Photographic Lenses

Bausch and Lomb Optical Co.

ROCHESTER N.Y.

Made with IIb Tessar by Harry R. Hippler

INTRODUCING OURSELVES

A LEADING pioneer in the movement for the development of the photographic lens was the Bausch and Lomb Optical Company. The activities of this firm had, from the beginning, a very important effect upon the advancement and popularization of photography in America.

Prior to the early 80's most of the photographic lenses used in this country were imported from Europe. But these were high in price, and the problem before these American pioneers was that of attaining the quality of the foreign lenses and of reducing the cost to the photographer. Long study and experiment resulted in the production of photographic lenses of high-grade that merited and gained the American photographers' enthusiastic welcome.

In the early 90's the Carl Zeiss Optical Works, of Jena, entered the photographic field and introduced the anastigmat lens, invented by Drs. Abbe and Rudolph, and patented in this country. Recognizing our position in the industry, and desiring to enter the American market, they made an agreement with us, whereby we, as as their licensees, began to manufacture and sell these new lenses under their formulæ.

This relationship with the Zeiss Works gradually became strengthened until in January, 1908, a corporate alliance with that company concentrated the resources, the experience and

the energies of the two leading optical firms of the Old and New World.

The practical result of this closer union is that every invention or improvement made either by Zeiss or by us is at once available to the other. The free interchange of ideas and of methods is an advantage to each center of progress—an advantage amply demonstrated in the successful advance of these initial years.

The present catalog aims to place before those who are interested in photographic lenses brief information of the wide range of our products in this field. For those who may desire fuller information on the Portrait Unar or photo-engraving lenses, we have prepared additional literature which we are glad to send on application. We shall always be pleased to to answer inquiries as to further details of any lens or supplementary appliances mentioned in this volume.

The reader is referred to a later division (Page 61) for specific suggestions as to terms of purchase, shipment, etc.

In the Harbor

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MODERN LENSES

How They Became What They Are

THE inventors—or, perhaps, we should say the discoverers—of photography were required to work with exceedingly imperfect implements. The immense furore occasioned by the new science incited many experimenters in lens-making, a few of which only were successful in advancing the development of that difficult problem. The first lenses that represented a material improvement were vastly quicker than the earlier lenses, but they had, from the modern viewpoint, a narrow field and other serious drawbacks to higher efficiency.

To overcome these defects many ambitious opticians undertook to produce a lens with greater versatility, yet it was over twenty years before the mathematical genius of Germany produced a lens that could be regarded as a forward step. This lens was the first that demonstrated its fitness to survive by combining spherical correction for a comparatively large aperture with freedom from distortion over a large field. The type, known as Rectilinear,* has occupied an important place in the market, and is still widely used in the simpler outfits.

Its one serious drawback rests in the fact that it cannot be corrected for astigmatism and curvature of field at the same time.

If free from astigmatism it had a curved field, or if made to give a flat field the margins showed the blur of uncorrected astigmatism.

For years lens development halted in the face of this difficulty. But though mathematics was baffled science found a new avenue of advance. The new avenue was *a new glass.*

For this triumph modern optical science is indebted to the collaboration of Professor Abbe and Dr. Schott, of Jena. It was in 1881 that Dr. Schott, instigated and inspired by Professor Abbe, began experiments in the production of glass of 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

*See under "Distortion" in "Terms Used in Describing Lenses."

greater the dispersive power. Abbe's aim was to produce glasses which, though they had refractive indices as high as heavy flint glasses, should show no more dispersion than ordinary crown glass—glasses which should combine the refractive power of crown glass with the dispersion of flint glass.

Dr. Schott's experiments were so successful that in 1884 a glass plant producing a new type of glass was put into regular operation.

Dr. P. Rudolph, of the Zeiss Works, was the first to utilize the possibilities of the new glasses for the purposes of photography. To him we are indebted for the first Zeiss anastigmat made in 1890. This epoch-making lens had astigmatic correction over a large flat field and at the same time spherical correction for a large opening, well covering a large plate with a short exposure. The first lens of the new type was a "universal" lens with moderate speed and moderate angle of view. Lenses of higher speed, as well as wide-angle lenses, soon followed on the lines of this type, and in 1895 came the Convertible Protar Series VIIa, which, in its wide range of usefulness, has not been surpassed.

The superiority of Anastigmats over Rectilinear lenses was immediately recognized and gave a great stimulous to lens construction. The Zeiss Works and other manufacturers, persistently sought to acquire greater speed without sacrifice in the field of view. All efforts were distanced by the success of Dr. Rudolph in his invention, in 1903, of the Tessar type, unequalled in its perfection by any other known lens.

Nothing could more vividly illustrate a half century's progress in photographic lenses than a comparison between one of the best of the earlier Portrait lenses, mentioned in the opening paragraph of this sketch, and a lens of the Tessar type, say Series Ic.

Both lenses have the same speed, if the Portrait lens is diaphragmed down to F:4.5. Their brilliant images indicate perfect spherical corrections. But, while one of these early lenses, as ordinarily used in a studio, will just about cover field enough to image head and bust sharply and will not do any more, even when stopped down, the Tessar will, with full aperture, cover a field more than twice as great, and if stopped for depth will take a group. This result is obtained with the same number of lenses in both cases—one cemented pair, and one pair separated by an air space—and this immense advance has only been made possible by the use of the new glasses from Jena.

Made with Ic Tessar by A. R. Stone

Made with IIb Tessar by A. W. Pevare

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 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 so-called **optical center** of the lens, which is always (except in Series VII) near the diaphragm.

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 52 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 admitted 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 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 $\frac{64}{16} = 4$. 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 $\frac{1}{16}$ and $\frac{1}{64}$ 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.

Made with VIIa Protar No. 8 by H. Wm. Menke

Made with IIb Tessar by Frederick I. Monsen

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 in the original object will also be converged to a point, but not on the plate, the cone of light showing in either case a circular patch of light on the plate. This circle of light is known as the "circle of confusion." Its diameter can be used to express the amount of indistinctness existing in a picture. If the circle of confusion is

not greater than $\frac{1}{10}$ mm. or $\frac{1}{250}$ 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 $\frac{1}{10}$ 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: 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

Made with Tessar IIb by Frederick I. Monsen

Made with VIIa Protar by Frances B. Johnston

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, which 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.

Unsatisfactory spherical correction is indicated either by a general indistinct-

Made with Ic Tessar by A. E. Bisantz

ness 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 object 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.

It is only in recent years that it is possible to correct astigmatism, together with the curvature of field in lenses of high speed. 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 shaped,** when the curves are concave, and **barrel shaped,** when the curves are convex toward the margin of the plate.

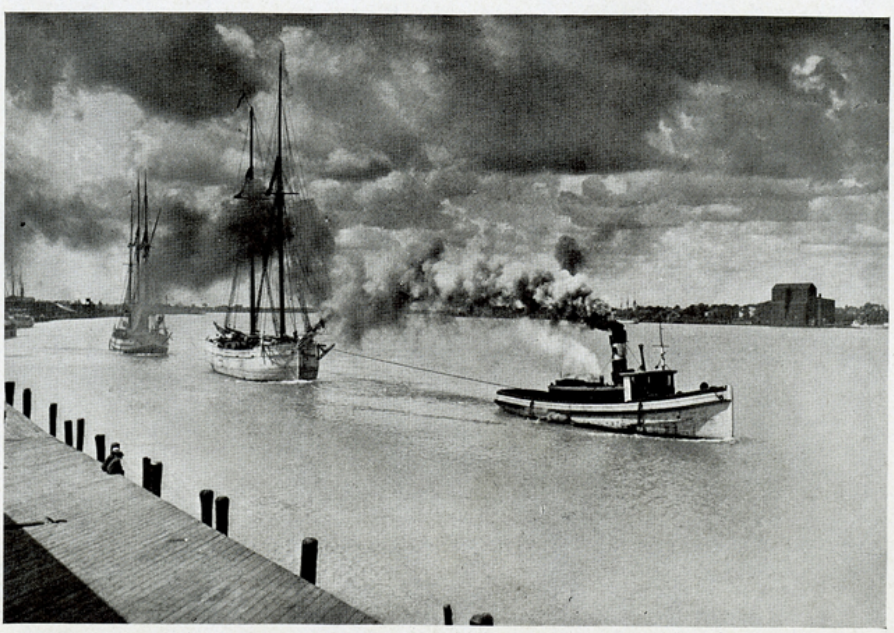
Lenses which are free from distortion are called **rectilinear.**

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 fect 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.



Made with Ic Tessar by John Boyd

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 high lights 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 lignt and least apt to appear when the light is coming from back of the camera.

Made with Ic Tessar by W. B. Starr

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 by way of first deciding upon the specific purposes for which a lens is to be used. Having so decided he may turn to the fuller statement of the lens or lenses recommended under this heading.

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 in proportion to the focal length of lens selected. In constricted spaces, Protar Series IV or Series V Wide Angle lenses are almost necessities. For the inaccessible details, such as cornices, gargoyles, etc., the Bausch & Lomb telephoto will be found to be invaluable.

ATHLETIC SPORTS.

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

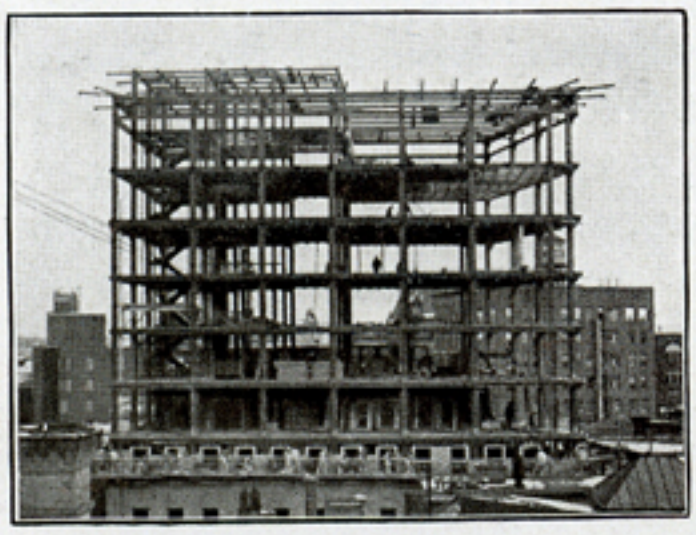
BUTTON AND STAMP PICTURES.

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 Ic Tessar, 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 Ic Tessar, F:4.5 is the best lens. With reflecting type of camera and the Ic Tessar, one can catch the fleeting expression of the child, make pictures of him at play, or a snap-shot in the house. The Ic Tessar is of necessity more bulky than the IIb, which is generally fitted to the folding type of hand camera. There are some types of cycle folding cameras with focusing ground glasses which can be fitted with a Ic Tessar but in general this type of camera will take only the IIb Tessar, F:6.3. The latter lens will do excellent work, for it has more than twice the speed of the ordinary camera lens.

CONSTRUCTION WORK.



A IIb Tessar, F:6.3 on a light hand camera should be used for reconnoitering and preliminary surveys. For all-around work by a resident photographer for large engineering projects a VIIa Protar, 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 IIb Tessar is excellent in this line and for an inexpensive copying lens the Series IV or V Wide Angle Protars are recommended. Specially corrected copying lenses are made for photo-engravers. (See heading Photo-Mechanical Work.)

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 to 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.

FLASHLIGHT PHOTOGRAPHY.

For flashlight work the most useful lens is one which has a large available image circle. Series VIIa or IIb Tessar allow focusing at large apertures, and save flashlight powder expense and smoke. Series IV 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 New Ray Filter is a necessity if the photograph is to show the differences in color values. Adjustment and utility of Ray Filter is described in accessories division of this catalogue.

GROUPS.

In no department of photography is the anastigmat more essential for results. In commercial work, such as photography of landscape gardening, buildings in construction, machinery and automobile photographs, as well as groups, the best investment is the VIIa Protar. 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 combinations are useful as longer focus lenses for distant objects.

If conditions do not justify expense, the IIb Tessar may be employed or the Ic Tessar. 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.

In making a group, the longer focus lenses are of course preferable as the front rows will be more in proportion to the back rows, but the focal length 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 IIb Tessar is obtained; if the combinations are unequal, an extra focal length, but a slight loss in 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 photographic work. If the image size is too small with the VIIa, a single element from the same tripod location can be used and larger image secured. The man with the Protar set finds the proper viewpoint and can usually pick some combination from his set to give him the scale and perspective which he desires.

LANTERN-SLIDE MAKING

For the reduction process of lantern-slide making, a IIb Tessar, F:6.3 should be employed with the cap end of lens facing negative and flange end of lens facing lantern-slide plate.

NATURALIST PHOTOGRAPHY.

Speed is important in this work, yet the image size must also be considered. For work from "blinds" with shutter operated from a distance, the Tessar should be selected. At a distance from the animal, the apparent motion of image on camera is not so great as when near the animal, for in this 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 Ic Tessar will appeal to the newspaper photographer. Its speed, F:4.5, will satisfy the requirements for exposures under difficult conditions, and since it can be stopped down and used at small apertures without suffering in definition, it serves also as a universal lens. The Ic Tessar, F:4.5 covers focus for focus a larger plate than competing lenses, which fact is a most important one. Moreover the Ic Tessar can always be used as a portrait lens when desired, for emergency photographs of celebrities in hotel rooms, etc., where the light conditions are frequently unfavorable for picture making.

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

PHOTO MECHANICAL WORK.

In this work the very highest precision is required. For the exacting demands of the three-color process, the Apochromat Tessar, Series VIII must be used since it is absolutely necessary to bring the images produced through the red, green and violet filters to the same focus so that the images shall be of exactly the same size. (Our special literature will be sent on request, covering photo-engraver's lenses, prisms and ray-filters for three-color work.)

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. (We also supply photomicrographic apparatus and microscopes, and have special literature on same which will be sent on request.)

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. For the professional studio, we also offer the Portrait Unar, which has a speed of F:4.5 which can be most successfully used for standing figures and groups as well as busts. A diffusion device for soft-focus effects is supplied. We publish a special descriptive circular of the Portrait Unar. 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. IIb Tessars 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 Ic Tessar, F:4.5 is here supreme. The speed F:4.5 is maintained in all sizes of the Ic Tessar 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.

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. Ic Tessar No. 18 or 18a is a good selection for an all around studio lens, on account of its speed combined with perfectly flat field. IIb Tessar No. 7, 8 or 9 can also be used with good success. For the portrait photographer who wishes a truly universal lens, the Portrait Unar, mentioned under "Portraiture," will furnish a lens for cabinet heads, standing figures, and groups, together with a diffusing device, which softens hard lines and reduces the retouching bill.

STEREOSCOPIC PHOTOGRAPHY.

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

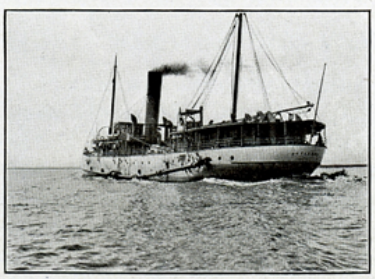
TELEPHOTOGRAPHY.

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 VIIa Protar 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 magnification possible with various camera extensions, with pictorial illustrations of telephoto work, are given in lens catalogue section.

WIDE ANGLE WORK.

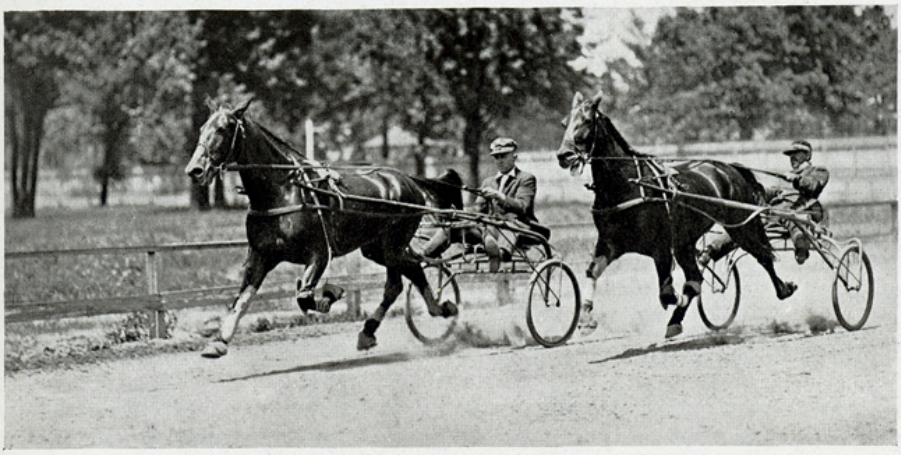
Series IV gives a medium angle and a moderate speed, F:12.5. Series V covers the demand for extreme angle and can be used for snap shots in good lights. Its speed is F:18. Series IV and V are also good for flash-light work. Those who own Convertible Protar VIIa lenses can also use them as wide-angle 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 IV or 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 the same.

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 in connection with a Compound shutter. For motor-boat racing, diving pictures, etc., a Tessar Ic, F:4.5 is of advantage as of necessity the exposures must be short enough to cut out movement of image on plate.

Catalogue of Lenses and Accessories



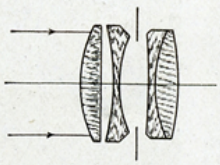
Bausch & Lomb-Zeiss TESSAR

Series Ic.
F:4.5

Universal application.

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

Actual Size



Construction

The Tessar Ic is composed of four single elements, so thin as to reduce the absorption of light to a minimum. Being an unsymmetrical lens, its single elements cannot be used separately. It is as small in bulk as is possible for a lens of so great an aperture, but it is not adaptable to the compact type of hand cameras, as is the Tessar Series IIb.

THE Tessar Ic is admittedly the most universal lens of the symmetrical type. Its simple construction of four thin elements of Jena glass, 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 Ic Tessar 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 Ic Tessar it is available whenever you need it. At F:6.3 you have the same depth of focus and rapidity as the IIb Tessar, 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. 17 are recommended for reflecting cameras. Details are given on page 59 which covers all popular cameras.

The professional will naturally select the No. 18-a 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 Ic Tessar, with its perfectly flat field, makes possible groups and standing figures at large apertures. Nos. 19 and 20 are recommended for 11 x 14 and 14 x 17 work.

After a Practice Spin—Made with Ic Tessar by W. F. Turner

Home portraiture demands the use of a moderate long focus lens, one which is compact enough to fit an easily portable camera, and yet long enough in focus for proper perspective. The No. 18 will exactly satisfy these conditions.

Motion-picture cameras can be supplied with F:3.5 Tessars No. 1 and No. 1-a, which lenses can be mounted in focusing founts if desired. These lenses are of nearly eight times the speed of ordinary lenses.

For autochrome and other color-photographic processes, Ic Tessar gives superior results because of its high speed and perfect color corrections. See price list on page 53.

The Two Extremes—Made with Ic Tessar by W. L. Beasley

Made with Ic Tessar by W. F. Turner

Made with Ic Tessar by W. M. Cline

Made with Ic Tessar by L. C. Bishop

BUBBLES

Made with Ic Tessar by Mrs. Ethel Grant Scott

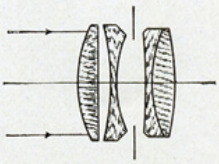
Made with Ic Tessar by W. F. Turner

Bausch & Lomb-Zeiss TESSAR

Series IIb.
F:6.3.

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

Three-Fourths Actual Size



Construction

The Tessar IIb is an unsymmetrical doublet consisting of four very thin lenses which absorb but little light. The component parts are not designed to be used singly. They are separated so as to allow the Volute or our other between-tne-lens shutters to be fitted to the lens.

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 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 characterictic 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:3.2, the angle will increase to 66°, allowing its use on larger size plates as indicated by the table.

Its simple construction of four thin lenses gives practically no absorption. Its remarkable definition adapts it to photo-mechanical work and a special modification known as the Apochromat Tessar Series VIII will be found listed on another page. Tessar negatives will stand great enlargement, one of the most rigid proofs of their precision.

For enlarging Tessar IIb has special qualifications. 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. A special booklet on this fascinating work will be sent on request. 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 a compact hand-camera with short bellows extension, on which the advantages of a lens of several foci like the VIIa Protar cannot be utilized. Moreover, the simpler construction and hence, lower price of the Tessar, makes it preferable wherever the universal applicability of the VIIa Protar is not required. The smaller sizes, including 5a and 6 are generally selected, fitted with Compound or Volute shutters.

For telephotography, IIb Tessar 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 transferring 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 53.

Made with IIb Tessar by Frederick I. Monsen

Made with IIb Tessar by Frederick I. Monsen

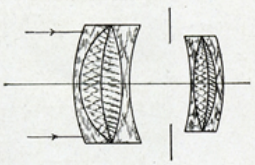
Made with IIb Tessar by Frederick I. Monsen

Bausch & Lomb-Zeiss PROTAR

Series VIIa
F:6.3

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

Actual Size



Construction

Series VII lenses are composed of four highly corrected elements. Two Series VII lenses used together make a VIIa lens. When used alone, the single elements are preferably used in the barrel or shutter with diaphragm in front of lens.

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 anastigmatic 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.

Made with VIIa Protar by Frances B. Johnston

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 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 landscape, 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 of 11 3-16 inches and 13¾ inches focus respectively, listed to cover 6½ x 8½ 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 8¾ inches. The addition of this lens forms the C set of Convertible Protars listed on page 55. 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 13¾ inches and 8¾ inches with a resulting focal length of 6⅛ inches covering a 4¼ x 6½ plate and a speed of F:7.7; or we can form one of 8¾ inches and 11 3-16 inches having 5⅝ inches focus, covering a 4¼ x 6½ 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 $101.00 or an average of $16.84 apiece. Is it possible to purchase any other perfect Anastigmat at so low a cost? But this is not all. The addition of another Series VII No. 5 lens gives us three additional lenses, a single Anastigmat and two doublets at the price of a single lens, $49.50, that is, the whole set of nine lenses, four single and five doublets, will cost $150.50 or $16.73 each.

Flashlight—Made with VIIa Protar by L. C. Bishop

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 55.

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 lists and specifications on pages 54 and 55.

Bausch & Lomb-Zeiss Convertible Protar VIIa.

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 mount with iris diaphragm, cap and flange, and focusing scale, the single Protar lenses (three or four, as the case may be); a neat and compact morocco case containing all the parts of the set. 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. There is no unnecessary multiplication of lens boards, shutters, barrels, flanges and adapters. 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 53.

Made with Ic Tessar and Ray Filter by Nathan R. Graves

Illustrating "C" Set, Convertible Protar, VIIa

THE following series of six photographs of the arch in Prospect Park Plaza, Brooklyn, N. Y., were made with "C" set of the Convertible Protar, VIIa. The camera remained in the same position throughout six exposures. Details of combinations, exposure, etc., are given under each picture. Negatives by A. K. Hanks.

No. 1. 5⅝ inch doublet and Compound shutter, "C" set F:22. ½ second. About 11 A. M. gray day in February,

No. 2. 6⅛ inch doublet, "C" set. F:22. ½ second.

No. 3. 7 inch doublet, "C" set, F:22. ½ second.

No. 4. 8¾ inch single combination, "C" set, F:32, 1 second.

No. 5. $11\frac{3}{16}$ inch single combination, "C" set, F:32. 1 second.

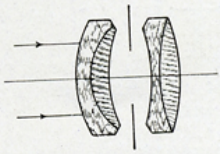
No. 6. 13¾ inch single, "C" set, Compound shutter F:32. 1 second. Position of camera not changed. Would be impossible to secure this result by getting closer with doublet.

Bausch & Lomb-Zeiss MEDIUM WIDE ANGLE

Series IV. F:12.5

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

Actual Size



Construction

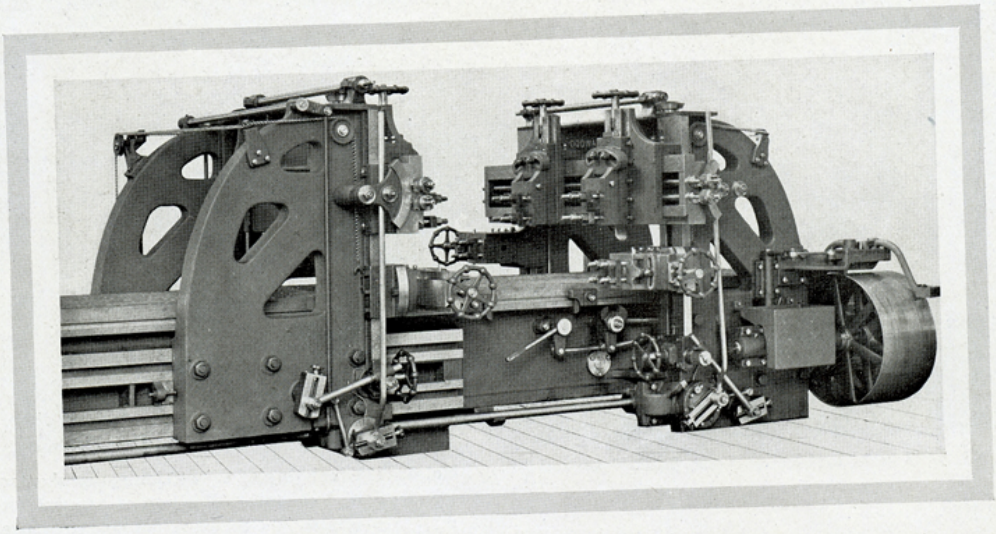
This lens is an unsymmetrical doublet and its components cannot be used separately.

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, hence less speed.

The first six numbers cover an angular field of more than 100°; the others, an angle of 85°, of which 70° and 45° respectively are utilized on the plates for which the various focal lengths are listed.

We recommend Nos. 1 to 6 inclusive for rapid, wide angle work, for example, architectural or other subjects to be photographed instantly, 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. Volute Shutter can be fitted easily to these lenses, but Compound Shutters cannot be fitted on account of slight separation of elements. See price list and specifications of lenses on page 56.



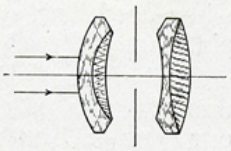
Made with Series IV by H. E. Carlton

Bausch & Lomb-Zeiss EXTREME WIDE ANGLE

Series V.
F:18

For architectural and interior work requiring an extreme wide angle lens.

Actual Size



Construction

An unsymmetrical lens and hence can only be used as a doublet.

THIS series is intended for the most exacting wide angle photography. It is the most desirable lens made for this purpose and should be selected for architectural and interior work wherever an extreme wide angle lens is required Anastigmatic and spherical corrections are the most perfect yet obtained in a lens of this character. No other extreme wide angle lens has equal speed, covering power and effective angle.

In the Laboratory—Made with V Protar by Walter B. Starr

With full opening it covers a field of 75°. In the sizes up to and including 7a, the image circle corresponds to an angle of over 100°, and above that number the full angle utilized is about 90°. Larger plates are well covered when used with smaller stops. To obtain extreme angle, use lens listed for plate one size smaller than one you wish to cover.

The speed F:18 is sufficient for outdoor instantaneous photography under favorable conditions of light. We can easily fit Series V lenses to our Volute Shutter, which, being of the diaphragm type, can easily go between the lens combinations. Compound shutters cannot be fitted. See price list and specifications of lenses on page 56.

Made with V. Prota

Photo-Engraving Lenses, Prisms, etc.

Apochromat Tessar, Series VIII—For Photo-engravers

THE photo-engraver's needs are fully covered by us and we will not go into detailed descriptions which may be obtained in our special photo-engraving literature. This is sent free on request.

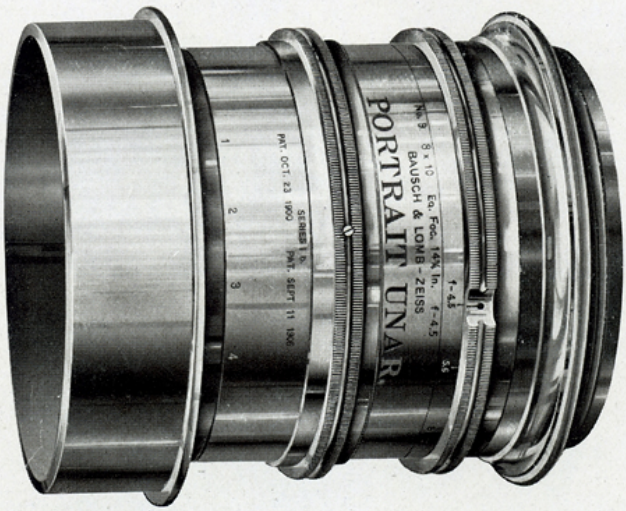
The Apochromat Tessar Series VIII is the lens to use for three-color work, and on account of its high corrections in this direction, is equally good for black and white work. In three-color work, it is essential that the images made through the red, green and violet filters shall come to the same plane of focus, otherwise the printing blocks would not register. The Apochromat Series VIII satisfies these difficult conditions to the highest perfection.

Prisms for reversing the image so as to save stripping the films are made by us and can be fitted to any lens for process work. To ensure accurate fittings, 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 register of images thrown off. We make the Precision Ray-Filter of highest possible perfection for finest work and a very good filter known as the Special Ray-Filter for work which does not demand the highest standard.

Other sundries are focusing glasses, engraver's glasses, and magnifiers of all kinds, which are given in our special literature. See price list and specifications of lenses on page 56.

Portrait UNAR



For Professional Portrait Photography

THE Portrait Unar represents the highest type of portrait lens. It easily makes a sharp picture at its largest opening, F:4.5. As the older type of lenses have to be stopped down to F:8 and F:11 in order to cover anywhere near the same field, the Portrait Unar may truthfully be said to be three to five times as fast as the old portrait lenses. This feature is most valuable.

The greater part of the work in a portrait studio is the making of cabinet heads. For this the photographer requires a certain amount of softness so that, if we focus upon the eyes with a Portrait Unar, the ears and nose are soft enough not to detract from the general effect of the photograph. The Portrait Unar of moderate focus satisfies these conditions, but should you require further softness you can use the diffusing device, which gives varying degrees of softness as the indicator on the device is moved from No. 1 towards No. 4.

This diffusing device gives a controllable amount of diffusion. The photographer can now be governed entirely by his artistic instincts, and can give full play to his individuality.

One of the great points of advantage on the Portrait Unar is the fact that a lens such as the No. 9, 14¾-inch focus, would easily cover an 8 x 10 plate, whereas a portrait lens of the same focus will cover only the cabinet area, unless, of course, greatly stopped down. The practical outcome is that you are forced to use longer focus lenses, which means that the subject poses at a greater distance from the camera, making it harder to do the posing and to operate the camera at the same time. This is of serious importance in these days of short studios. The important point about the Portrait Unar is the fact that it really covers the plates for which it is listed. It is, of course, wise to buy the longest focus Portrait Unar that your studio will allow, on account of perspective reasons, but you will always be able to make the full-size plates at larger apertures instead of having to sacrifice either the covering power or the speed.

The Portrait Unar being of the anastigmat construction is supreme for group work and standing figures. It has a much greater covering power

to the same focal length than the Rapid Rectilinear, because the field of the Anastigmat type of lens is flat. There is no necessity for curving the ends of the groups, which process, although making sharp images, will introduce the defect of making the end figures out of proportion.

The advantages of having one lens that will do all the work of the studio, a lens which you can put on a camera for work outside as well as for work in the studio, and the ease with which you can change from a sharp-working group lens to a lens with any amount of diffusion or softness, are self-evident. See price list and specifications on page 56.

"Will They Bite?"
Made with Bausch & Lomb-Zeiss Portrait Unar

Telephoto Attachment

Two-Thirds Actual Size

For distant buildings, mountains, architectural details, otherwise inaccessible views, etc.

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.

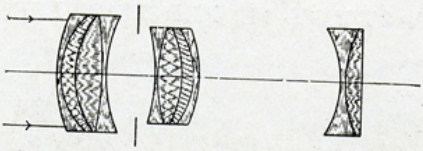
Because of the magnification of its image by the Telephoto, the photographic lens should be as perfect as possible, for all defects will be magnified in exactly the same proportion as is the image. With the magnification of the image there is a decrease of illumination, because the same amount of light 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.

Made with No. 2, Series V, $4\frac{7}{8}$ e. f.

Made with No. 6, IIb Tessar, $8\frac{1}{4}$ e. f.

Made with No. 12, VIIa, $9\frac{1}{8}$ e. f.

SERIES ILLUSTRATING POSSIBILITIES OF TELEPHOTO ATTACHMENT AND WITH OPTICAL EQUIPMENT OF VARYING



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 guaranteed. 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.

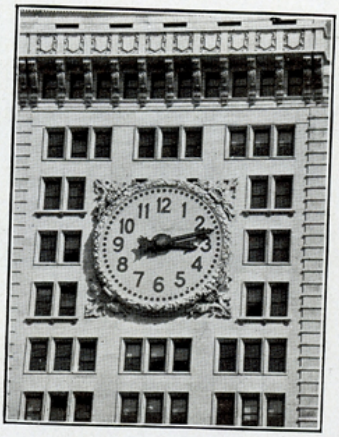
For instance: the exposure for No. 15 Tessar Ic with stop F:16 may be ½ second; with a magnification 3x, the exposure would have to be 9 times longer, i. e., 4½ seconds, and with a magnification 8x, an exposure of 64 x ½ = 16 seconds.

POSITIVE LENS		TELE-PHOTO	AT THREE MAGNIFICAT'N		AT EIGHT MAGNIFICAT'N	
Number	Equival't Focus Inches	Negative Elem't	Image Circle Inches	Bellows Draw Inches	Image Circle Inches	Bellows Draw Inches
15 Ic	6	2	5¼	4⅜	16	16
15a Ic	7 1/16	2	5	4⅜	14¼	16
5 IIb	6⅛	2	5	4¾	15½	16¼
5a IIb	7 1/16	2	4½	4⅜	13	16
5k IIb	6⅞	2	5	4⅞	13½	16
6 VIIa	6⅛	2	4¼	4⅝	15	16¾
7 VIIa	6⅜	2	4¾	4⅜	16	17¼
8 VIIa	7	2	4¼	4½	13¼	16⅛
9 VIIa	7½	2	5	4½	14	16¼
16 Ic	8¼	3	6	5¾	18	19¼
17 Ic	9⅜	3	6	5½	20	19¾
6 IIb	8¼	3	5⅞	5½	16¾	19⅞
7 IIb	10	3	5½	5⅝	17	20⅛

POSITIVE LENS		TELE-PHOTO	AT THREE MAGNIFICAT'N		AT EIGHT MAGNIFICAT'N	
Number	Equival't Focus Inches	Negative Elem't	Image Circle Inches	Bellows Draw Inches	Image Circle Inches	Bellows Draw Inches
10 VIIa	7⅞	3	5½	5⅝	17½	19⅞
11 VIIa	8½	3	5½	5½	16	20¼
12 VIIa	9⅛	3	5¼	5 7/16	15½	19¾
13 VIIa	9¼	3	5½	5 9/16	17¾	19¾
14 VIIa	10	3	5¼	5⅜	16	19⅝
18 Ic	11⅞	4	9	7¼	24	26⅛
8 IIb	12	4	8¼	7½	21½	26¼
15 VIIa	10⅞	4	8½	7⅞	22½	27⅝
16 VIIa	10 13/16	4	8	7 5/16	21½	26¾
17 VIIa	11⅞	4	7¾	7⅜	21	26½
18 VIIa	12¾	4	8	7½	23	27
19 VIIa	13¼	4	8½	7⅞	22½	28

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 57.

Made with No. 6, Series VII, 18⅞ e. f.



Made with No. 6, IIb and Telephoto at 5 power

Made with No. 6, IIb and Telephoto at 8 power

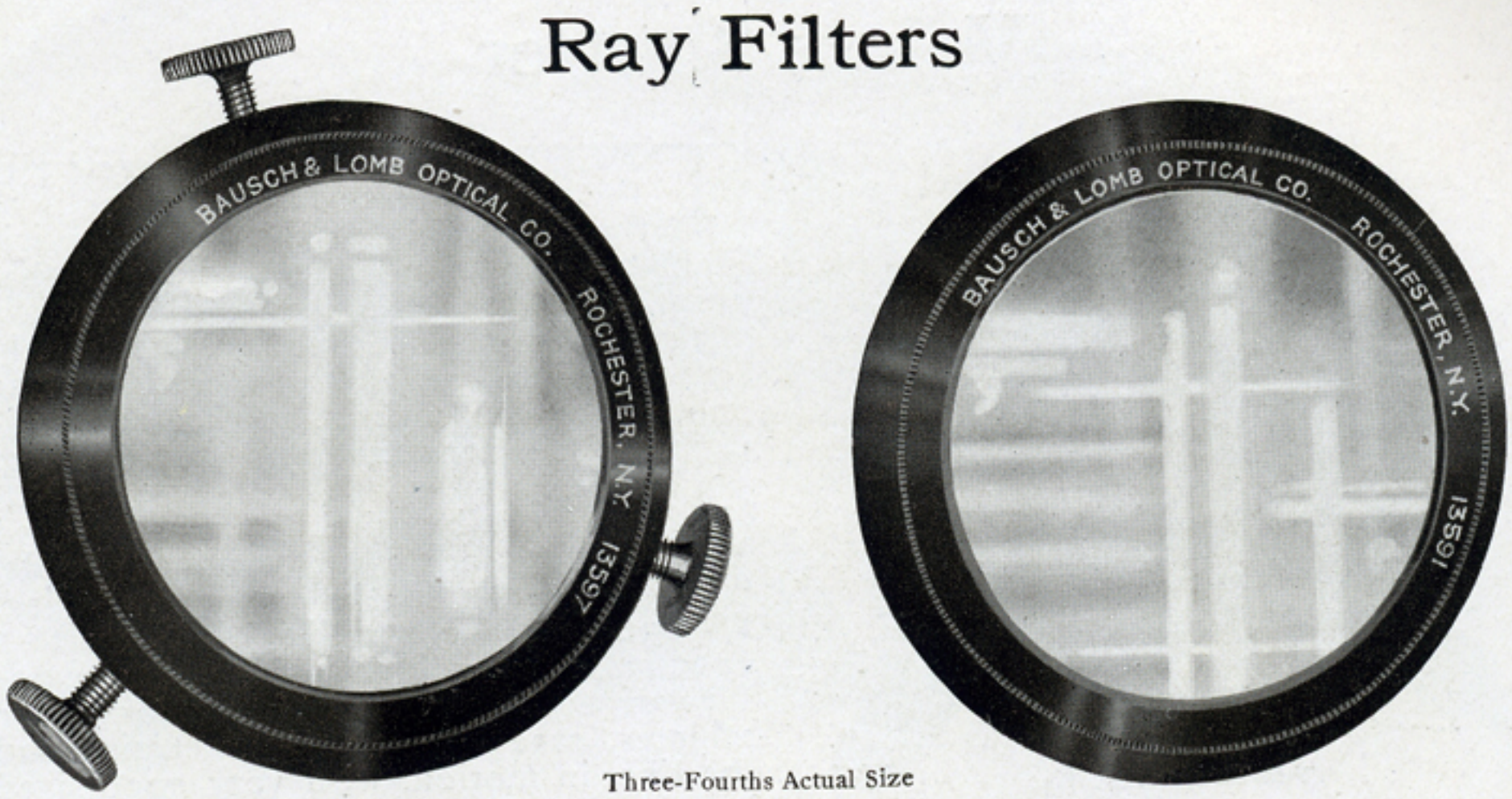
DEMONSTRATING ANGLE OF VIEW ON GIVEN SIZE PLATE AT GIVEN DISTANCE FOCAL LENGTHS — Negatives by A. K. Hanks

A STUDY IN PERSPECTIVE

Made with $8\frac{1}{4}$ in. IIb Tessar on 5 x 7 plate, illustrating correct focal length for use in perspective work

Made with No. 2, Series V, of $4\frac{7}{16}$ in. focus on same size plate, same position, and illustrates erroneous use of wide-angle lens

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 halation are absorbed and distant objects appear more distinctly in the image, even when photographed at a distance of miles.

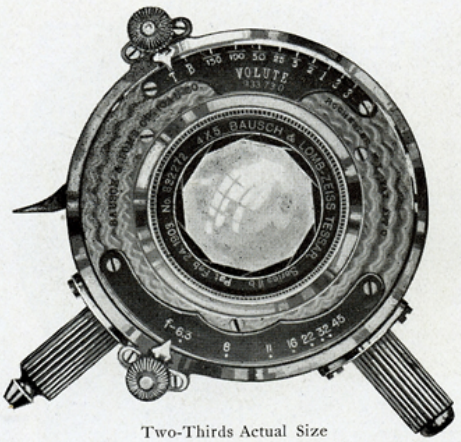
The form of Ray Filter herein presented supersedes the liquid type, which was a source of more or less inconvenience, owing to the leakage or evaporation of the fluid, or its improper preparation. Our new Ray Filter is a glass disc to be used in front of the lens. It is ground and polished from selected spectroscopic Jena 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 five 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. Style B has three adjusting screws and can be attached to lenses varying in size from the diameters given to ½ inch smaller.

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 58.

Volute Shutter



Two-Thirds Actual Size

THEORETICALLY and practically the proper place for a shutter is at the diaphragm of the lens. An iris diaphragm, opening and closing at that point, gives the maximum illumination with the minimum motion, absolutely uniform exposure, and an increase in the depth of focus, covering power and definition of the lens, with no distortion of the image.

It gives bulb and time exposures and works automatically at varying speeds, from 3 seconds to the maximum speed. All speeds are controlled by our patent pneumatic retarding device. An exposure of 1/150 second is fast enough for athletes, race horses, express trains and the like, in motion, with very good-sized images.

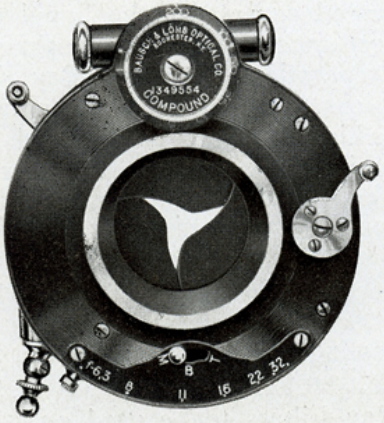
The shutter is set by simply moving the pointer at the top. Any size opening, from pin hole to largest stop, is obtained by placing the lower pointer opposite the stop number desired. No extra stops or diaphragms are needed.

Volute cannot open or expose the plate while being set. It can be arranged for use with two or more lenses.

When exposure is made, the shutter opens instantly and remains open to the full extent until the exposure is completed, when it closes instantly, thus giving the greatest possible exposure and correct relative exposures for all speeds.

All working parts are enclosed within the case, protecting them from dust and making the shutter more convenient to use. The actuating mechanism is simple, durable and not liable to get out of repair. The workmanship is the very finest throughout. Volute is made in three sizes and can be applied to any lenses up to and including those having an aperture of 2 inches. See price list on page 57.

Compound Shutter



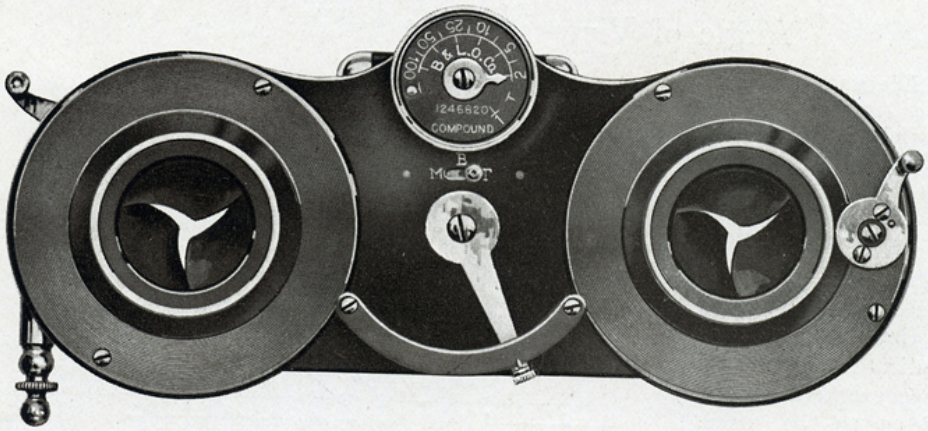
Two-Thirds Actual Size

THE Compound Shutter is adapted for use by photographers whose speed-requirements are met by a between-lens shutter. It is an automatic and setting shutter combined, in which the adjustments are prevented from interfering with each other by an ingenious locking device. Both bulb and time exposures can be made automatically, while speeds of from one second to 1/250 second can be given automatically with No. 0 when the shutter is set. In the larger sizes the speeds are somewhat less.

The mechanism is accurate and not liable to injury. An iris diaphragm is employed for stopping down, and segments of steel form the shutter leaves. The opening of the segments is star-shaped, giving even illumination over the entire plate from the instant the exposure is started. In size 0 there are three segments and in the large sizes proportionately more.

The aluminum case of the shutter is handsomely finished in black, so that the shutter is not only very light in weight, but pleasing in appearance as well. It is dust proof, an important feature; all adjustments can be made with the shutter in position. See price list on page 57.

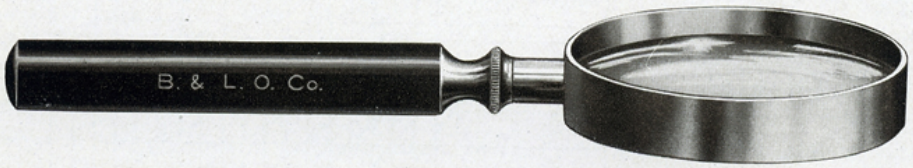
Stereo Compound Shutter



Three-Fourths Actual Size

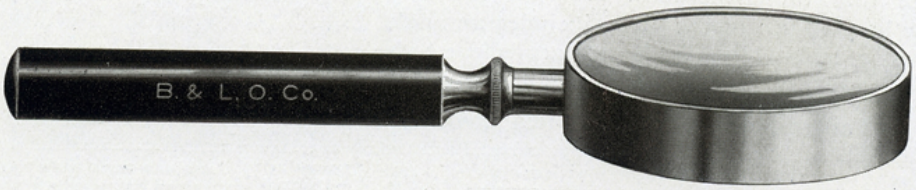
THE Compound Shutter has proven so satisfactory in use that we are making a Stereo Compound for stereoscopic work. What has been said of the Compound applies equally to the Stereo Compound.

Focusing and Retouching Glasses



Large field of view and magnifying power particularly adapt these lenses for this class of work. They are our own production in their entirety. The lenses are carefully ground and the mountings are neat and durable, with nickeled rim and ebonized wood handle.

Reducing Glasses

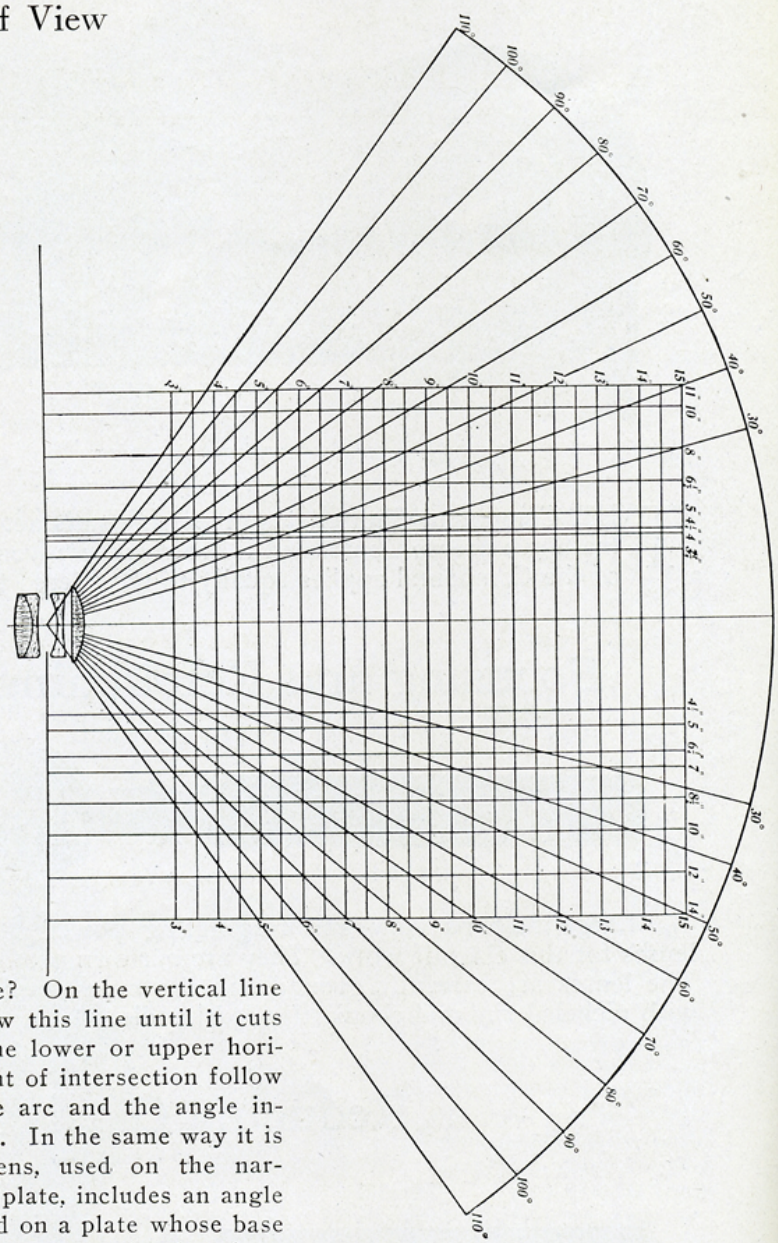


These glasses are very useful, especially in industrial photography. The lens is double concave and mounted in nickeled rim with ebonized wood handle. See price lists on pages 57 and 58.

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 15, 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				
		90°	80°	70°	60°	50°
3¼ x 3¼	4.6	2.3"	2.74"	3.29"	3.98"	4.93"
3¼ x 4¼	5.3	2.65	3.16	3.78	4.59	5.68
4 x 5	6 4	3.2	3.81	4.57	5.54	6.86
4¾ x 6½	8.0	4.0	4.77	5.71	6.93	8.58
5 x 7	8.6	4.3	5.13	6.14	7.45	9.22
6½ x 8½	10.7	5.35"	6.38"	7.64"	9.27"	11.47"
8 x 10	12.4	6.2	7.39	8.85	10.74	13.30
10 x 12	15.6	7.8	9.30	11.14	13.51	16.73
12 x 15	19.4	9.7	11.56	13.85	16.80	20.80

PRICE LISTS

of Bausch & Lomb-Zeiss 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	Fitted with Aluminum Volute Shutter	Fitted with Aluminum Compound Shutter
Haema	**13**	2½ x 3½	3¼ x 4¼	4½	1	**$36.00**	**$53.00**	**$50.50**
Hafter	**14**	3¼ x 4¼	4 x 5	5	1 3/16	**40.50**	**57.50**	**56.75**
Hagdon	**15**	4 x 5	4¼ x 6½	6	1 5/16	**47.00**	**65.50**	**63.25**
Haggle	**15a**	5 x 7	5 x 8	7 1/16	1 9/16	**57.50**	**76.00**	**77.50**
Hail	**16**	5 x 8	6½ x 8½	8¼	1⅞	**72.00**	**92.00**	**92.00**
Hairen	**17**	6½ x 8½	8 x 10	9⅞	2¼	**115.50**	**135.50**	**137.50**
Hakim	**18**	8 x 10	10 x 12	11⅞	2 5/8	**162.00**		
Halberd	**18a**	10 x 12	11 x 14	14 5/8	3 5/16	**210.00**		
Halfer	**19**	11 x 14	12 x 16	15¾	3 9/16	**252.00**		
Halicore	**20**	14 x 17	16 x 18	19¾	4 7/16	**360.00**		

For matching lenses for stereoscopic work, add $3.00 to the price of the lenses.
Each lens is furnished in a case which protects it from injury. Lens cap is included.
When ordering lenses to be fitted with shutter, by telegraph, specify *Volute* or *Compound* in addition to the code word for the size of lens.

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

Code Word	No.	Size of Plate Covered with Stop F:3.5 Inches	Equivalent Focus Inches	Diameter Lens Inches	Lens and Barrel with Iris Diaphragm	Lens in Special Focusing Mount
*Hack**	**1**	¾ x 1	2	9/16	**$29.00**	**$32.50**
*Hade**	**1a**	1¼ x 1¼	3	27/32	**36.00**	**39.50**

*When ordering lenses in focusing mount, by telegraph, add word *Focus* to code word for size of lens.

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

Code Word	No.	Size of Plate Covered with Stop F:6.3 Inches	Size of Plate Covered with Small Stops Inches	Equivalent Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm	Fitted with Aluminum Volute Shutter	Fitted with Aluminum Compound Shutter
Hallux	**3**	2½ x 3½	3¼ x 4¼	4⅜	¾	**$32.50**	**$49.50**	**$44.50**
Halogen	**4**	3¼ x 4¼	4 x 5	5⅜	15/16	**34.50**	**51.50**	**49.00**
Halones	**5**	4 x 5	5 x 7	6⅛	1 1/16	**36.00**	**53.00**	**52.25**
Halser	**5k**	3¼ x 5½	5 x 7	6⅞	1 3/32	**46.00**	**63.00**	**60.50**
Halyard	**5a**	5 x 7	5 x 8	7 1/16	1¼	**50.50**	**69.00**	**66.75**
Hamble	**6**	5 x 8	6½ x 8½	8¼	1 7/16	**61.50**	**80.00**	**81.50**
Hamlet	**7**	6½ x 8½	8 x 10	10	1¾	**83.00**	**101.50**	**103.00**
Hammock	**8**	8 x 10	10 x 12	12	2⅛	**122.50**	**142.50**	**144.50**
Hamper	**9**	10 x 12	12 x 15	14⅜	2 7/16	**158.50**	**178.50**	
Hamular	**9a**	11 x 14	14 x 17	16½	2¾	**193.00**		
Handbill	**10**	14 x 17	16 x 20	19¼	3 5/16	**252.00**		
Handsel	**11**	16 x 20	20 x 24	23⅛	3 15/16	**324.00**		

For matching lenses for stereoscopic work, add $3.00 to the price of the lenses.
Each lens is furnished in a case which protects it from injury. Lens cap is included.
When ordering lenses fitted with shutter, by telegraph, specify *Volute* or *Compound* in addition to the code word for the size of lens.

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 Equival't Focus Inches	Speed F	Lens only	Fitted with Aluminum Volute Shutter	Fitted with Aluminum Compound Shutter
				Front Lens	Back Lens					
Hem	1	3¼ x 3¼	3¼ x 4¼	7 3/16	7 3/16	4⅛	6.3	$48.50	$65.50	$63.00
Hematin	2	3¼ x 4¼	4 x 5	8¾	7 3/16	4½	7	52.50	69.50	67.00
Hematite	3	4 x 5	4¾ x 6½	11 3/16	7 3/16	5	7.7	57.50	74.50	72.00
Hemin	4	4 x 5	4¾ x 6½	8¾	8¾	5 1/16	6.3	56.00	73.00	70.50
Hemipter	5	4¼ x 6½	5 x 7	11 3/16	8¾	5⅝	7	61.50	78.50	76.00
Hemisect	6	4¼ x 6½	5 x 7	13¾	8¾	6⅛	7.7	68.50	87.00	84.75
Hemitone	7	4½ x 7¼	5 x 8	11 3/16	11 3/16	6⅜	6.3	66.50	83.50	82.75
Hemlock	8*	5 x 7	6½ x 8½	13¾	11 3/16	7	7	73.50	92.00	89.75
Hempen	9	5 x 8	6½ x 8½	16⅛	11 3/16	7½	7.7	86.00	104.50	106.00
Henbane	10	5 x 8	7 x 9	13¾	13¾	7⅞	6.3	80.50	99.00	96.75
Henotic	11	6½ x 8½	8 x 10	16⅛	13¾	8½	7	93.00	111.50	113.00
Hepar	12	6½ x 8½	8 x 10	18⅞	13¾	9⅛	7.7	114.50	134.50	134.50
Hepatica	13	6½ x 8½	8 x 10	16⅛	16⅛	9¼	6.3	105.00	123.50	125.00
Heptad	14	7 x 9	10 x 12	18⅞	16⅛	10	7	127.00	147.00	147.00
Heptane	15	7 x 9	10 x 12	23⅛	16⅛	10⅞	7.7	148.50	168.50	170.50
Heptoic	16	7 x 9	10 x 12	18⅞	18⅞	10 13/16	6.3	147.50	167.50	167.50
Heraldic	17	8 x 10	11 x 14	23⅛	18⅞	11⅞	7	169.00	189.00	191.00
Herand	18	8 x 10	11 x 14	27	18⅞	12¾	7.7	199.50	219.50	221.50
Herbage	19	8 x 10	12 x 16	23⅛	23⅛	13¼	6.3	186.00	206.00	208.00
Herbar	20	10 x 12	14 x 17	27	23⅛	14 5/16	7	217.00	237.00	
Herd	22	10 x 12	16 x 18	27	27	15½	6.3	243.00	263.00	
Herdic	25	10 x 12	17 x 20	30¾	30¾	18¼	6.3	340.50		
Hereon	28	11 x 14	18 x 22	33⅞	33⅞	20¼	6.3	444.50		
Heresy	30	12 x 16	22 x 27	39¼	39¼	23⅜	6.3	585.00		

*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 Volute No. 1 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 only	Fitted with Aluminum Volute Shutter	Fitted with Aluminum Compound Shutter
Hector	1	4¾ x 6½	5 x 7	7 3/16	8	¾	$27.00	$44.00	$41.50
Hederic	2	5 x 7	6½ x 8½	8¾	9¾	15/16	30.50	47.50	45.00
Hedonic	3	6½ x 8½	10 x 12	11 3/16	12 7/16	1 3/16	36.00	53.00	50.50
Heelless	4	8 x 10	11 x 14	13¾	15¼	1½	43.50	62.00	59.75
Hegge	5	10 x 12	12 x 16	16⅛	17¾	1¾	56.00	74.50	76.00
Heiress	6	11 x 14	16 x 18	18⅞	20⅝	2	77.50	97.50	97.50
Helena	7	12 x 16	18 x 22	23⅛	25¾	2⅛	99.00	119.00	121.00
Helican	8	13 x 16	22 x 27	27	30	2½	129.50	149.50	
Heliotype	9	16 x 18	24 x 30	30¾	34	2¾	180.00		
Helix	10	16 x 20	27 x 35	33⅞	37½	3¼	234.00		
Helmet	11	18 x 22	30 x 40	39¼	43½	3¾	306.00		

For matching lenses for stereoscopic work, add $3.00 to the price of the lenses.

When ordering lenses fitted with shutter, by telegraph, specify *Volute* or *Compound,* 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 screen ring for ray filter is included.

The diaphragm scale is graduated for each focal length.

C SET—BAUSCH & LOMB-ZEISS CONVERTIBLE PROTAR VIIa

Complete in case, **$101.00.** Code word, *Hermes.*
Fitted with aluminum Volute Shutter, **$119.50**; fitted with aluminum Compound Shutter, **$117.25.**

Series	No.	Size of Plate Covered with Largest Stop* Inches	EQUIVALENT FOCUS OF LENSES IN INCHES			Speed
			Front Lens	Back Lens	Combined Focus	
VII	2	5 x 8		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	5 x 7	13¾	8¾	6⅛	F:7.7
	8	5 x 8	13¾	11 3/16	7	F:7.7

*Larger Plates covered with smaller stops. See tabular matter on VII and VIIa Protars.

D SET—BAUSCH & LOMB-ZEISS CONVERTIBLE PROTAR VIIa

Complete in case, **$197.50.** Code word, *Heriot.*
Fitted with aluminum Volute Shutter, **$217.50**; fitted with aluminum Compound Shutter, **$217.50.**

Series	No.	Size of Plate Covered with Largest Stop* 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		16⅛		F:12.5
	6	11 x 14		18⅞		F:12.5
VIIa	8	5 x 8	13¾	11 3/16	7	F:7.0
	9	5 x 8	16⅛	11 3/16	7½	F:7.7
	9a	5 x 8	18⅞	11 3/16	8	F:7.7
	11	6½ x 8½	16⅛	13¾	8½	F:7.0
	12	6½ x 8½	18⅞	13¾	9⅛	F:7.7
	14	8 x 10	18⅞	16⅛	10	F:7.0

*Larger Plates covered with smaller stops. See tabular matter on VII and VIIa Protars.

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 Large Lens Inches	Lens only	Fitted with Aluminum Volute Shutter
Harden	1	3¼ x 4¼	4 x 5	2 7/16	¼	$17.50	
Hardock	2	4 x 5	4¼ x 6½	3⅞	⅜	17.00	$34.50
Harem	3	4¼ x 6½	5 x 7	4 11/16	½	21.00	38.00
Hark	4	5 x 8	6½ x 8½	6 1/16	⅝	24.50	41.50
Harmel	5	8 x 10	10 x 12	7 11/16	13/16	31.50	48.50
Harmonic	6	10 x 12	12 x 15	10¼	1	47.00	64.00
Harness	7	12 x 15	16 x 20	15 3/16	1 5/16	71.50	90.00
Harpoon	8	16 x 20	18 x 22	23 13/16	2	125.50	145.50
Harrow	9	20 x 24	24 x 30	35 11/16	2 5/16	282.50	
Hart	10	24 x 30	28 x 36	48⅜	3⅞	631.00	

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 is 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 Largest Lens Inches	Lens Only	Fitted with Aluminum Volute Shutter
Hauteur	1	4¼ x 6½	5 x 8	3⅜	5/16	$23.00	$40.00
Havildar	2	5 x 7	8 x 10	4 7/16	⅜	23.00	40.00
Hawk	3	6½ x 8½	10 x 12	5 9/16	½	29.00	46.00
Haybote	4	8 x 10	12 x 15	7 3/16	9/16	36.00	53.00
Haytian	5	10 x 12	16 x 18	8⅜	11/16	45.00	62.00
Hazle	6	11 x 14	18 x 22	10½	13/16	56.00	73.00
Health	7	12 x 15	20 x 24	12⅜	15/16	66.50	83.50
Heard	7a	16 x 18	22 x 27	15⅜	1	88.50	105.50
Heathen	8	14 x 17	17 x 20	18⅛	1	88.50	105.50
Heave	9	16 x 18	22 x 27	24⅞	1⅜	129.50	148.00
Heben	10	20 x 25	24 x 30	37 5/16	2⅛	255.50	275.50

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 included.

APOCHROMAT TESSAR—Series VI

Code Word	No.	Speed	Equivalent Focus Inches	Diameter Lens Inches	Covers for Same Size Reproduction Inches	Covers for Reductions Inches	Price
Kernel	0	F:10	13	1 9/16	11 x 14	7 x 9	$108.00
Keeler	1	F:10	18 3/32	2⅛	14 x 17	8 x 10	144.00
Keese	2	F:10.3	25 3/16	2⅞	20 x 24	12 x 15	234.00
Keg	3	F:10.3	33 1/16	3 5/16	28 x 32	16 x 20	342.00
Kelp	4	F:12.5	46 1/16	3¾	32 x 36	24 x 30	540.00
Kelter	5	F:15	70⅞	4¾	48 x 60	32 x 36	1,260.00

PORTRAIT UNAR—F:4.5

No.	Focus	Covers	Flange	Diameter of Lens	Lens to Subject*	Net Price
7	10 in.	5 x 8	3 in.	2 5/16	8¼ ft.	$110.00
8	12 in.	6½ x 8½	4 in.	2¾	5½ ft.	150.00
9	14¾ in.	8 x 10	4 in.	3 5/16	7½ ft.	200.00
10	18 in.	10 x 12	5 in.	4¼	8 ft.	276.00

*Head size 1 in. with 7, 2 in. with 8, 9 and 10.

Lens board supplied with each lens. Specify size of lens board required.

TELEPHOTO ATTACHMENT

Code Word	Catalog No.	Focus Inches	Fitted to Bausch & Lomb Lenses	Fitted to Lenses of Other Manufacture
Hidden	2	2⅜	$22.00	$26.00
Hieron	3	3	28.00	32.00
Highly	4	4	37.00	42.00

In every instance lenses should be sent to us to secure correct adjustment in fitting Telephoto Attachments. Full directions accompany each attachment.

VOLUTE SHUTTER

Bausch & Lomb Condensers For Enlarging

These condensing lenses are of our own manufacture and are admirably adapted for enlarging work. They are carefully ground, annealed and polished and have long been considered standard. When desired mounted, we furnish them in our improved mounting which is designed to minimize the danger of breakage from excessive heat.

PRICE LIST

(Be sure to state diameter of lens when ordering.)

Code Word	Diameter in Inches	Focus in Inches	One Lens Unmounted	Pair of Lenses Mounted
Hispanic	6½	10	$3.50	$8.50
Hispid	8	12	7.00	17.00
Hist	9	14	9.00	22.50
Histoid	10	15	12.00	29.00
Histrion	12	18	24.00	54.00
Histozyme	14	21	36.00	79.00

In telegraph orders add "Mounted" to code word if pair of lenses are wanted in mounts.

Price, each . . . . . $ .10 .10 .00 .00 .00 .70 .80 .00 1.00

FOCUSING AND RETOUCHING GLASSES

Catalogue No.	Diameter Inches	Focus Inches	Price
200	2	5	$0.60
202	2½	6	.80
204	3	7	1.00
206	3½	8	1.50
208	4	10	2.00
210	5	13	2.50

REDUCING GLASSES

Catalogue No.	Diameter Inches	Focus Inches	Price
200 c. c.	2	5	**$1.00**
202 c. c.	2½	6	**1.50**
204 c. c.	3	7	**2.00**
206 c. c.	3½	8	**3.00**
208 c. c.	4	10	**4.00**

B. & L. PHOTO-ENGRAVING PRISMS

Code Word	Aperture of Prism Inches	For Bausch & Lomb-Zeiss Apochr. Tessar Series VIII	For Bausch & Lomb-Zeiss Protar, Series IIa	For Bausch & Lomb-Zeiss Tessar, Series, IIb	Fitted to B. & L.-Zeiss Lenses	Fitted to Lenses of Other Make
Kafir	2½	.....	No. 6	No. 8	**$54.00**	**$56.00**
Kage	3	No. 1	No. 7	No. 9	**82.00**	**84.00**
Kail	3½	No. 2	No. 8	No. 9a	**100.00**	**102.00**
Kalki	4	No. 3	No. 9	No. 10	**140.00**	**143.00**
Kamsin	4½	No. 4	.....	No. 11	**220.00**	**225.00**
Kand	5	No. 5	.....	.....	**310.00**	**315.00**

RAY FILTERS

Code Word	Cat. 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	**$4.00**
Himpne	**A1P**	1¼	13-14	3-4-5-5k	1-2-3	3-5-7	**4.00**
Hindoo	**A2**	2	15-15a	5a-6	4-5	6-8-9-10-11-13	**6.00**
Hinge	**A3**	2¾	16-17	7-8	6-7	12-14-15-16-17-19	**9.00**
Hippa	**B1**	1¼	13-14	3-4-5-5k	1-2-3	3-5-7	**4.00**
Hircic	**B2**	2	15-15a	5a-6	4-5	6-8-9-10-11-13	**6.00**
Hirudo	**B3**	2¾	16-17	7-8	6-7	12-14-15-16-17-19	**9.00**

* Use screen ring furnished with lens to attach filter.

B. & L. PRECISION RAY FILTER

Code Word	No.	Clear Aperture	For Apo-Tessar Lenses	For IIa Protar Lenses	For IIb Tessar Lenses	Price with Adapter
Kapia	**2P**	2¾	1	6, 7	8, 9, 9a	**$50.00**
Karma	**3P**	3¾	2, 3, 4	8, 9	10	**65.00**

Allowance for adapter if not required, $1.50.

B. & L. SPECIAL RAY FILTER

Code Word

Karob No. 3 Special Ray Filter with adapter, clear aperture, 2¾ in. . **$15.00**

Kasack No. 4 Special Ray Filter with adapter, clear aperture, 3¾ in. . **20.00**

Kava No. 3a Set of 3 No. 3 Filters with one adapter **40.00**

Kawn No. 4a Set of 3 No. 4 Filters with one adapter **55.00**

For list of lenses to which they can be fitted, see table under Precision Ray Filters.

Table Showing the Sizes of Lenses and Shutters Which Can Be Adapted to Various Cameras

	Size	Ic Tessar	Volute Shutter	Compound Shutter	IIb Tessar	Volote Shutter	Compound Shutter	VIIa Protar	Volute Shutter	Compound Shutter
KODAK										
1a Speed Kodak	2½ x 4¼	14			4					
1a Special Kodak	2½ x 4¼				4		0			
1a F. P. K. Special	2½ x 4¼				4		0			
3 F. P. K.	3¼ x 4¼				4	1	0			
3 Special Kodak	3¼ x 4¼				4	1	0			
3a F. P. K.	3¼ x 5½				5k	1	1			
3a Special Kodak	3¼ x 5½				5k	1	1			
4 F. P. K.	4 x 5				5k	1	1			
4a Folding Kodak	4¼ x 6½				6	2	2			
4a Speed Kodak	4¼ x 6½				6	2				
GRAFLEX										
1a Graflex	2½ x 4¼	14			4					
3a Graflex	3¼ x 5½	15a			5a			7		
Auto Graflex	3¼ x 4¼	14			4					
Auto Graflex	4 x 5	15			5					
Auto Graflex	5 x 7	16			6					
Rev. Back Auto Graflex	3¼ x 4¼	15a			5a			10		
Rev. Back Auto Graflex	4 x 5	17			7			13		
Telescopic R. B. Auto Graflex	4 x 5	15a			5a			10		
Home Portrait Graflex	5 x 7	17			7					
Press Graflex	5 x 7	16			6			13		
Stereo Auto Graflex					Pair 5					
Naturalists' Graflex	4 x 5							19		
HAWKEYE										
1a Hawkeye, Model 1	2½ x 4¼				3		0			
3 Hawkeye, Model 8	3¼ x 4¼				4	1	0			
3a Hawkeye, Model 3	3¼ x 5½				5	1	1			
4 Hawkeye, Model 3	4 x 5				5	1	1			
4 Hawkeye, Model 4	4 x 5							7	1	1
Stereo Hawkeye Model 6					Pair 4		0s*			
CENTURY										
Petite Grand	3¼ x 5½				5	1	1	7	1	1
Century, Model 46	4 x 5				5	1	2	7	1	2
Century, Model 46	5 x 7				6	2	3	10	2	2
Century, Model 46	6½ x 8½				7	2	3	13	2	3
Century Grand Sr.	4 x 5				5	1	2	7	1	2
Century Grand Sr.	5 x 7				6	2	3	10	2	2
Century Grand Sr.	6½ x 8½				7	2	3	13	2	3
GRAPHIC										
Revolving Back Cycle Graphic	4 x 5	15	2	2				7	1	2
Revolving Back Cycle Graphic	5 x 7	16	3	3				10	2	2
Revolving Back Cycle Graphic	6½ x 8½	17	3	4				13	2	3
Revolving Back Cycle Graphic	8 x 10							17	3	4
Stereoscopic Graphic	5 x 7				Pair 4			Pair 7		
Speed Graphic	3¼ x 5½	15a						7		
Speed Graphic	4 x 5	15						4		
Speed Graphic	5 x 7	16						10		

* Stereo Shutter.

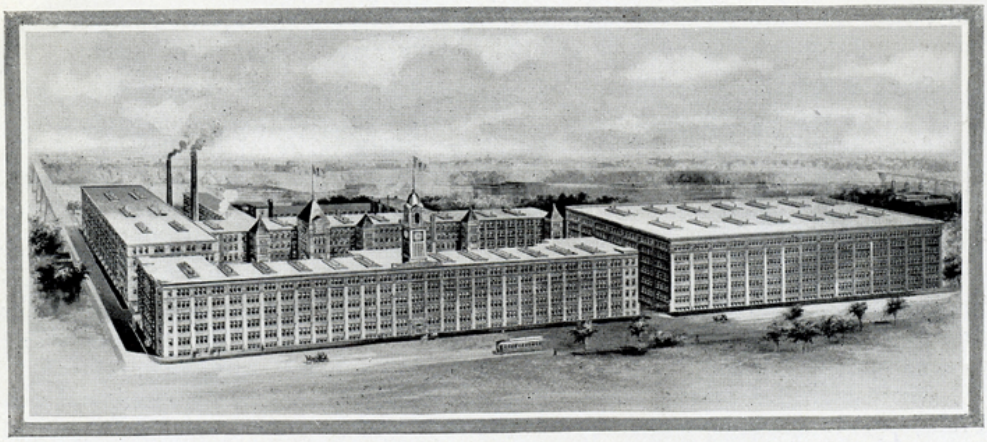
		Size	Ic Tessar			IIb Tessar			VIIa Protar		
			Volute Shutter	Compound Shutter		Volute Shutter	Compound Shutter		Volute Shutter	Compound Shutter
	PREMO										
1	Premoette Special	2¼ x 3¼			3		0			
1a	Premoette Special	2½ x 4¼			4		0			
	Film Plate Premo	3¼ x 4¼			4	1	0			
	Film Plate Premo	3 x 5¼			5	1	1			
	Film Plate Premo	4 x 5			5	1	1			
	Film Plate Premo	5 x 7			5a	2	2			
4	Pony Premo	4 x 5			5	1	1	3	1	1
4	Pony Premo	5 x 7			5a	2	2	8	1 or 2	2
4	Stereo Premo	5 x 7			Pair 4		1s*	Pair 2		1s*
6	Pony Premo	4 x 5			5	1	1	3	1	1
6	Pony Premo	5 x 7			5a	2	2	8	1 or 2	2
6	Stereo Premo	5 x 7			Pair 4		1s*	Pair 2		1s*
6	Pony Premo	6½ x 8½			7	2	3	11	2	3
7	Pony Premo	4 x 5			5	1	1	3	1	1
7	Pony Premo	5 x 7			5a	2	2	8	2	2
7	Stereo Premo	5 x 7			Pair 4		1s*	Pair 2		1s*
7	Pony Premo	6½ x 8½			7	2	3	11	2	3

* Stereo Shutter.

Above table gives fittings for current models of cameras. Many former models can be adapted with our lenses and shutters. State size of lens board on which shutter or lens is fitted, also bellows extension which is distance from lens board to ground glass (film or plate surface in cameras which focus by scale) when bellows is fully extended.

We can supply you with information regarding cameras not listed above.

Made with VIIa Protar No. 16 by Frances B. Johnston



Works of the Bausch & Lomb Optical Company, Rochester, N. Y.

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 new 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. **High Power Telephoto Lenses** 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. Parties unknown to us are requested to send cash with order; or, if they desire to open a credit account, to give information and references that will enable us to pass upon the matter. Checks drawn on banks other than New York, Boston, Philadelphia or Chicago, are subject to collection charges of ten cents for amounts less than one hundred dollars, or one-eighth of one per cent. for amounts more than one hundred dollars, and this sum should be added to remittance.

When cash accompanies order, and goods are to be sent by mail, **add amount of postage to remittance,** otherwise goods will be sent by express, charges collect. Goods sent by mail are at purchaser's risk. Goods will be sent by express C. O. D.

only when amounting to more than five dollars, express and return charges to be borne by purchaser. One-fourth of total amount should accompany order.

Sample Prints. A special set of sample prints illustrating the scope of any desired lens will be sent on receipt of ten cents. In addition to this 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, who 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, testing cameras, charts for testing lenses will be found there, and we venture the belief that customers in search of advice and information will not be disappointed in having their wants supplied.

Eleventh U. S. Cavalry

Made with Ic Tessar by R. A. Knowles

Bausch & Lomb Optical Company

OUR PRODUCTS

IN addition to Photographic Apparatus, we manufacture the following products, regarding which we issue separate publications, which we shall be glad to send on request to interested parties:

Astronomical Instruments
Chronographs
Eye Glasses
Field Glasses
Graduated Glassware for Precise Work
Lenses
Levels, Wye, Dumpy, Precise, etc.
Magnifiers
Measuring Instruments
Microscopes
Microtomes
Observation Telescopes
Photomicrographic Apparatus
Projection Apparatus
Range Finders
Reading Glasses
Reducing Glasses
Searchlight Mirrors
Telescopic Gunsights
Theodolites
Transits
Equipment for Biological, Chemical and Research Laboratories

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Executive Office and Manufactory

515-565 St. Paul Street, Rochester, N. Y., U. S. A.

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