

On account of the light which is reflected from the water and sky, the lenses can almost always be stopped down. For yachting pictures the Convertible Protar VIIa, F:6.3, is useful, as for a long distance exposure the single lenses can be used. For motor-boat racing, diving pictures, etc., a Tessar Ic, F:4.5, is of advantage as the exposures must be short on account of rapid movement of object.





Catalogue of Lenses and Accessories

W. T. Tilden, Jr., in Action—Made by W. H. Zerbe with Tessar Ic

BAUSCH & LOMB TESSAR

Series Ic
F:4.5

Universal Application.

Actual Size

Unexcelled for ultra rapid work, portraits, groups, landscapes, etc.

THE Tessar Ic is admittedly the most universal lens of the unsymmetrical type. Its simple construction of thin glass elements makes the absorption of light practically nothing. The leading characteristic is speed. This aperture, F:4.5, is maintained in every size up to the largest, and its covering power in proportion to its focal length exceeds all other F:4.5 anastigmats. Combined with speed, we also have the highest optical corrections and needle-point definition.

The definition of the Tessar Ic at its full aperture, F:4.5, is remarkable. The lens will do all that it is possible to do with the Series IIb Tessar, and in addition has twice as much speed. This speed becomes available when the lens is opened up for short exposures at high speeds, or exposures when the light is very weak.

Tessar Ic is unequalled for the most difficult speed photography on reflecting cameras, for studio work, for home portraiture, groups, landscapes and other applications of the art. Compactness of mounting is an important factor in lenses for reflecting cameras, and the short barrel with inclined diaphragm ring, allowing easy reading of scale from front of camera, appeals to everyone. The lens is finished in black lacquer throughout.

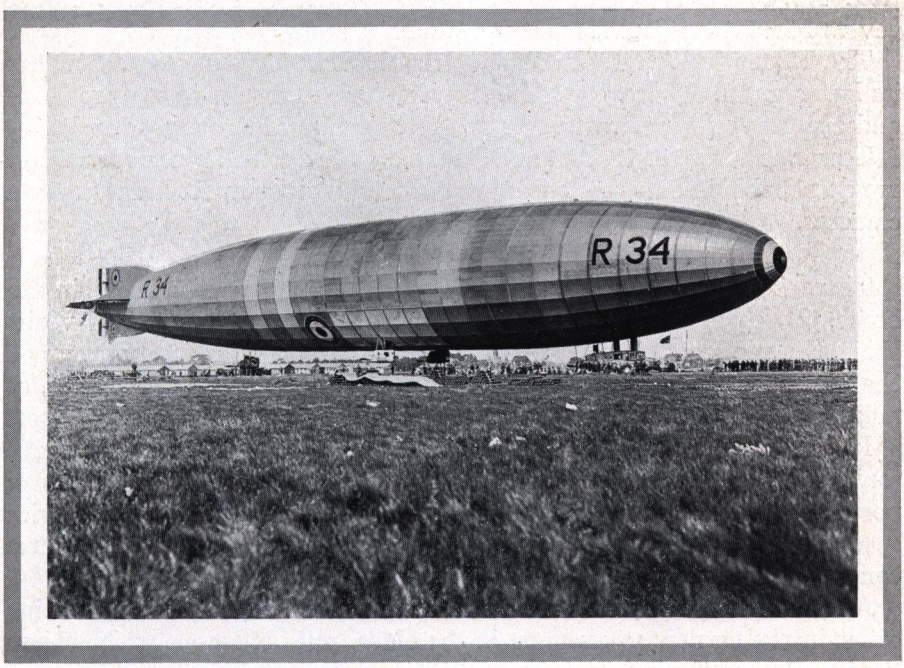
The advantage of speed in a lens needs no argument. In the Tessar Ic it is available whenever you need it. At F:6.3 you have the same depth of focus and rapidity as the Tessar IIb, and so on through the smaller apertures. Tessar Ic should be put on all cameras which will accommodate its greater bulk, as it has twice the speed of the Tessar IIb and about four times the speed of the ordinary camera lenses.

The sizes No. 13 to No. 18 are recommended for reflecting cameras. Details are given on page 57 which cover all popular cameras.

Nos. 14 and 15 can be supplied also with **Sunk Mount,** required for use with some reflecting cameras. This should not be confused with the focusing style of mounting. It can be fitted to certain cameras usually provided with focal plane shutter, whose adjustable bellows extension folds into a very small, compact size. It has an adjustable diaphragm, actuated by turning the front combination mounting. See price list and specifications on page 57.

The professional will naturally select the No. 18a as an ideal lens for work in ordinary size studios, for cabinets, groups, etc. To cover the same size plate the older types of portrait lenses would require a much longer focus, which is a great inconvenience in group work. The Tessar Ic, with its perfectly flat field, makes possible groups and standing figures at large apertures. Special information on portraiture work with Tessar Ic is given on page 30.

For autochrome and other color-photographic processes, Tessar Ic gives superior results because of its high speed and perfect color corrections.



Ready for Trans-Atlantic Flight—Made by F. A. Korff with Tessar Ic

Tessar Ic can be used for difficult night photographs, for photographing windows at night, and is invaluable as a lens for enlarging from dense negatives where the lens must be worked at a large opening to save exposure time; or for enlarging work on the slower gaslight papers. See price list on page 57.

TESSAR Ic FOR STUDIO WORK

The larger sizes of the Tessar Ic are extremely popular for professional portraiture. They differ radically from the older types of portrait lenses, which could only cover when of inconveniently long focal lengths, owing to their limited central definition due to the greatly curved field. In the Tessar Ic, efficiency is the key-note—extreme covering power combined with the highest practical speed.

The flat field means ability to handle standing figures and groups at much larger apertures than the ordinary type of lenses. Exposures may be made with the Tessar Ic at much larger stops, which means less plates spoiled by possible movements of the subjects.

The reserve covering power of the lenses allows their use on larger size plates than regularly listed for, as in the case of groups. This reserve power is of great value also when the swing backs are used.

No. 18 lens is an ideal lens for home portraiture, and we have given information below in detail regarding this lens. For the ordinary studio with an 8 x 10 camera, the No. 18a with its longer focus is a better selection. No. 19 lens is excellent for large heads and for 11 x 14 work. No. 20 covers 14 x 17 and gives exquisite roundness and perspective.

The Tessar IIb is a less expensive lens than the Tessar Ic on account of its lower speed. The larger sizes, therefore, are in demand as group lenses and also serve for portrait work up to the limits of their speed.

Tessar Ic Nos. 18, 18a, 19 and 20 are supplied with lens hoods. These are detachable in case the lenses are to be used on compact home portrait cameras.

HOME PORTRAITURE

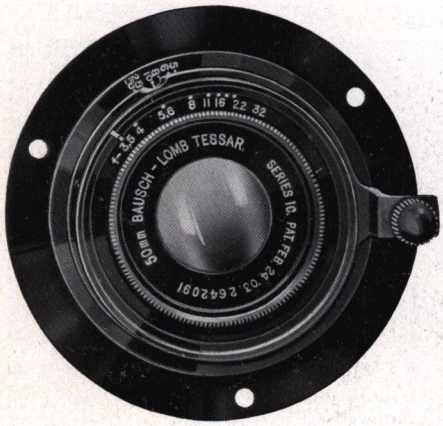
There is a steadily increasing demand for photographs made in the home, photographs with the home touch, the kind which show the favorite chair, the window seat with the little ones at play or the merry group on the stairway. These are the elements which add that subtle touch, so many times lacking in studio pictures, and make the negatives that sell.

In this class of work it is imperative that the lens have speed. At the same time it must be compact enough to go upon the lens boards of portable cameras. Efficiency, which is covering power combined with speed, is a necessity and the Bausch & Lomb Tessar Ic fills these ideal conditions especially in No. 18 size, listed for 8 x 10.

A lens for home portraiture should have a flat field, and the vignetting effect in the corners so common in the older types of lenses, which shows the inability of the lens to cover, cannot be tolerated in home portraiture.

Home Portrait—Made by Morrall Studios with Tessar Ic

In the home you must take conditions just as you find them. You will probably be hampered by lack of room. The No. 18 lens is about 12 inches in focus; it is short enough to work within the limits of space of the ordinary house and yet long enough in focus not to give the strained perspective of a lens too short in focus.



Actual Size

Series Ic, F:3.5

For Motion Picture Cameras of Any Make

The rise of the motion picture industry has brought up new problems, including a demand for lenses of enormous speed, as the motion picture operator cannot control the weather conditions and must usually take his pictures just as he finds them.

Owing to the short focal lengths which are ordinarily demanded, the speed of F:3.5 is attained. This means that the light admitted to the film is almost double that of the Series Ic Tessar, F:4.5, used on the reflecting cameras. Compared to ordinary camera lenses, Tessar Ic, F:3.5, is five times faster.

Owing to the short focal length of the lenses, 2 inch for the No. 1 and 3 inch for the No. 1a, the lenses have enormous depth even at fullest aperture. A greater speed than F:3.5, while attainable and useful on some occasions, shows a lack of depth qualities. F:3.5 represents the highest practical speed and it will be found that the lenses must be stopped down in good light, so as to prevent overexposure.

Lenses may be furnished in barrels with iris diaphragms, in focusing mounts illustrated above or in special mountings fitting a rack and pinion jacket. By revolving the lens hood, the diaphragm openings are changed and a pointer operating against a scale on the hood of the lens indicates the opening used. The lever on the side, pushes the lenses in or out, indicating the distance on the scale around the body of the mount.

In the rack and pinion mount, we have an ideal outfit for the man who wishes to use two or more lenses. The lenses set back in a double tube, the outer one fitting the jacket by a sliding fit and the inner one rotating so as to control the diaphragm. The mountings also serve as lens hoods, and the diaphragm settings can be read off on the outer end of the tubes.

For wide angle effects, the Tessar Ic, F:4.5, 32 mm (1¼ inches) focus, can be supplied. This lens is useful also for fixed focus work. It can be fitted to the focusing mount, if desired.

On the standard size film, No. 1a lens gives 20°, No. 1 lens gives 29° and the 32 mm Ic F:4.5 lens gives 44°. No. 1a lens will give a larger image from the same standpoint than the No. 1 or the 32 mm lenses.

For still larger images, an adapter tube carrying a No. 13, 15, 15a or 16 Tessar Ic can be furnished. The increase in image size is approximately in proportion to the focal length, a 15a Tessar Ic, 7½ inch focus, giving an image about three and three-quarter times bigger than 2 inch No. 1 lens.

See price list of lenses and adapters on page 57.

BAUSCH & LOMB TESSAR

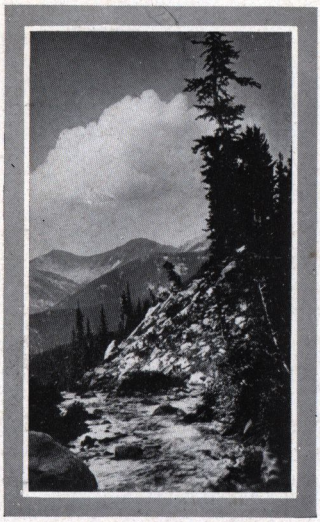
Series IIb
F:6.3

Actual Size

For general use on hand-cameras, groups, landscapes, commercial photography, enlargements, etc.

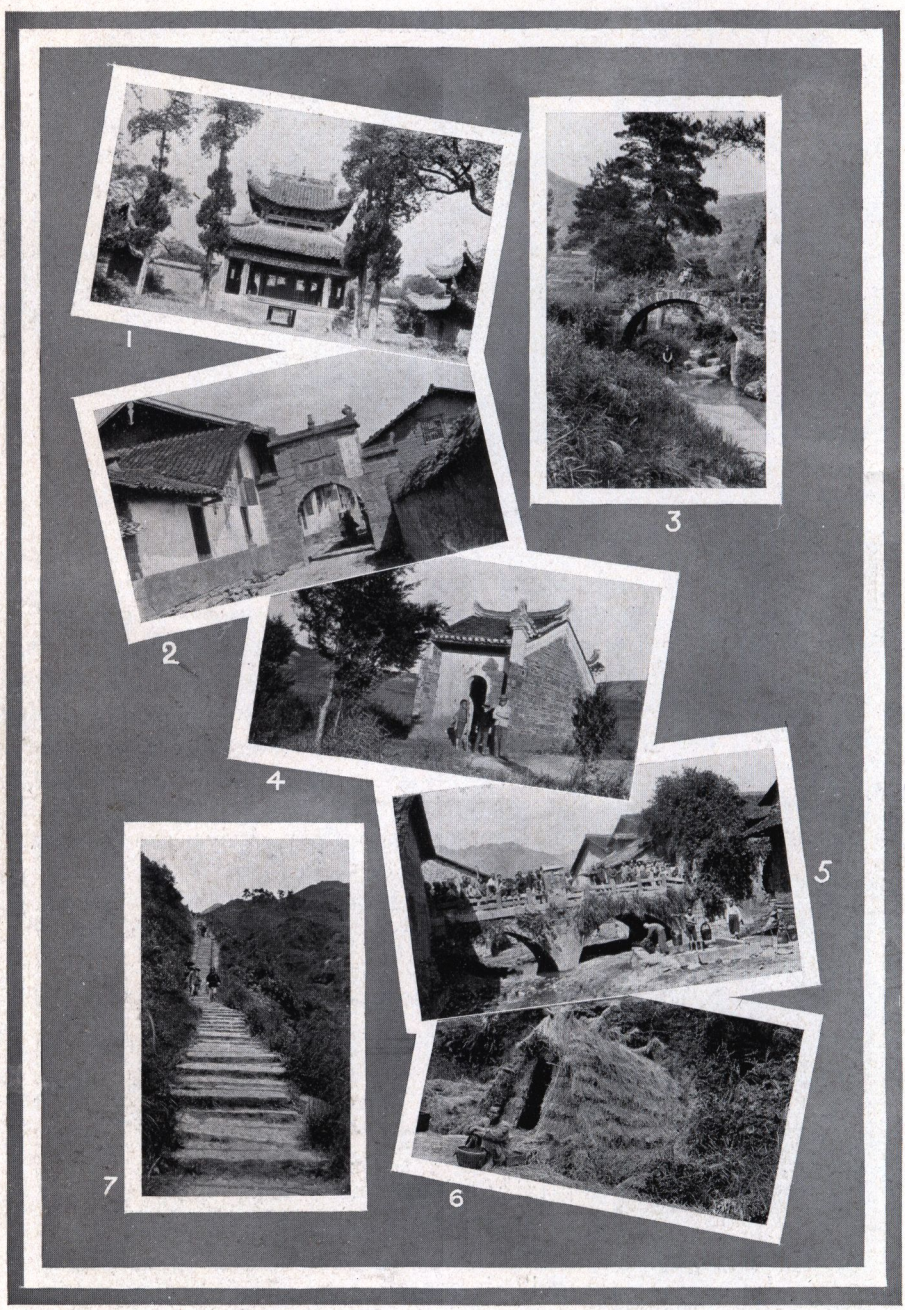
TESSAR IIb is one of the most compactly mounted and lightest lenses on the market, and can be fitted almost without exception to any compact hand camera on the market. It increases wonderfully the efficiency of any hand camera by making possible exposures on dull days, or late in the day, when ordinary lenses are completely out of commission. It has twice the speed of the ordinary camera lenses, and gives wonderful definition over the whole surface of the plate, way up into the corners.

The striking characteristic of Tessar IIb is the precision and sharpness of the image on the plate from center to margin, and hence it is especially recommended for use on small cameras where the negatives are to be subsequently enlarged. When stopped down, Tessar IIb increases in covering power. Its image circle is 60° when used at F:6.3 on plates for which it is listed, but on stopping down to F:32, the angle will increase to 66°, allowing its use on larger size plates as indicated by the tables.



"Lonesome Pine"
Made by J. Haberstroh,
with Tessar IIb

"Washington's Profile"
Made by Gen. C. C. Sniffen, U. S. A.
with Tessar IIb



Travel Views in China—Made by Rev. T. Kellar with Tessar IIb

1—Theater Stage in Court Yard of Main Temple, Nan Yoh; 2—Entrance to Main Street, Nan Yoh; 3—Bridge at Nan Yoh; 4—Wayside Shrine; 5—Village Well; 6—Blind Beggar and His Hut; 7—Foot of Ten-Mile Road up Sacred Mountain, Hunan

Its simple construction of four thin lenses gives practically no absorption.

For enlarging, Tessar IIb has special qualifications. Lenses intended primarily for enlarging can be specially corrected for this work.

For home portraiture, the amateur will find the lens invaluable, as it will allow him to make seemingly impossible pictures of the baby in the house. For flash-lights Tessar IIb is also invaluable, as the focusing can be done with wide open lenses, an enormous advantage and convenience.

Tessar IIb is invaluable when a lens is desired for compact hand camera with short bellows extension, on which the advantages of a lens of several foci like the Protar VIIa cannot be utilized. Moreover, the simpler construction and hence, lower price of the Tessar, makes it preferable whenever the universal applicability of the Protar VIIa is not required. The smaller sizes, including 5a and 6 are generally selected, fitted with the Volute shutter.

For telephotography, Tessar IIb may be used in conjunction with our telephoto attachment, on account of its superb definition.

For copying and lantern-slide making the smaller numbers may be used by transfering them to cameras of suitable bellows extension, provided this is not available in the camera on which they are used.

The professional will find the larger numbers, from 8 x 10 upwards, to be invaluable for group work, exterior or interior. The advantage of a lens which will cover sharply with a moderately short focal length will be obvious to those who have been hampered by lack of room in making groups. See price lists and specifications of lenses on page 58.

Bridal Veil Meadow, Yosemite Valley—Made by B. M. DeCou with Protar VIIa

Old Mill, Busch's Gardens, Pasadena—Made by B. M. DeCou with Protar VIIa

BAUSCH & LOMB PROTAR

Series VIIa
F:6.3

Actual Size

A rapid, convertible lens, adapted for landscapes, architecture, portraits, groups, etc.

THE Series VIIa lens has satisfactorily solved the problem of variety and convenience; for composed as it is of two Series VII single Anastigmats, the doublet resulting from the combined components is simply perfection in all the qualities desired in a photographic lens.

As single Anastigmats, the Series VII lenses have a distinct field of their own. They are perfect single lenses, having a speed of F:12.5, which is ample for instantaneous exposures out of doors under favorable light conditions. So perfect are the spherical and astigmatic corrections as to make the single lens almost equal to the doublet, and not only equal, but actually superior to many doublet lenses of other makes, for which strong claims to perfection are made. The field has an angle of 40° with full opening and with smaller stops 50°.

Series VII lenses may be used for a variety of purposes requiring long focus, medium speed and narrow angle, as, for instance, landscape work, commercial work, large portraits and groups. Naturally, they cover a smaller angle of view on the same size plate than the doublets of which they are a part, but they are, however, practically rectilinear.

For landscape work, they cover larger plates, as indicated in the tabular matter in the Series VII price list. They are excellent for distant objects, for this lens, like a telephoto, gives a large image at long range, and while its magnification is less than the telephoto, its speed is much greater.

Inasmuch as the component lenses can be used singly or together, it is evident that we have in the VIIa a **convertible lens,** which, as will be shown, is universal in application.

If in forming our Series VIIa doublet, we select two lenses of equal foci, we get a lens with a speed of F:6.3; if, however, we combine two unequal foci, there results a doublet with a speed of F:7 or F:7.7, according to the

Banff Hotel and Sulphur Range—Made by B. M. DeCou with Protar VIIa

relative foci employed. Thus, we have in one and the same lens one or two long focus single lenses adapted for a variety of work and an extra rapid doublet adapted for all kinds of instantaneous work. Although a doublet composed of two lenses of equal foci gives us a larger relative aperture and hence greater speed than one composed of two unequal foci, the latter has the advantage of being convertible into three lenses of different foci, where the former is convertible into two only.

While the single lenses (as has been stated) are adapted for instantaneous outdoor work when light conditions are favorable, for landscapes, portraits and groups, the doublet, if composed of two similar lenses, is an extra rapid lens working at a speed twice as great as the ordinary Rectilinear lens, hence is adapted for all kinds of instantaneous work, for groups, for architecture, and all subjects requiring medium angle, good covering power and brilliancy.

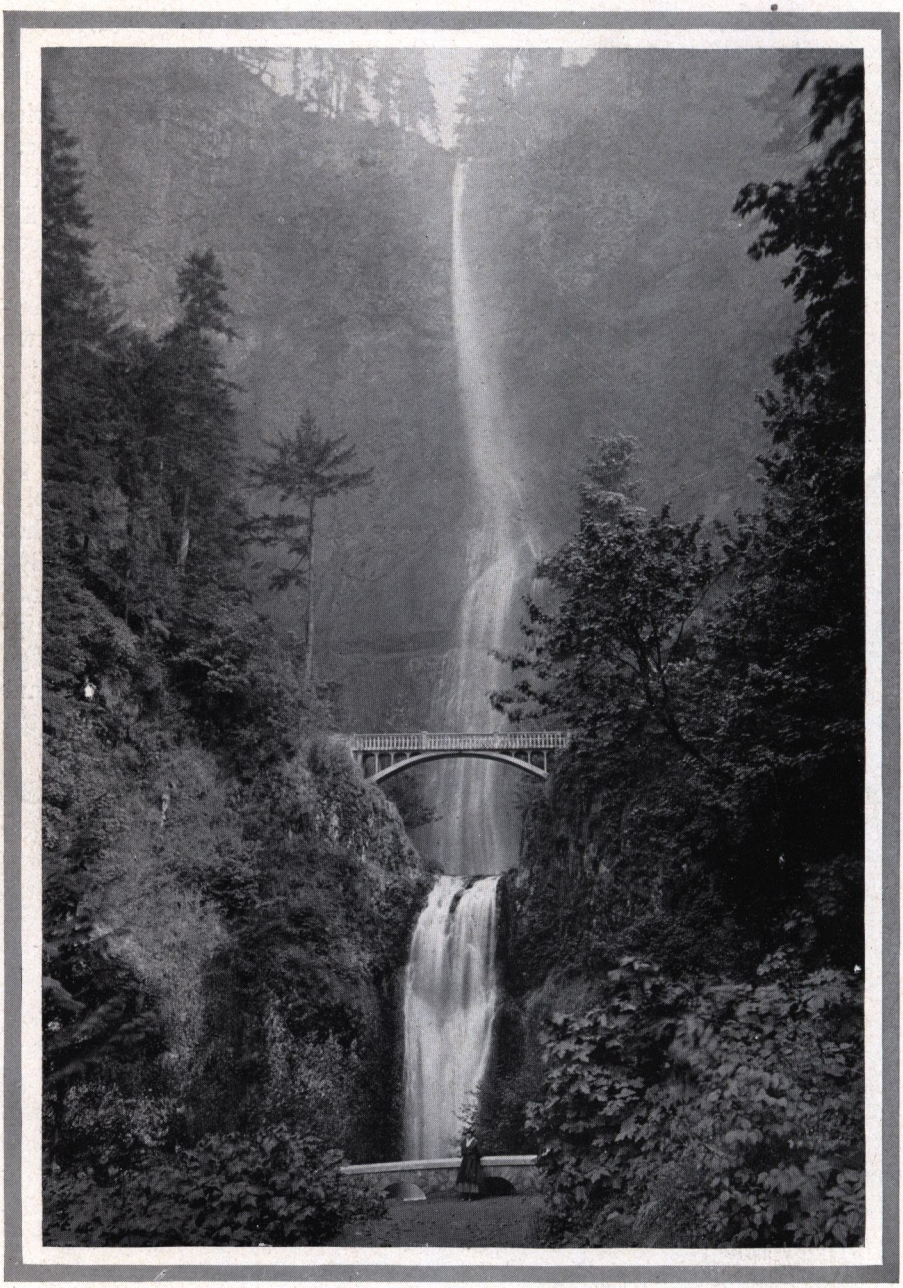
When stopped down, the available image circle covers an angle of from 85° to 90°. The doublet can therefore be used as a wide-angle lens on larger size plates, allowing focusing with plenty of illumination.

These lenses stand at the head of the list both in optical qualities and their adaptability to the limited space allowed for the lens. When the bellows draw is sufficient to enable the use of a long focus lens the VIIa is especially desirable, because it is not only a doublet of moderate focal length, but also one or two long focus single lenses according as the doublet is composed of lenses of equal or unequal foci. In selecting the lens one

must be sure that the back focus of no combination selected is longer than the greatest extension of which the bellows is capable.

To illustrate the facility with which sets of Convertible Protars may be made up and the uses to which they may be put, let us start with a Series VIIa doublet No. 8. This lens is listed to cover a 5 x 7 plate, has a focal length of 7 inches and a speed of F:7, which is almost twice as fast as the ordinary camera lens. It is composed of two perfectly corrected single Anastigmats Nos. 3 and 4 Series VII of 11 3/16 inches and 13 3/4 inches focus respectively, listed to cover 6 1/2 x 8 1/2 and 8 x 10 plates with an opening of F:12.5, which is sufficient for instantaneous work under normal light conditions. We have, in other words, three Anastigmat lenses in one—two single Anastigmats and a doublet. Now let us add to this equipment a No. 2 Series VII which covers a 5 x 7 plate and has a focal length of 8 3/4 inches. The addition of this forms the C set of Convertible Protars listed on page 59. We have now three single lenses which we may combine as follows: our original doublet of 7 inches focus; we can form a doublet with our 13 3/4 inches and 8 3/4 inches with a resulting length of 6 1/8 inches covering a 4 1/4 x 6 1/2 plate and a speed of F:7.7; or we can form one of 8 3/4 inches and 11 3/16 inches having 5 5/8 inches focus, covering a 4 1/4 x 6 1/2 plate and having a speed of F:7. In other words, we have three single Anastigmats and three doublets. The cost of these lenses is $131.00 or an average of $21.83 apiece. Is it possible to purchase any other perfect Anastigmat at so low a cost?

Washington's Tomb, Mt. Vernon—Made by A. Melzer with Protar VIIa



Multnomah Falls, Columbia River Highway—Made by B. M. DeCou with Protar VIIa

"Paradise Valley"—Made by A. R. Barnes with Protar VIIa

If we desire a faster lens we need only to match one of our single lenses to form a symmetrical doublet having a speed of F:6.3. The choice of lens is governed by the class of work to be done. This illustration demonstrates the enormous advantage of the Convertible Protars and proves their claim to convertibility, variety and usefulness. Other combinations may be formed by selecting such lenses of the Series VII as can be combined. The lenses which it is practicable to use together, are shown in the list on page 59.

To sum up the advantages of the Series VIIa lenses:

They are perfectly corrected as are all our Anastigmats.

Every doublet is in reality three lenses, each perfectly adapted for a different kind of work.

The addition of one system adds three lenses, making six in all.

The addition of two systems adds seven lenses, making ten in all.

The greatest possible compactness is secured.

The least weight.

The fewest parts to lose or wear out.

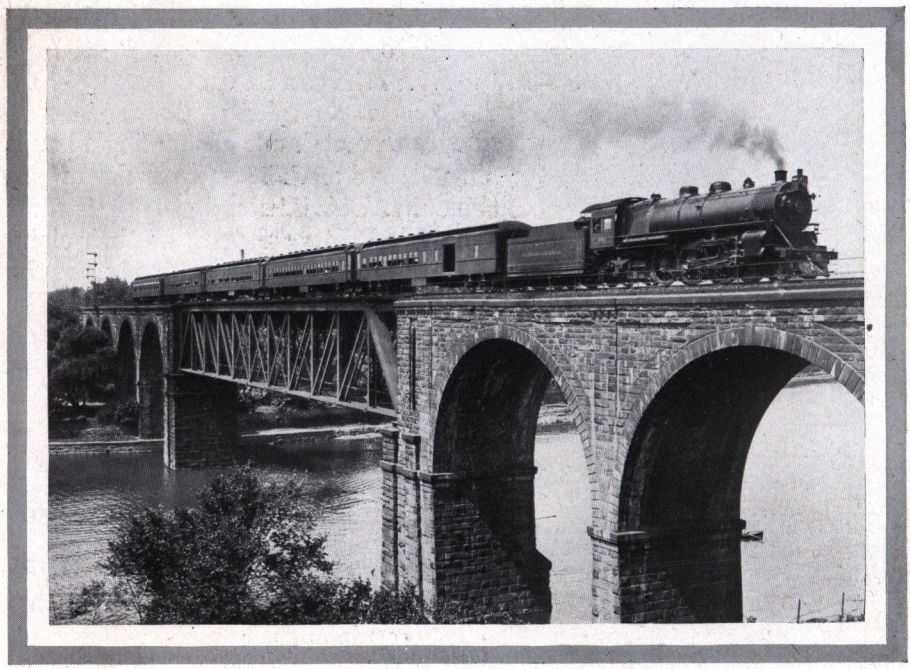
When two Series VII lenses of unequal foci are combined, the longer focus Series VII should be used in the front to obtain the largest possible aperture and hence, the greatest speed. See price list and specifications on pages 58 and 59.

BAUSCH & LOMB CONVERTIBLE PROTAR VII
IN SETS

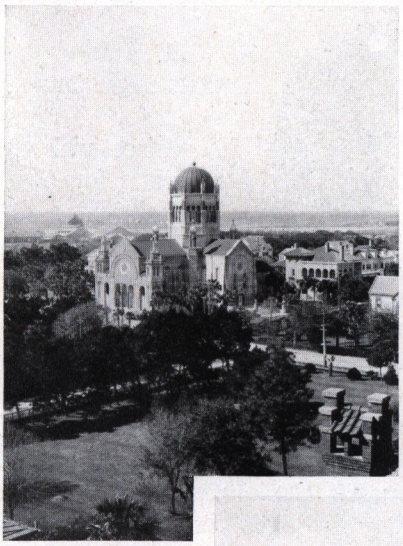
WE list a large number of doublet combinations, and the purchase of additional Series VII combinations will furnish new focal lengths, thus increasing proportionately the usefulness of the lens.

We offer two sets complete with lenses mounted interchangeably, each set consisting of: one lens barrel with iris diaphragm, cap and flange, and set of screws, the single Protar lenses (three or four, as the case may be); a neat and compact leatherette case containing all the parts of the set, or including shutter if so ordered. A screen ring is also furnished to screw into front of barrel or shutter when single elements are being used. This furnishes a method of attaching a ray filter if desired.

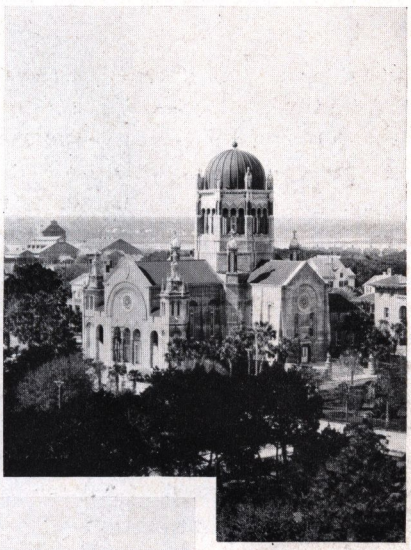
The advantages of such sets are manifold. Every commercial photographer has a desire to own a set on account of their convenience. A lens for any purpose is instantly at hand. Many advanced amateurs are possessors of these sets which may be built up gradually if the entire investment cannot be made at once. See price lists and specifications of lenses on page 59.



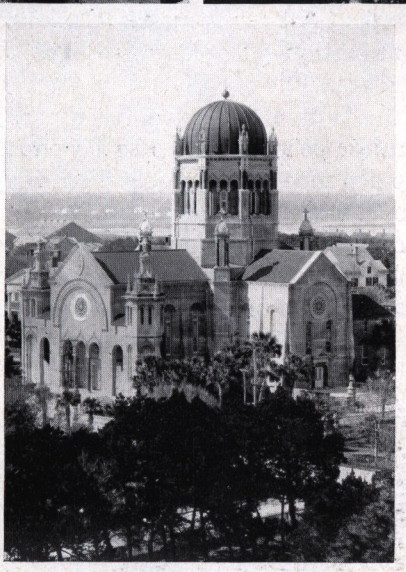
Pennsylvania Bridge over Schuylkill River, Philadelphia—Made by J. B. Rich with Protar VIIa



Made with
Protar VIIa
No. 12, 9⅛-in. Focus



Made with
Protar VII, Back
Combination
13¾-in. Focus



Made with Frotar VII, Front Combination
18⅞-in. Focus

THE above series of three photographs of Memorial Chapel, St. Augustine, illustrate some of the different image size possibilities obtainable with Convertible Protar. The camera remained in the same position throughout the three exposures. Details of combinations are given under each picture.

BAUSCH & LOMB MEDIUM WIDE ANGLE

Series IV
F:12.5

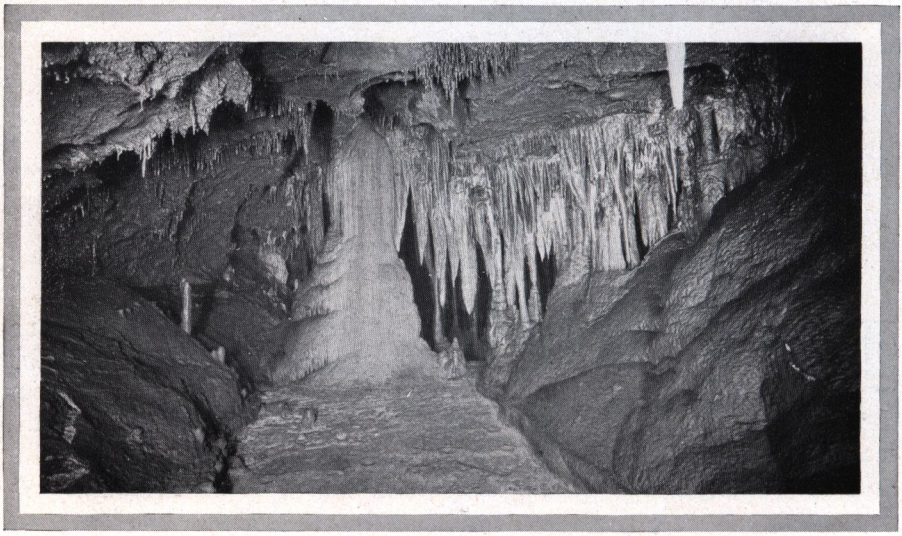
Actual Size

A rapid wide angle lens for architectural work, for flashlight interiors and groups

SERIES IV has two special points of merit—speed and covering power. It works at a speed of F:12.5, which is sufficient for instantaneous exposures out of doors, under favorable light conditions. Its large relative aperture makes it an admirable lens for flashlights of interiors and groups, admitting ample light for focusing interiors, and enabling one to obtain sufficient illumination with less flashlight than is possible with lenses of smaller aperture.

We recommend Nos. 1 to 6 inclusive for rapid, wide angle work, for example, architectural or other subjects to be photographed instantaneously, and where the distance of the object from the camera is such as to necessitate the use of a wide angle lens.

A Series IV lens of moderately short focus will cover a comparatively large plate. The volute shutter can be fitted easily to these lenses, but other shutters cannot be fitted on account of slight separation of elements. See price list and specifications of lenses on page 60.



Luray Cavern—Flashlight by A. Melzer with Protar V

BAUSCH & LOMB EXTREME WIDE ANGLE

Series V
F:18

Actual Size

For architectural and interior work requiring an extreme wide angle lens

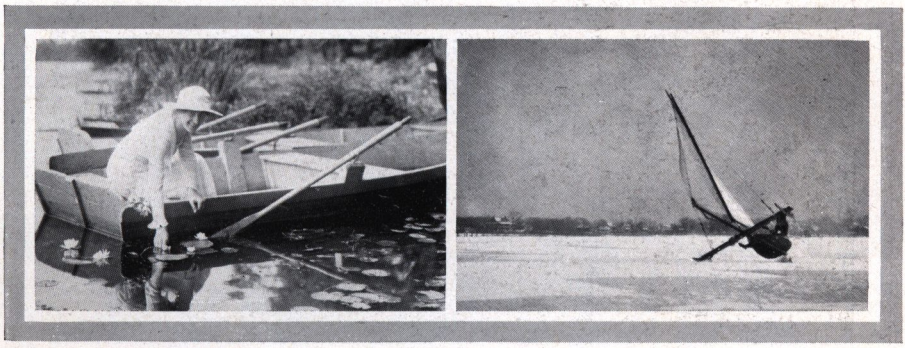
THIS lens should be chosen for the most exacting wide angle photography, because the corrections for flatness of field and astigmatism have been carried to a greater degree of perfection than in other lenses of a similar type. Its effective angle and covering capacity especially recommend the Series V for architectural and interior reproductions.

Larger plates are well covered at smaller apertures with increased angle of view. The Series V is unsymmetrical, and the combinations cannot be used singly.

The speed F:18 is sufficient for outdoor instantaneous photography under favorable light conditions. We can easily fit the Series V lenses to our Volute shutters. These are of the diaphragm type and can easily go between the combinations, which in the series V are very close together.

In order to get the widest angle upon the Series V lenses we use a smaller size than listed for the plate we wish to cover. When this is done, the lens of course has to be stopped down somewhat to gain the extra covering power.

Series V lenses may be used for flashlights, copying, etc., and in fact for any work up to their limits of speed. The longer focus members are excellent for copying work. Prices on page 60.



Stalking Water Lilies — Ice Boating with a Thrill

Made by W. H. Zerbe with Tessar Ic

Interior—Made by Henry Fuermann with Protar V

BAUSCH & LOMB PROCESS ANASTIGMAT—F:10

Actual Size

THIS new lens, presented here for the first time, is corrected to meet the full requirements of the modern photo-engraver. While designed primarily for black and white work, its perfect register of colors permits it to be used most satisfactorily at the smaller apertures for three and even four colors. It is made after our own formula, entirely of our own glass, and, we believe, is the first process lens for color work to be produced in America.

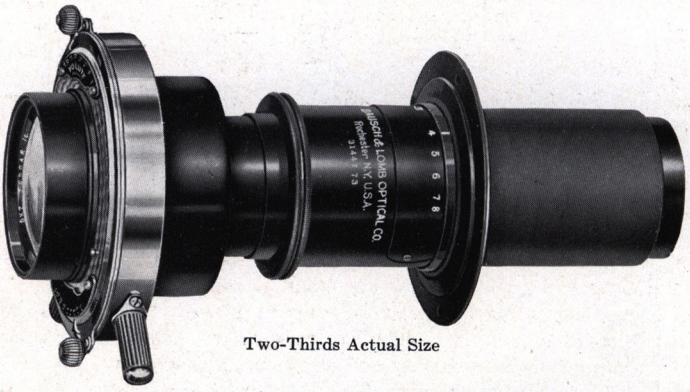
For commercial photography, as enlarging and copying, this lens is also very satisfactory, giving critical definition throughout the field with all plates of the sizes listed. It can even be used with larger plates in such cases as do not require critical definition to the very corners.

Prisms for reversing the image, in order to save stripping the films, are made by us and can be fitted to any lens for process work. To ensure their accurate fitting the lenses should always be sent to us.

Ray filters for three-color processes must be made with the highest accuracy; otherwise the delicate corrections of the lenses would be disturbed and the register of images thrown off. We make the Precision Ray Filter, of highest possible quality for the finest grade of work, and will gladly quote prices upon request.

These and other sundries, including focusing and retouching glasses, are listed on page 62. For price list and specifications of the Bausch & Lomb Process Lens, see page 60.

TELEPHOTO ATTACHMENT

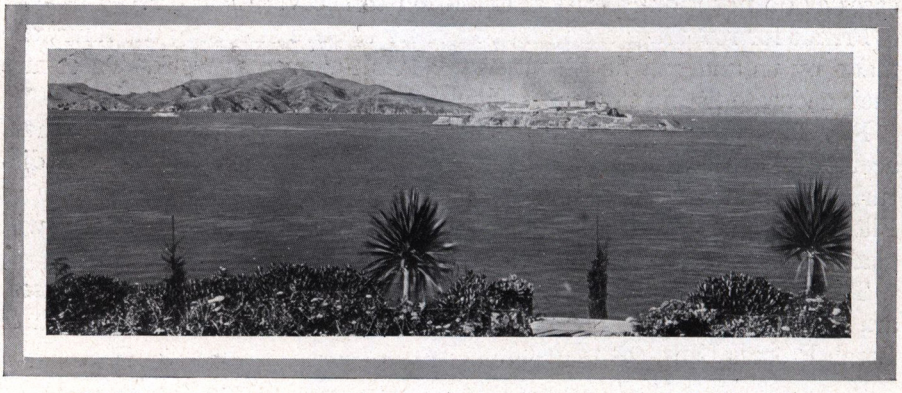


Two-Thirds Actual Size

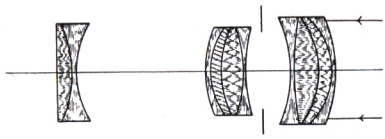
A TELEPHOTO lens is a so-called negative element, that is, a dispersive lens, and it must be used in connection with a photographic objective, which is the positive element. It is always of shorter focal length than the positive. It magnifies the image produced by the latter, so that it forms a valuable adjunct to a photographic equipment, especially since it makes it possible to get pictures of views otherwise inaccessible by reason of distance or location.

The Telephoto affords a very wide range of focus with ordinary bellows extension, and gives the same good perspective as the long-focus lens with the same bellows extension.

Because of the magnification of its image by the Telephoto, the photographic lens should be as perfect as possible, for all defects will be magnified in exactly the same proportion as is the image. With the magnification of the image there is a decrease of illumination, because the same amount of light is distributed over a considerably larger area. Thus, the exposure must be longer and it is, therefore, highly desirable to use a fast lens for this class of work in order that the exposure may not be too prolonged.



U. S. Military Prison on Alcatraz Island, San Francisco Bay—Made by R. E. Merville with Protar VIIa, No. 8



Illustrating Construction of Telephoto Attachment

Again, the magnification has a direct bearing upon the size of the plate covered. With otherwise equal conditions as to equivalent focus, relative aperture, etc., as the magnification decreases, there will be a proportionate decrease in the area of the field, that is to say, with a higher magnification the plate will be more fully covered than with a lower one. This is due to the fact that in the lower magnification the mounting cuts off the marginal rays and thus prevents the plate from being fully covered.

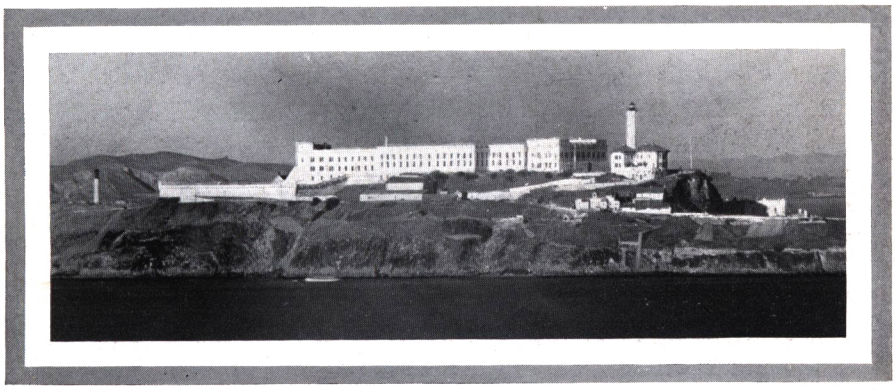
Our Telephoto is thoroughly corrected for spherical and chromatic aberrations, so that with proper manipulation, good results are assured. The negative lens (Telephoto) is mounted in a tube adjustable by means of a spiral device. The tube is graduated to indicate the varying magnifications which can be obtained. The photographic objective screws into the front of the tube at the end opposite the Telephoto lens. We list Telephotos suitable for use with lenses of from 6 to 14 inches equivalent focus.

The time of exposure required for Telephoto combinations can be found by multiplying the time that would be required by the positive element alone by the square of the magnification used.

For instance: the exposure for No. 15 Tessar Ic with stop F:16 may be ½ second; with a magnification 3x, the exposure would have to be 9 times longer, i. e., 4½ seconds, and with a magnification 8x, an exposure of 64 x ½=32 seconds.

Positive Lens		Tele-photo	At Three Magnificat'n		At Eight Magnificat'n		Positive Lens		Tele-photo	At Three Magnificat'n		At Eight Magnificat'n	
Number	Equival't Focus Inches	Neg-ative Elem't	Image Circle Inches	Bellows Draw Inches	Image Circle Inches	Bellows Draw Inches	Number	Equival't Focus Inches	Neg-ative Elem't	Image Circle Inches	Bellows Draw Inches	Image Circle Inches	Bellows Draw Inches
15 Ic	6½	2	5¼	4⅝	16	16	10 VIIa	7⅞	3	5½	5⅝	17½	19⅞
15a Ic	7½	2	5	4⅜	14¼	16	11 VIIa	8½	3	5½	5½	16	20¼
5 IIb	6⅛	2	5	4¾	15½	16¼	12 VIIa	9⅛	3	5¼	5 7/16	15½	19¾
5a IIb	7 1/16	2	4½	4⅜	13	16	13 VIIa	9¼	3	5½	5 9/16	17¾	19¾
5k IIb	6 11/16	2	5	4⅞	13½	16	14 VIIa	10	3	5¼	5⅜	16	19⅝
6 VIIa	6⅛	2	4¼	4⅝	15	16¾	18 Ic	11¾	4	9	7¼	24	26⅞
7 VIIa	6⅜	2	4¾	4⅜	16	17¼	8 IIb	12	4	8¼	7½	21½	26¼
8 VIIa	7	2	4¼	4½	13¼	16⅛	15 VIIa	10⅞	4	8½	7⅞	22½	27⅝
9 VIIa	7½	2	5	4½	14	16¼	16 VIIa	10 13/16	4	8	7 5/16	21½	26¾
16 Ic	8½	3	6	5¾	18	19¼	17 VIIa	11⅞	4	7¾	7⅜	21	26½
17 Ic	9⅞	3	6	5½	20	19¾	18 VIIa	12¾	4	8	7½	23	27
6 IIb	8¼	3	5⅞	5½	16¾	19⅞	19 VIIa	13¼	4	8½	7⅞	22½	28
7 IIb	10	3	5½	5⅝	17	20⅛							

In the above table will be found the combinations which we recommend, together with the magnification and bellows draw for the two extreme magnifications. See price list on page 61.



U. S. Military Prison on Alcatraz Island—Made by R. E. Merville with Protar VIIa, No. 8 and Telephoto Attachment, 5X Magnification

Bank Interior, Buffalo, N. Y.—Made by W. B. Starr with Tessar IIb

RAY FILTERS

Three-Fourths Actual Size

For use in photographing flowers, landscapes, clouds, colored objects, etc.

WHITE light, as is well known, is composed of various colors, which do not all have the same effect upon the photographic plate. The Ray Filter is designed to counteract this by absorbing certain rays of light. The effect is that color values are more accurately reproduced in the monochrome picture. Particularly good results are achieved in landscape and flower pictures. Over-exposure of the sky is prevented and details in clouds reproduced. The blue rays causing over-exposure are absorbed and distant objects appear more distinctly in the image, even when photographed at a distance of miles.

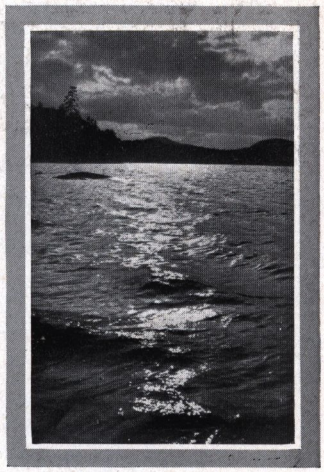
The form of Ray Filter herein presented supersedes the liquid type, which was a source of more or less inconvenience, owing to the leakage or evaporation of the fluid, or its improper preparation.

Our Ray Filter is to be used in front of the lens. It is ground and polished from selected glass, which is homogeneous and free from striae. It is very carefully made, for imperfections would render the lens, with which it is used, less effective. The use of a Ray Filter necessarily prolongs the time of exposure, which should be approximately three times longer than you would give without the filter.

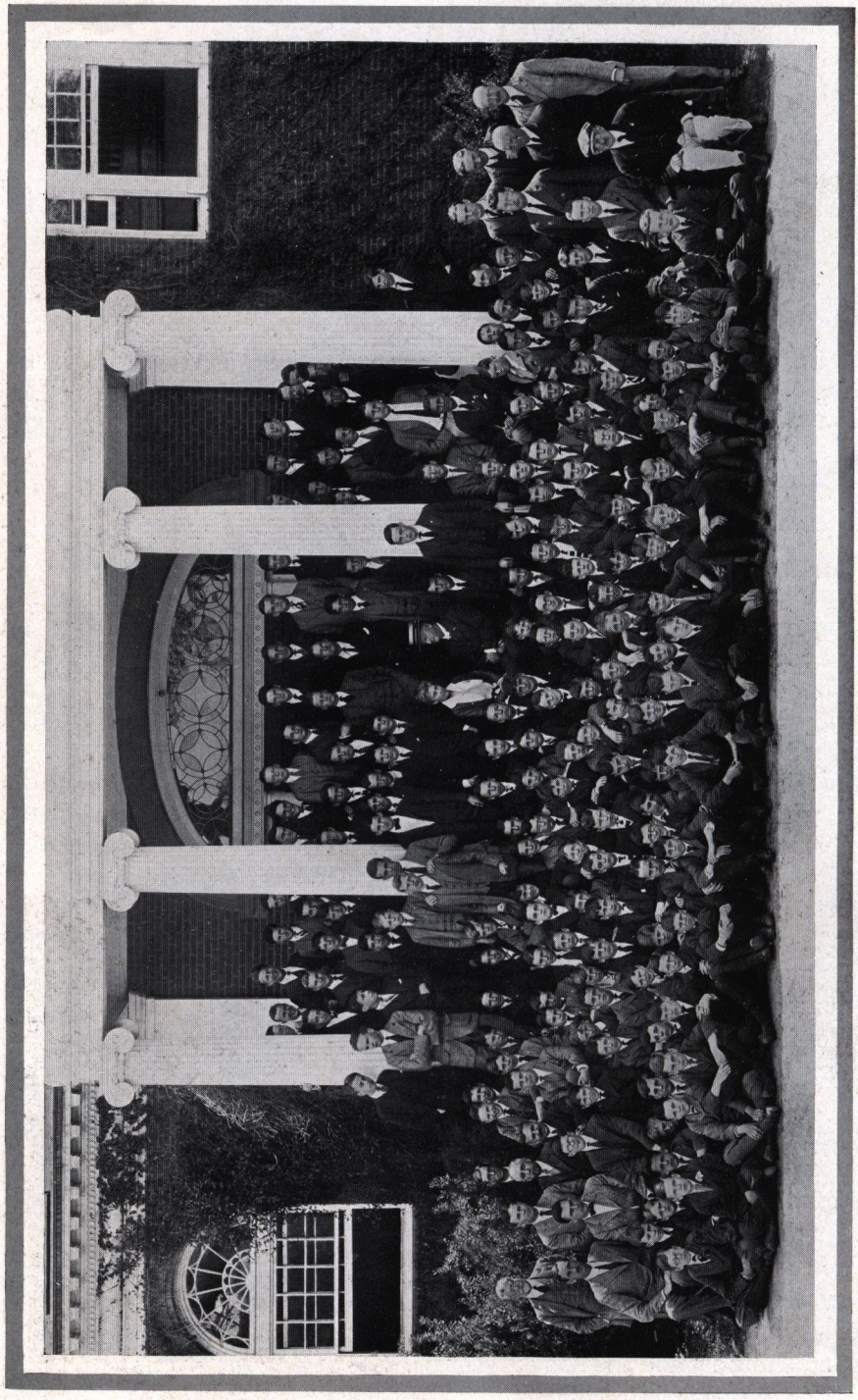
Orthochromatic plates must be used to secure the best results. Style A has a cork lining to fit over the lens mounting. It can be used with any of our regular mounts.

We furnish a reduced adapter for Ray Filters to be used on hand-cameras fitted with Automat shutters, or other models having the pumps attached to the face of the shutter close to the lens. These filters are designated Style 1p, and should be ordered under this catalog number.

When ordering, it is necessary for us to know the outside diameter of the lens mounting. It will be sufficient if a strip of paper just reaching around the hood is sent us. See price list on page 62.

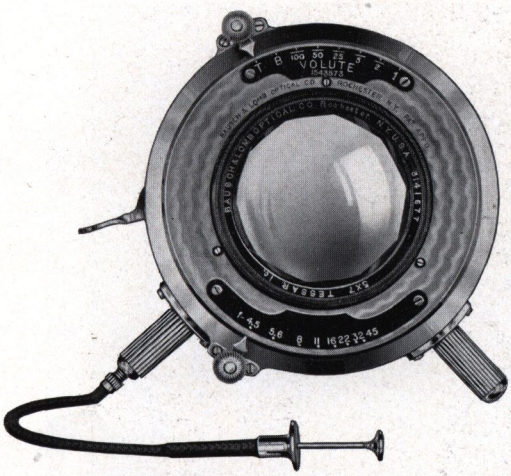


Made by E. F. Schermerhorn



Groton School, 1919—Made by Kimball Studio with Tessar Ic

VOLUTE SHUTTER



IN the Volute Shutter the diaphragm blades are the same as the shutter blades, thus giving maximum illumination with minimum motion; and, as there are more blades in the Volute Shutter than in any other shutter on the market absolutely uniform exposure, covering power and definition result.

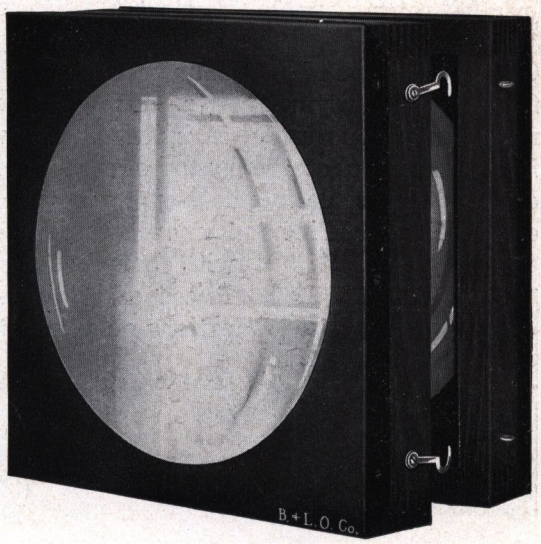
The Volute Shutter is a setting shutter, with a maximum exposure of one second, while the minimum exposure, fast enough for moving objects if one does not work too close, varies in the different models.

The pointer on the top sets for the various exposures, while the lever on the side sets the shutter and also serves as a finger release. The scale below is graduated for the various diaphragm readings. Additional scales can be put on where combinations are numerous. The shutter cannot open and expose a plate while being set. Volute shutters can be fitted to lenses of very slight separation such as our Series IV and Series V, as there is but one set of blades to go between the combinations.

See price list and specifications on page 61.

CONDENSING LENSES

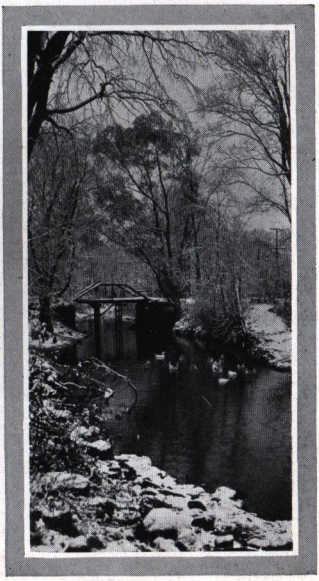
Our condensers are well annealed and carefully ground and polished. The improved mount illustrated is easily opened for cleaning, and as the mounts are square, they do not roll when placed on edge, nor is there any temptation to lay them flat with danger of scratching the outside surfaces. A ground glass can be put between lenses if desired. Prices and specifications on page 61.



Machine Shop Interior—Made by W. B. Starr with Protar V

FOCUSING RETOUCHING AND REDUCING GLASSES

The standard Bausch & Lomb Reading Glasses are popular on account of their large field and magnifying power. Our concave reducing glass is useful in industrial work, for examining photographs to be reproduced on a reduced scale in photo-engraving processes. Furnished in handsome nickel mounts with ebony handles. Prices and specifications on page 62.

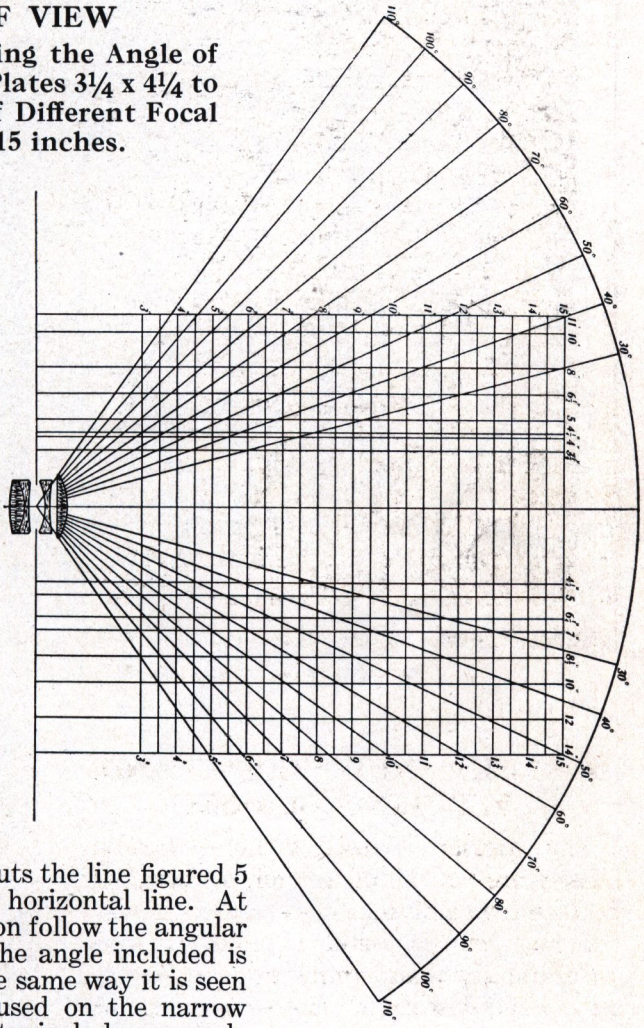


Made by A. R. Stone with Tessar Ic

We are indebted to Dr. Julius Martin and the Photo Miniature for permission to reproduce this diagram and accompanying explanation:

ANGLE OF VIEW

A Diagram Showing the Angle of View Included on Plates 3¼ x 4¼ to 11 x 14, by Lenses of Different Focal Lengths from 3 to 15 inches.



To use the diagram, follow the horizontal line, which indicates the base measurement of the plate to be used, until it intersects the vertical line, which indicates the focal length of the lens used. At this intersection, take the nearest angular line and follow it to the arc at the side of the diagram. Here the angle of view included by the lens upon the plate to be used is expressed in degrees.

Examples: What angle of view will be included by a 5-inch lens upon the longest way of a 5 x 7 plate? On the vertical line find the figure 7; follow this line until it cuts the line figured 5 at the lower or upper horizontal line. At the point of intersection follow the angular line to the arc and the angle included is seen to be 70°. In the same way it is seen that the same lens, used on the narrow base (5-in.) of the plate, includes an angle of about 52°, while used on a plate whose base measures 12 inches, we get an angle of 100°.

Table Showing Angular Field Covered with Different Focal Lengths

Plate Inches	Image Circle = Diagonal of Plate	Angular Field with Focus					Plate Inches	Image Circle = Diagonal of Plate	Angular Field with Focus				
		90° In.	80° In.	70° In.	60° In.	50° In.			90° In.	80° In.	70° In.	60° In.	50° In
3¼ x 3¼	4.6	2.3	2.74	3.29	3.98	4.93	6½ x 8½	10.7	5.35	6.38	7.64	9.27	11.47
3¼ x 4¼	5.3	2.65	3.16	3.78	4.59	5.68	8 x 10	12.4	6.2	7.39	8.85	10.74	13.30
4 x 5	6.4	3.2	3.81	4.57	5.54	6.86	10 x 12	15.6	7.8	9.30	11.14	3.51	16.73
4¾ x 6½	8.0	4.0	4.77	5.71	6.93	8.58	12 x 15	19.4	9.7	11.56	13.85	6.80	20.80
5 x 7	8.6	4.3	5.13	6.14	7.45	9.22							

Waterfall in Grimes' Glen, Naples, N. Y.—Made by A. Melzer with Protar VIIa

PRICE LISTS

BAUSCH & LOMB PHOTOGRAPHIC LENSES

TESSAR Ic, F:4.5—*The Lens for Speed*

Code Word	No.	Size of Plate Covered with Stop F:4.5 Inches	Size of Plate Covered with Small Stops Inches	Equivalent Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm	In Volute Shutter Without Barrel	
							No.	Price
Habit	12	2¼ x 3¼	3½ x 3½	3½	¾	$ 42.00	1	$ 65.00
Haema	13	2½ x 3½	3¼ x 4¼	4½	1 1/32	45.00	1	68.00
Hafter	14	3¼ x 4¼	4 x 5	5½	1¼	52.50	1	75.50
Hagdon	15	4 x 5	4¼ x 6½	6½	1½	62.50	2	87.50
Haggle	15a	5 x 7	5 x 8	7½	1 23/32	75.00	2	100.00
Hail	16	5 x 8	6½ x 8½	8½	1 15/16	92.50	3	119.50
Hairen	17	6½ x 8½	8 x 10	9⅞	2 3/32	147.50	3	174.50
Hakim	18	8 x 10	10 x 12	11¾	2 11/16	200.00		
Halberd	18a	10 x 12	11 x 14	14¾	3 3/8	267.50		
Halfer	19	11 x 14	12 x 16	15⅝	3 9/16	325.00		
Halicore	20	14 x 17	16 x 18	19 7/16	4 7/16	460.00		

For matching lenses for stereoscopic work, add $4.00 to the price of the lenses.

Each lens is furnished in a case which protects it from injury. Lens cap and flange are included.

When ordering lenses to be fitted with shutter, by telegraph, specify *Volute* in addition to the code word for the size of lens.

Tessar Ic is furnished in **Sunk Mount** in Sizes 14 and 15, at an extra charge of **$2.25** for No. 14 and **$5.00** for No. 15. Regular barrel is not included. When ordering, add *Sunk* to code word or catalog number.

TESSAR Ic, F:3.5—*For Motion Picture Cameras*

In Barrel with Iris Diaphragm

Code Word	Speed	Catalog No.	Covers at Full Opening	Equivalent Focus		Diameter	Price
				In.	Mm.		
Hack	F:3.5	1	¾ x 1	2	50	19/32	$37.50
Hade	F:3.5	1a	1¼ x 1¼	3	75	29/32	45.00
Hangle	F:4.5		¾ x 1	1¼	32	5/16	40.00

In Spiral Focusing Mount

Code Word	Speed	Catalog No.	Covers at Full Opening	Equivalent Focus		Diameter	Price
				In.	Mm.		
Hackfocus	F:3.5	1	¾ x 1	2	50	19/32	$42.50
Hadefocus	F:3.5	1a	1¼ x 1¼	3	75	29/32	50.00
Hanglefocus	F:4.5		¾ x 1	1¼	32	5/16	45.00

In Tubes for Rack and Pinion Mount

(Rack and Pinion Mount Extra)

Code Word	Speed	Catalog No.	Covers at Full Opening	Equivalent Focus		Diameter	Price
				In.	Mm.		
Hackrack	F:3.5	1	¾ x 1	2	50	19/32	$42.50
Haderack	F:3.5	1a	1¼ x 1¼	3	75	29/32	50.00

Rack and Pinion Mount—Complete with flange, suitable for lenses in above table or in connection with adapter below, for Tessar Ic Nos. 15, 15a **$7.50**

Lens Hood **1.50**

Adapter for Tessars No. 15 or 15a, each **3.00**

TESSAR IIb, F:6.3—*The Lens for Hand Cameras*

Code Word	No.	Size of Plate Covered with Stops F:6.3 Inches	Size of Plate Covered with Smaller Stops Inches	Equivalent Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm	In Volute Shutter Without Barrel	
							No.	Price
Hag	**2a**	2¼ x 3¼	3½ x 3½	3½	9/16	$ 32.50*	1	
Hallux	**3**	2½ x 3½	3¼ x 4¼	4⅝	13/16	42.50	1	$ 65.50
Halogen	**4**	3¼ x 4¼	4 x 5	5¼	29/32	45.00	1	68.00
Halones	**5**	4 x 5	5 x 7	6¼	1 1/32	47.50	1	70.50
Halser	**5k**	3¼ x 5½	5 x 7	7 1/16	1 3/32	57.50	1	80.50
Halyard	**5a**	5 x 7	5 x 8	7 1/16	1 3/16	65.00	2	90.00
Hamble	**6**	5 x 8	6½ x 8½	8⅜	1 7/16	80.00	2	105.00
Hamlet	**7**	6½ x 8½	8 x 10	10	1 11/16	107.50	2	132.50
Hammock	**8**	8 x 10	10 x 12	12	2	160.00	3	187.00
Hamper	**9**	10 x 12	12 x 15	14¼	2⅜	205.00	3	232.00
Hamular	**9a**	11 x 14	14 x 17	16½	2 11/32	247.50		
Handbill	**10**	14 x 17	15 x 20	19 3/16	3 5/32	325.00		
Handsel	**11**	16 x 20	20 x 24	23¼	3 13/16	417.50		

For matching lenses for stereoscopic work, add $4.00 to the price of the lenses.

Each lens is furnished in a case which protects it from injury. Lens cap and flange are included.

When ordering lenses fitted with shutter, by telegraph, specify *Volute* in addition to the code word for the size of lens.

*Supplied in cells for use on Vest Pocket Kodak.

VIIa CONVERTIBLE PROTAR—F:6.3–F:7.7

The Most Universal Lens Made

Code Word	No.	Size of Plate Covered with Full Aperture Inches	Size of Plate Covered with Small Stops Inches	Combinations of Single Protars Focus, Inches		Combined Equivalent Focus Inches	Speed F	Lens and Barrel with Iris Diaphragm	In Volute Shutter Without Barrel	
				Front Lens	Back Lens				No.	Price
Hem	**1**	3¼ x 3¼	3¼ x 4¼	7 3/16	7 3/16	4⅛	6.3	$ 65.00	1	$ 88.00
Hematin	**2**	3¼ x 4¼	4 x 5	8¾	7 3/16	4½	7.0	68.50	1	91.50
Hematite	**3**	4 x 5	4¾ x 6½	11 3/16	7 3/16	5	7.7	75.00	1	98.00
Hemin	**4**	4 x 5	4¾ x 6½	8¾	8¾	5 1/16	6.3	72.00	1	95.00
Hemipter	**5**	4¼ x 6½	5 x 7	11 3/16	8¾	5⅝	7.0	78.50	1	101.50
Hemisect	**6**	4¼ x 6½	5 x 7	13¾	8¾	6⅛	7.7	88.50	2	113.50
Hemitone	**7**	4½ x 7¼	5 x 8	11 3/16	11 3/16	6⅜	6.3	84.00	1	107.00
Hemlock	**8**	5 x 7	6½ x 8½	13¾	11 3/16	7	7.0	94.00	2	119.00*
Hempen	**9**	5 x 8	6½ x 8½	16 3/16	11 3/16	7½	7.7	110.50	2	135.50
Henbane	**10**	5 x 8	7 x 9	13¾	13¾	7⅞	6.3	103.00	2	128.00
Henotic	**11**	6½ x 8½	8 x 10	16 3/16	13¾	8½	7.0	119.50	2	144.50
Hepar	**12**	6½ x 8½	8 x 10	18⅞	13¾	9⅛	7.7	147.00	3	174.00
Hepatica	**13**	6½ x 8½	8 x 10	16 3/16	16 3/16	9¼	6.3	136.00	2	161.00
Heptad	**14**	7 x 9	10 x 12	18⅞	16 3/16	10	7.0	163.50	3	190.50
Heptane	**15**	7 x 9	10 x 12	23¼	16 3/16	10⅞	7.7	192.00	3	219.00
Heptoic	**16**	7 x 9	10 x 12	18⅞	18⅞	10 13/16	6.3	190.00	3	217.00
Heraldic	**17**	8 x 10	11 x 14	23¼	18⅞	11⅞	7.0	218.50	3	245.50
Herand	**18**	8 x 10	11 x 14	27⅛	18⅞	12¾	7.7	257.00	3	284.00
Herbage	**19**	8 x 10	12 x 16	23¼	23¼	13¼	6.3	240.00	3	267.00
Herbar	**20**	10 x 12	14 x 17	27⅛	23¼	14 5/16	7.0	278.50	3	305.50
Herd	**22**	10 x 12	16 x 18	27⅛	27⅛	15½	6.3	312.00	3	339.00
Herdic	**25**	10 x 12	17 x 20	30¾	30¾	18¼	6.3	429.00		
Hereon	**28**	11 x 14	18 x 22	33⅞	33⅞	20¼	6.3	563.00		
Heresy	**30**	12 x 16	22 x 27	39¼	39¼	23⅜	6.3	743.00		

*No. 2 Volute is here regularly supplied. If it is desired to use the lens on a hand camera and No. 2 Volute is not wanted, we can adapt the No. 1 Volute by reducing the diameter of the lens. This in no way affects the speed of the combination. In ordering, kindly specify whether No. 1 or No. 2 Volute is to be furnished.

VII PROTAR—F:12.5

Code Word	No.	Size of Plate Covered with Stop F:12.5 Inches	Size of Plate Covered with Small Stops Inches	Equivalent Focus Inches	Back Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm	In Volute Shutter Without Barrel	
								No.	Price
Hector	1	4¾ x 6½	5 x 7	7 3/16	7¾	¾	$ 36.50	1	$ 59.50
Hederic	2	5 x 7	6½ x 8½	8¾	9⅝	⅞	40.00	1	63.00
Hedonic	3	6½ x 8½	10 x 12	11 3/16	12¼	1⅛	46.50	1	69.50
Heelless	4	8 x 10	11 x 14	13¾	15	1⅜	56.50	2	81.50
Hegge	5	10 x 12	12 x 16	16 3/16	17½	1 21/32	73.00	2	98.00
Heiress	6	11 x 14	16 x 18	18⅞	20½	1⅞	100.50	3	127.50
Helena	7	12 x 16	18 x 22	23¼	25¼	2	129.00	3	156.00
Helican	8	13 x 16	22 x 27	27⅛	29 11/16	2 7/16	167.50	3	194.50
Heliotype	9	16 x 18	24 x 30	30¾	34	2¾	231.00		
Helix	10	16 x 20	27 x 35	33⅞	37½	3¼	301.50		
Helmet	11	18 x 22	30 x 40	39¼	43½	3¾	394.00		

For matching lenses for stereoscopic work, add $4.00 to the price of the lenses.

When ordering lenses fitted with shutter, by telegraph, specify *Volute*, in addition to the code word for the size of lens.

Each lens is furnished in a case which protects it from injury. Lens cap, flange and screen ring for ray filter are included.

The diaphragm scale is graduated for each focal length.

C SET—BAUSCH & LOMB CONVERTIBLE PROTAR VIIa

With barrel in case, $131.00. Code word, *Hermes*.
Fitted with aluminum Volute Shutter, in case, without barrel, $159.00.

Series	No.	Size of Plate Covered with Largest Stops* Inches	Equivalent Focus of Lenses in Inches			Speed
			Front Lens	Back Lens	Combined Focus	
VII	2	5 x 7	....	8¾	....	F:12.5
	3	6½ x 8½	....	11 3/16	....	F:12.5
	4	8 x 10	....	13¾	....	F:12.5
VIIa	5	4¼ x 6½	11 3/16	8¾	5⅝	F:7.0
	6	4¼ x 6½	13¾	8¾	6⅛	F:7.7
	8	5 x 7	13¾	11 3/16	7	F:7.7

* Larger plates covered with smaller stops.

D SET—BAUSCH & LOMB CONVERTIBLE PROTAR VIIa

With barrel in case, $253.50. Code word, *Heriot*.
Fitted with aluminum Volute Shutter, in case, without barrel, $283.50.

Series	No.	Size of Plate Covered with Largest Stops* Inches	Equivalent Focus of Lenses in Inches			Speed
			Front Lens	Back Lens	Combined Focus	
VII	3	6½ x 8½	....	11 3/16	....	F:12.5
	4	8 x 10	....	13¾	....	F:12.5
	5	10 x 12	....	16 3/16	....	F:12.5
	6	11 x 14	....	18⅞	....	F:12.5
VIIa	8	5 x 7	13¾	11 3/16	7	F:7.0
	9	5 x 8	16 3/16	11 3/16	7½	F:7.7
	9a	5 x 8	18⅞	11 3/16	8	F:7.7
	11	6½ x 8½	16 3/16	13¾	8½	F:7.0
	12	6½ x 8½	18⅞	13¾	9⅛	F:7.7
	14	7 x 9	18⅞	16 3/16	10	F:7.0

* Larger plates covered with smaller stops

MEDIUM WIDE ANGLE—Series IV, F:12.5

Code Word	No.	Size of Plate Covered with Stop F:12.5 Inches	Size of Plate Covered with Small Stops Inches	Equivalent Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm	In Volute Shutter Without Barrel	
							No.	Price
Harden	1	2½ x 3¼	3½ x 3½	2 7/16	¼	$ 22.00		
Hardock	2	3¼ x 4¼	4 x 5	3 7/8	7/16	22.00	1	$ 45.00
Harem	3	4¼ x 6½	5 x 7	4 11/16	½	26.50	1	49.50
Hark	4	5 x 8	6½ x 8½	6 1/16	5/8	31.00	1	54.00
Harmel	5	6½ x 8½	8 x 10	7 11/16	13/16	41.00	1	64.00
Harmonic	6	10 x 12	12 x 15	10¼	1⅛	59.50	1	82.50
Harness	7	12 x 15	16 x 20	15 9/16	1⅝	93.50	2	118.50
Harpoon	8	16 x 20	18 x 22	23 13/16	2⅝	165.00	3	192.00
Harrow	9	20 x 24	24 x 30	35 11/16	2 15/16	374.00		
Hart	10	24 x 30	28 x 36	48⅜	3⅞	810.00		

For matching lenses for stereoscopic work, add $4.00 to the price of the lenses.

When ordering lenses fitted with shutter, by telegraph, specify *Volute* in addition to the code word for the size of lens.

Each lens is furnished in a case which protects it from injury. Lens cap and flange are included.

EXTREME WIDE ANGLE—Series V, F:18

Code Word	No.	Size of Plate Covered with Stop F:18 Inches	Size of Plate Covered with Small Stops Inches	Equivalent Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm	In Volute Shutter Without Barrel	
							No.	Price
Hauteur	1	4 x 5	4¼ x 6½	3 5/16	11/32	$ 31.00	1	$ 54.00
Havildar	2	5 x 7	6½ x 8½	4 7/16	7/16	31.00	1	54.00
Hawk	3	6½ x 8½	8 x 10	5 9/16	9/16	37.50	1	60.50
Haybote	4	8 x 10	11 x 14	7 3/16	23/32	46.50	1	69.50
Haytian	5	10 x 12	14 x 17	8½	⅞	58.50	1	81.50
Hazle	6	11 x 14	18 x 22	10 9/16	1 1/16	73.00	1	96.00
Health	7	12 x 15	20 x 24	12 7/16	1¼	87.00	1	110.00
Heard	7a	16 x 18	22 x 27	15⅜	1 3/32	115.50	1	138.50
Heathen	8	14 x 17	17 x 20	18 5/16	1 3/32	115.50	1	138.50
Heave	9	16 x 18	22 x 27	24 7/8	1½	165.00	2	190.00
Heben	10	20 x 25	24 x 30	37¼	2 3/16	330.00	3	357.00

For matching lenses for stereoscopic work, add $4.00 to the price of the lenses.

When ordering lenses fitted with shutter, by telegraph, specify *Volute* in addition to code word for the size of lens. Each lens is furnished in a case which protects it from injury. Lens cap and flange are included.

BAUSCH & LOMB PROCESS ANASTIGMAT—F:10

Code Word	No.	Equivalent Focus, Inches	Diameter of Lens, Inches	Covers for Same Size Reproduction, Inches	Covers for Reduction, Inches	Price
Kernel	0	13	1⅜	11 x 14	8 x 10	$120.00
Kerato	0a	16	1¾	12 x 15	10 x 12	155.00
Keeler	1	18	2	14 x 17	12 x 15	175.00
Keese	2	25	2⅝	20 x 24	16 x 20	280.00

TELEPHOTO ATTACHMENT

Code Word	No.	Focus, Inches	Fitted to Bausch & Lomb Lenses	Fitted to Lenses of Other Manufacture
Hidden	2	2 3/8	$34.50	$ 41.00
Hieron	3	3	44.00	49.50
Highly	4	4	57.50	65.00

In every instance lenses should be sent to us to secure correct adjustment in fitting Telephoto Attachments

BAUSCH & LOMB CONDENSERS FOR ENLARGING

Code Word	No.	Diameter in Inches	Focus in Inches	One Lens Unmounted	Pair of Lenses Mounted
Hispanic	6½D	6½	10	$ 6.75	$20.50
Hispid	8D	8	12	13.50	35.00
Hist	9D	9	14	16.50	42.00
Histoid	10D	10	15	22.00	54.00
Histrion	12D	12	18	40.00	92.00
Histozyme	14D	14	21	55.00	123.00

In telegraph orders add the word *Mounted* to code word when lenses are desired mounted.
(Be sure to state diameter of lens when ordering.)

VOLUTE SHUTTER

Code Word	No.	Will Take Lenses with Opening of	Automatic Exposure	Volute Shutter Only	Fitted to Our Lens—Add	Fitted to Other Lens or Our Lens fitted to Other Shutter Sent—Add
Hitch	1	1	1 sec. to 1/150 sec.	$23.00	$4.50	$6.00
Hitter	2	1 7/16	1 sec. to 1/100 sec.	25.00	5.50	7.00
Hive	3	2	1 sec. to 1/75 sec.	27.00	6.00	8.50

Cable release regularly supplied; if bulb and hose are preferred, specify with order.

BRASS FLANGES FOR BAUSCH & LOMB LENSES

Diameter, In.	1 5/16	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/2	4	4 1/2	5	5 1/2	6
Price, each	$0.85	$1.15	$1.45	$1.55	$1.75	$1.85	$2.00	$3.00	$3.75	$4.60	$5.50	$6.35	$7.50

CAPS FOR BAUSCH & LOMB LENSES

Diameter, Inches	1 5/16	1 9/16	1 11/16	2	2 3/16	2 3/8	2 5/8	2 7/8
Price, each	$0.60	$0.65	$0.70	$0.70	$0.75	$0.80	$0.85	$0.90
Diameter, Inches	3 1/4	3 5/8	3 7/8	4 1/16	4 3/16	4 9/16	4 5/8	6 1/16
Price, each	$1.00	$1.25	$1.40	$1.50	$1.60	$1.75	$2.00	$2.90

RETOUCHING GLASSES

Catalog No.	Diameter, Inches	Focus, Inches	Price
202	2½	6	**$2.75**
204	3	7	**3.00**
206	3½	8	**3.75**
208	4	10	**4.25**
209	4½	12	**5.25**

FOCUSING GLASSES

Catalog No.	Specifications	Price
4545	DOUBLET FOCUSING GLASS, consisting of two plano-convex lenses, mounted with screw focusing adjustment; equivalent focus, 38 mm.	**$ 5.00**
4540	ACHROMATIC FOCUSING GLASS, consisting of triple aplanatic magnifier of wide angle and sharp definition, mounted in tube with screw focusing adjustment and clamping ring; equivalent focus, 38 mm.	**10.00**

REDUCING GLASS

Catalog No.	Diameter, Inches	Focus, Inches	Price
204 c. c.	3	7	**$3.75**

BAUSCH & LOMB PHOTO-ENGRAVING PRISMS

Code Word	Aperture of Prism Inches	For Bausch & Lomb Process Anastigmat	For Bausch & Lomb Tessar, IIb	Fitted to B. & L. Lenses	Fitted to Lenses of Other Make
Kafir	2½	No. 0	No. 8	**$ 74.00**	**$ 79.00**
Kage	3	No. 0a	No. 9	**112.00**	**117.00**
Kail	3½	No. 1	No. 9a	**136.00**	**141.00**
Kalki	4	No. 2	No. 10	**190.00**	**196.00**
Kamsin	4½	.....	No. 11	**300.00**	**310.00**
Kand	5	.....	.....	**420.00**	**430.00**

RAY FILTERS

Code Word	No.	Inside Diameter	FITS LENSES				Price
			Ic	IIb	VII*	VIIa	
Hilt	**A1**	1¼	13-14	3-4-5-5k	1-2-3	3-5-7	**$ 6.25**
Himpne	**A1P**	1¼	13-14	3-4-5-5k	1-2-3	3-5-7	**6.25**
Hindoo	**A2**	2	15-15a	5a-6	4-5	6-8-9-10-11-13	**8.50**
Hinge	**A3**	2¾	16-17	7-8	6-7	12-14-15-16-17-19	**12.00**

*Use screen ring furnished with lens to attach filter.

TO OUR PATRONS

THE goods listed herein can be obtained from dealers in photographic goods in the United States and Canada and our agents in foreign countries. We prefer that they be ordered through dealers. If, however, there is any difficulty in procuring them through this channel, we shall be pleased to supply them direct, as per prices and information conveyed in this catalog.

In the interest of greater convenience in manipulation, we are supplying our Tessar lenses in mountings, which have the diaphragm scale marked on the front bevel of the diaphragm ring. This enables one to read the scale from the front of the lens. All mountings are engraved according to the F system of lens stops. For explanation and comparison of this system with the U. S., see page 13.

Lenses on approval. Lenses will be sent on ten days' approval to responsible parties who send satisfactory references, or they will be forwarded for examination and trial in care of the express companies, provided a deposit is made covering transportation charges one way. The purchaser may, if he wishes, forward the price of the desired goods with his order. They will then be sent on ten days' trial, and if not wanted, the amount in full will be returned on the payment of charges and the receipt of the goods, within two weeks, uninjured.

Lenses may be ordered on approval through dealers in photographic goods. **Telephoto Attachments** must be specially fitted to individual lenses and are, therefore, **not sent out on approval.** Special sizes of lenses, either larger or smaller than listed, will be made to order only. Prices on application.

Terms. To avoid delay, purchasers with whom we have no account and who have no mercantile rating, should accompany their first order with commercial references or remittance in cash, money orders, or New York or Chicago current funds, as your local check may be subject to collection charges.

Under an arrangement made by the Western Union Telegraph Co. orders can now be sent by telegraph between points in the United States, in the same message with remittance. Code words or catalog numbers may be used. Information may be secured on application to nearest Western Union manager. No C. O. D. shipments will be made unless sufficient funds to cover delivery charges both ways accompany the orders. Goods made on special order, or to be sent on memorandum account, will not be forwarded C. O. D.

Sample Prints. We are prepared to furnish original contact prints from which many of the illustrations in this catalog were made and shall be glad to send them on receipt of ten cents each in stamps. We invite users of our lenses to send us samples of their work for inspection.

To the Interested Inquirer. We do not go into detail regarding photo-engraving lenses and sundries, photo-engravers' prisms or color

filters for the three-color process, and will be pleased to take up inquiries in detail by correspondence and to send special literature. Write us if you are in doubt on any points.

Our established branch offices in New York, Chicago, Washington and San Francisco are maintained for the convenience of our customers, whom we hope will take advantage of them. They will find our representatives ready to extend to them every courtesy. Sample prints showing the work of our lenses and cameras for testing lenses will be found there. We venture the belief that customers in search of advice and information will not be disappointed in having their wants supplied.

BAUSCH & LOMB OPTICAL COMPANY

EXECUTIVE OFFICE AND MANUFACTORY

611-713 ST. PAUL STREET, ROCHESTER, N. Y., U. S. A.

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OTHER PRODUCTS

In addition to the products listed herein the Bausch & Lomb line includes Microscopes, Projection Apparatus (Balopticons), Photo-micrographic Apparatus, Binoculars, Ophthalmic Lenses and Instruments, Range Finders and Gun Sights for Army and Navy, Searchlight Mirrors, Optical Measuring Instruments, Reading Glasses, Magnifiers and other high-grade optical equipment and accessories. Catalogs or information on request.

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