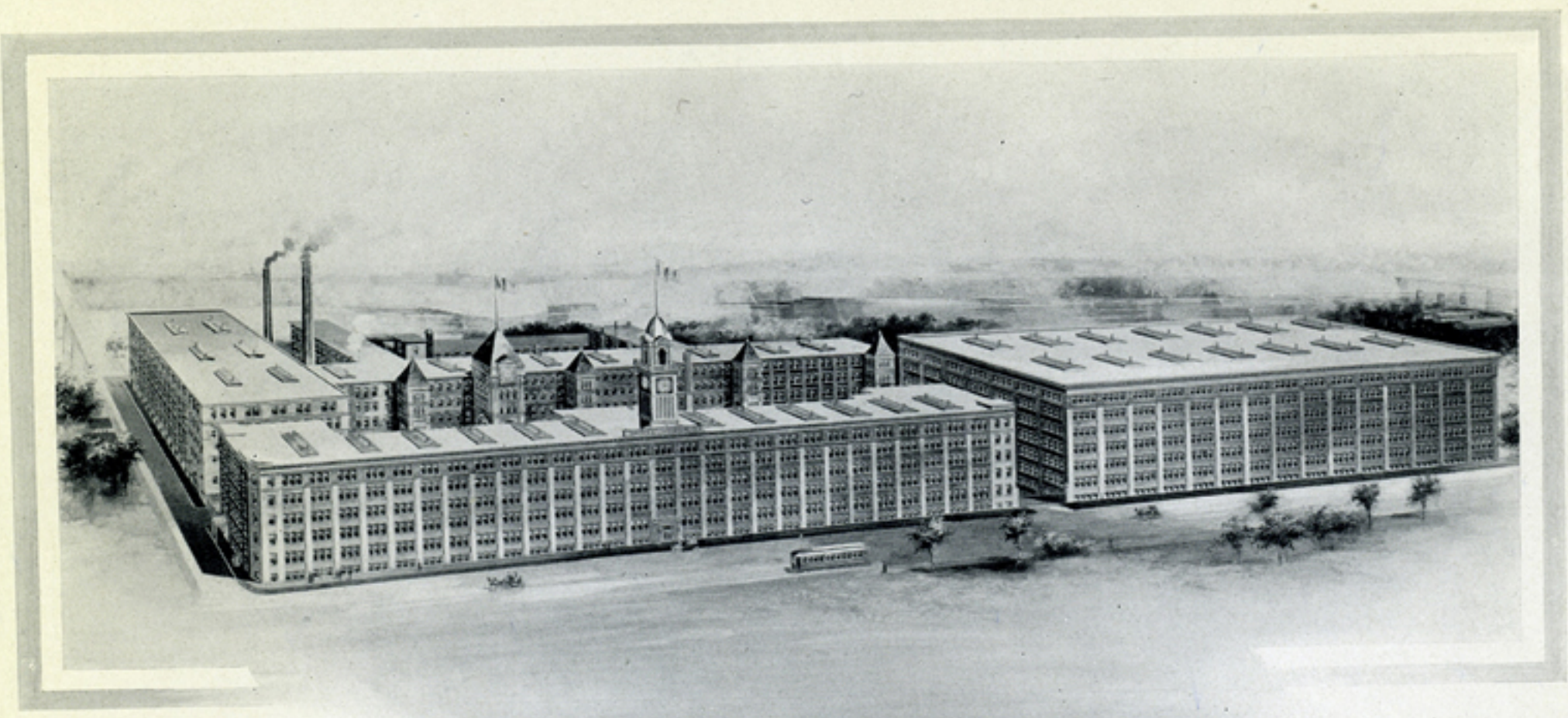
PHOTOGRAPHIC LENSES

BAUSCH & LOMB OPTICAL CO.

PHOTOGRAPHIC LENSES



Works of the

Bausch & Lomb Optical Co.

Rochester, N. Y.

PHOTOGRAPHIC LENSES

BAUSCH & LOMB OPTICAL CO.

NEW YORK
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ROCHESTER, N.Y. U.S.A.

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Foreword

AN important change, occurring since the issuance of our last complete Photographic Catalog, has resulted in a closer union with the Carl Zeiss Optical Works, of Jena.

Beginning in 1892 as licensees for the manufacture of their photographic lenses, that relationship has culminated in an alliance entered into January 1, 1908, as a result of which they became members of our corporate organization. This step was the practical expression of a desire to concentrate the knowledge, skill, experience and energy of the two leading optical firms of the new and old worlds, and our aim is to produce the best instruments which physicists can devise and skilled workmen can fabricate. We have adopted as our trade-mark the following emblem, which symbolizes the "Triple Alliance in Optics." The third factor in the "Triple Alliance" is George N. Saegmuller. At the time of this union the Bausch, Lomb, Saegmuller Co., which had been organized in 1905, to manufacture Astronomical and Engineering Instruments ceased its independent corporate existence and became a part of the Bausch & Lomb Optical Co. To those interested in learning more about this alliance, we shall be pleased to send a booklet issued shortly after its consummation. As a result of this closer union, all improvements and inventions made by Zeiss or us, are immediately available to the other, and the interchange of ideas and methods is as free as possible. After a career of more than half a century, during which time our products have gained an undisputed reputation for excellence and achieved a consequent world-wide distribution, we look forward to even greater accomplishment.

Last year we made our one millionth high-grade photographic lens. We shall continue to lead in quality as in quantity.

HE LOVES ME—LOVES ME NOT
Made with Tessar Ic by A. R. Stone, Rochester, N. Y. Full Opening, 1-25 Second

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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.

New Apparatus. There are listed for the first time in our complete Photographic Catalog the Compound Shutter, both single and stereo, also our new Telephoto Attachment and improved Ray Filters. These will be found illustrated, priced and fully described on pages 49, 44 and 46.

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 16.

In accordance with our established custom to reduce to as few as possible the different kinds of lenses listed, we have dropped from this catalog the Plastigmat and the Extra Rapid Universal lenses. We are enabled to do this because of the popularity of the Tessar lenses which are being selected for use wherever practicable. As to the Extra Rapid Universal, lenses of this type are being rapidly supplanted by the Anastigmat.

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.

Price for matching two lenses for stereoscopic work, $3.00.

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. In addition to the goods listed in this catalog, we make the Apochromat Tessar, which is specially made for the photo-engravers, and prisms and precision ray filters. These are described and priced in our Catalog K, Photo-Engravers' Optical Accessories, which we shall be glad to send to interested parties on request. We hope that with the information we have endeavored to include in this catalog, the purchaser may be able to make an intelligent selection. We shall be glad, however, to supplement this in every possible way, and solicit further inquiries if any suggest themselves.

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.

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Australia, Sydney, N. S. W.,	Donald Ross & Co., Ltd., Angel Place, off 127 Pitt St.

"HEREFORD CATTLE"
Made with Protar VIIa by H. Wm. Menke, Chicago, Illinois

Lenses—An Historical Sketch

SOON after the invention of photography, Joseph Petzval, of Vienna, constructed the Portrait Lens which bears his name, and which, although often masked by other names, enjoys even at the present time a great and well deserved popularity. It was the result of long and deep mathematical investigations and served its purpose in such an excellent manner, that we may safely say Petzval's result, as well as his method of obtaining it, were far in advance of his time. As befitted the purpose for which the lens was planned, it had immense speed, but a rather limited field.

Numerous unsuccessful efforts were made by practical opticians to produce a lens of greater universality, but their practical skill was not well enough supported by theoretical knowledge, and in consequence the constructions made during the next twenty years were but short-lived.

After this long period barren of results, the year 1866 marked a distinct step forward. There was produced a lens which was constructed in the "German way," namely based on exact mathematical calculations. This lens was Steinheil's Aplanat. It was the first universal lens worthy to survive, for the reason that it combined spherical correction for a comparatively large aperture with freedom from distortion over a large field. This type of lens under the name Rectilinear, has dominated the market for years, and holds its place even today in cheaper outfits.

It has one serious draw-back, namely—that the lens could not be corrected for astigmatism and curvature of field at the same time. It was either very free from astigmatism, but had a curved field, or showed a flat field, the marginal parts of which were blurred by the uncorrected astigmatism.

It was impossible to overcome this disadvantage with the theoretical knowledge of that time and with the limited variety of glasses then at command. Excepting for smaller improvements, lens construction was again at a standstill for years.

Meanwhile, two men whose names will forever be remembered in connection with modern optics, joined forces: Professor Abbe and Dr. Schott in Jena. In 1881, Schott, inspired by Abbe, began experiments for the purpose of producing glass types of new optical qualities. The experiments were successful, and in 1884 a glass

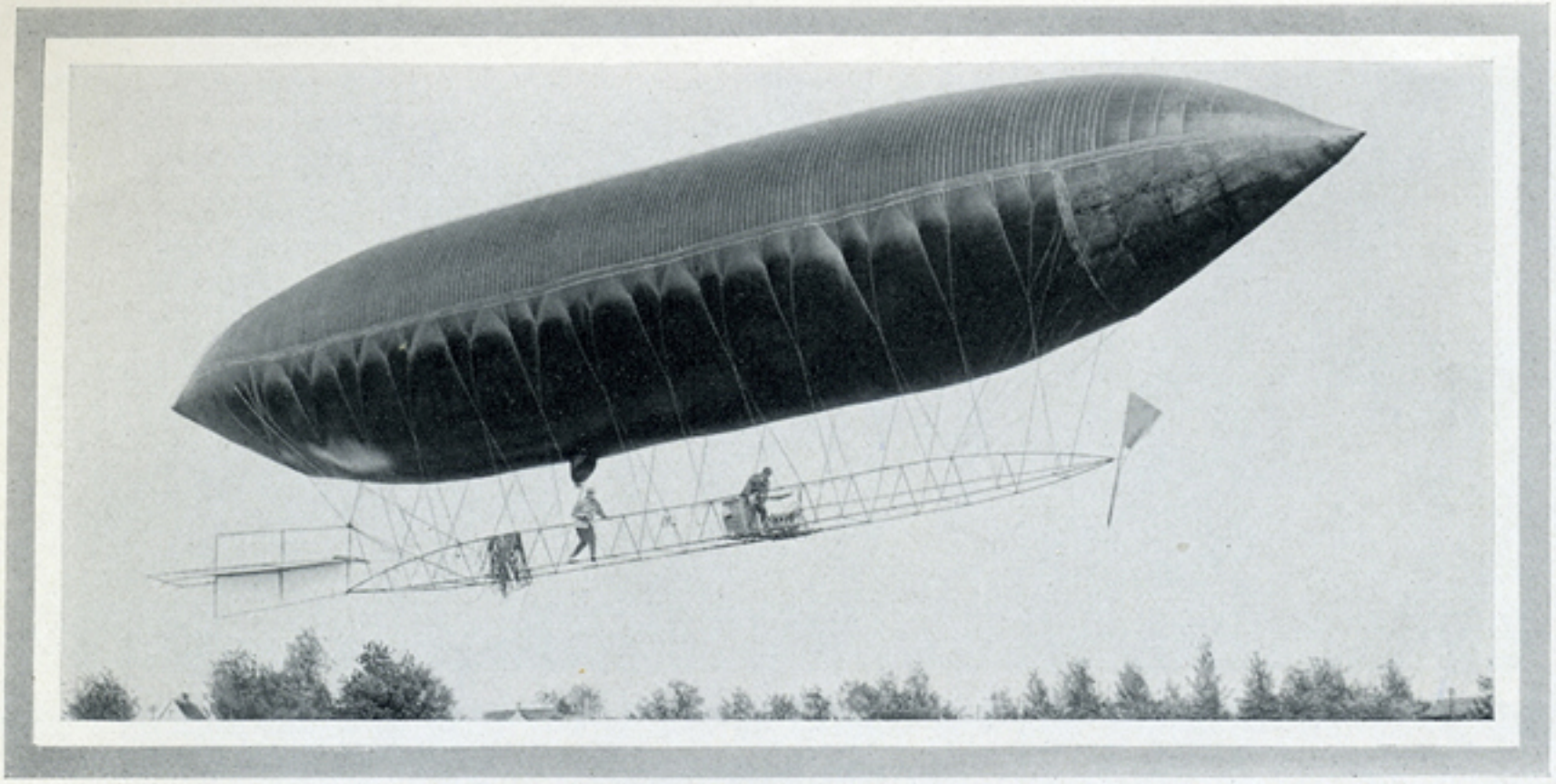
"THE PASTURE"
Made with Tessar Ic by A. R. Stone, Rochester, New York

plant was started to produce these glasses regularly. In the ordinary glass made up to that time, the optical qualities changed about proportionately to the specific gravity. The heavier the glass, the higher the refractive power and the greater the dispersive power. Abbe's aim was to produce glasses, which, although they had refractive indices as high as heavy flint glasses, show no more dispersion than ordinary crown glass, and also glasses which combine the refractive power of crown glass with the dispersion of flint glass. A variety of glasses of such character have been put on the market since 1886.

Dr. P. Rudolph, of the Zeiss Works, was the first one to make full use of the possibilities offered by these new glasses for the construction of photographic lenses, and the result of his efforts was the first Zeiss Anastigmat made in 1890. The term Anastigmat means a lens which has astigmatic correction over a large flat field, and at the same time spherical correction for a large opening, with the effect that a large plate can be well covered with a short exposure. The first lens of the new type was a universal lens having a moderate speed and angle of view. Lenses of higher speed followed and also wide angle lenses. In 1895 the Convertible Series VIIa was completed which, in its wide range of usefulness, has thus far not been surpassed.

The superiority of Anastigmats over Rectilinear Lenses was immediately recognized and the number of the new Lenses made ran up into the thousands. The following years saw several new constructions from the Zeiss Works, and a multitude of them from other manufacturers who endeavored to keep pace with the famous establishment. Most of these aimed at greater speed without sacrifice of field of view, but all of them were surpassed by the lenses of the Tessar type, invented by Dr. P. Rudolph in 1903, which type is unequalled in its perfection by any known construction. To show the immense progress made during the last 50 years, it may be of interest to compare the lens with which we began this short review with 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, and their brilliant images indicate perfect spherical corrections. But, while a Petzval lens of a focal length 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 has only been made possible by the use of the new glasses from Jena.



"KNABENSCHUE'S DIRIGIBLE"
Made with Protar VIIa by E. H. Turner, Toledo, Ohio

Glossary

THE technical terms used in photography are often a stumbling block to the amateur who, without much knowledge of the science of optics, would like to read understandingly about his favorite art.

We have, therefore, compiled this glossary and have tried to explain, with as few technical details as possible, the meaning of the most common phrases. We refer those wishing more specific information to the various numbers of Photo Miniature, which cover, most acceptably, many different fields of photography.

A manual called "Practical Suggestions Regarding the Selection and Use of a Photographic Equipment," by Austin K. Hanks, who has had every opportunity to try out his theories and reduce them to a working basis, is thorough and convincing, and the person in search of information will find it therein in usable form.

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

"CROWN POINT, IND., AUTO RACE"
Made with Tessar Ic by A. Varges, Chicago, Illinois

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 53 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.

Made with Protar VIIa by L. F. Brehmer, Rutland, Vt.

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=160x1:8=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. 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.

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.

Made by Belle Johnson, Monroe City, Missouri

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 an object somewhat forward or back of 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.

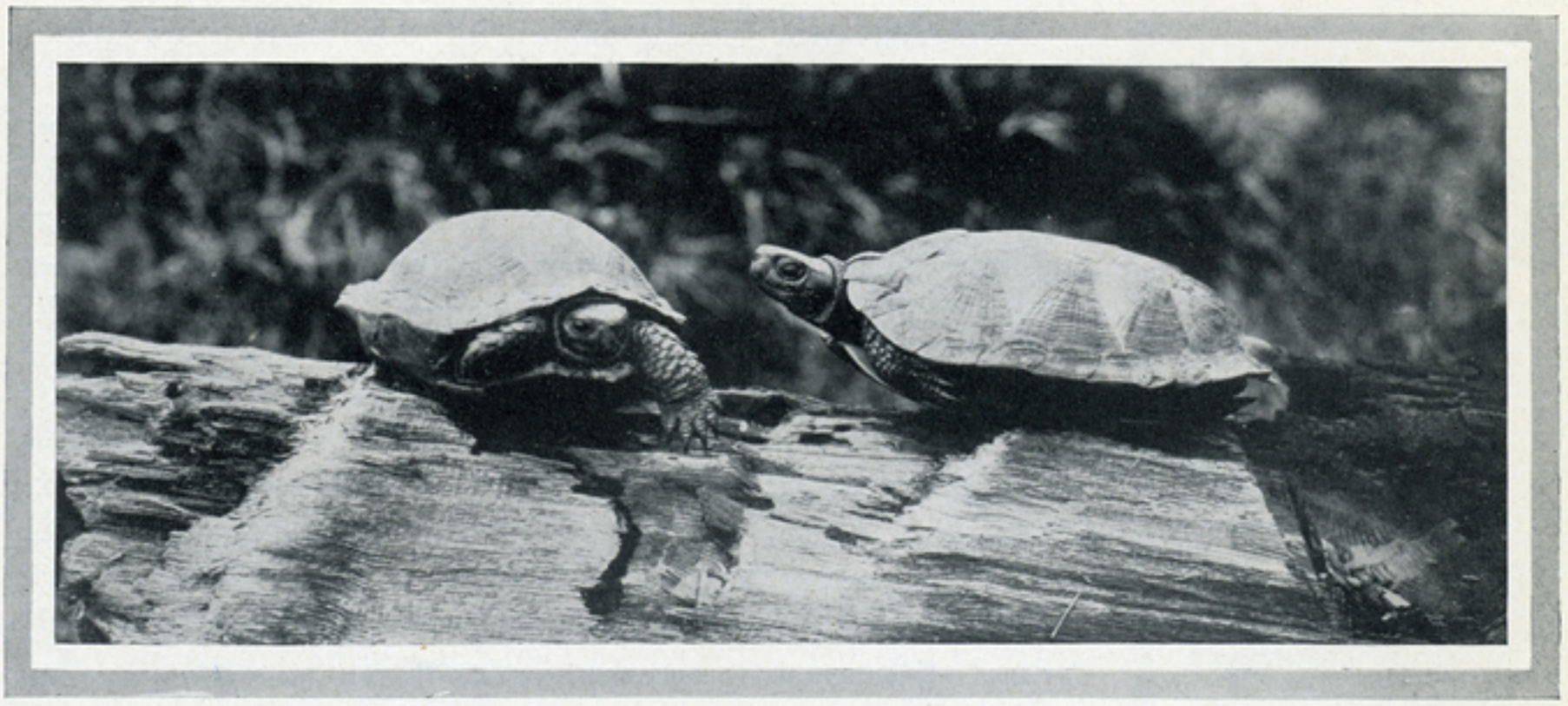
Of two lenses of the same equivalent focus, the one with the lower relative aperture (speed) has the greater depth of field. On the other hand: if the focal length of the lens is very short, a speed as high as F:4.5 will allow bringing every object from 10 feet to infinity to a sharp focus, while a studio lens of long focus and the same speed may not even image an object of the depth of a head sharply

"THE REFLECTION"
Made with Tessar Ic by A. R. Stone, Rochester, N. Y.

within the range of the length of a studio. Speed, great focal length and depth of focus cannot be combined in the same lens. **This is an unalterable law of optics.** If speed be the most desirable quality, depth of focus must be sacrificed; if depth of focus, speed. This does not detract from the value of fast lenses, because with a given lens the depth of focus can be increased by diaphragming down the lens which means reduction of speed. If a short exposure demands the use of the lens wide open, one must not expect great depth of focus. Under ordinary conditions of light and distance, with fair judgment, and with lenses not too long in focus, these opposing qualities may be happily combined, so that lack of depth is hardly perceptible.

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

Another case may be mentioned in which one lens may **really** have an advantage over another one, in regard to depth of focus. In some constructions, correction of astigmatism is obtained at a great sacrifice of simplicity by employing an unusual number of lenses separated by air spaces. There is a certain loss of light by reflection on a lens surface and it is easily intelligible that the fewer reflecting surfaces in a lens, the smaller the loss of light. In some constructions the number of the lens surfaces runs up as high as ten, while the Tessar contains only six. The consequence is that the lens with the greater number of reflecting surfaces requires a longer exposure than a lens of simple construction, although both may have the same relative aperture.



Made with a Protar VIIa, by L. F. Brehmer, Rutland, Vt.

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

Coma. The spherical aberration of pencils of light going through the 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.

Made with Tessar Ic
By H. Wm. Menke, Chicago

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 field.

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

Definition is that quality which enables a lens to produce sharp and crisp images and its presence in an objective is a proof of exact workmanship as well as careful computation. The best workmanship will be wasted on 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 Tessar Ic
By H. Wm. Menke, Chicago

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.

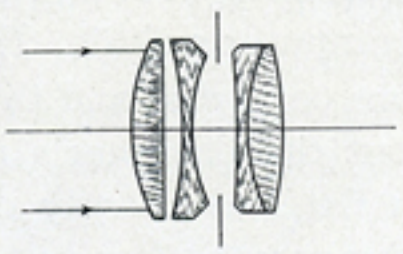
The greater the relative aperture and the greater the covering power, the more valuable the lens.

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



Actual Size

Bausch & Lomb-Zeiss TESSAR

Series Ic. F:4.5

A lens of universal application. Unexcelled for ultra rapid work, portraits, groups, landscapes, etc.

As a lens of remarkably wide range of application, the Tessar Ic is unequalled among unsymmetrical types of lenses. It is pre-eminently a lens for speed photography, and possesses the qualities which make it unsurpassed for home portraits, groups and landscapes, for enlarging, in short, for general photography, indoors and out, for both the professional and the amateur.

The leading characteristic of this lens is great speed, combined with high optical corrections. The available image circle embraces an angle of 55° at F:4.5 and of 64° at F:32. Its speed of F:4.5 is attained in all the sizes of the series, the largest as well as the smallest, and has not been obtained at the sacrifice of any optical qualities. On the contrary, the corrections of Tessar Ic are not equalled by any other lens, save by the Tessar IIb alone. It has perfect flatness of field and superior sharpness of definition and brilliancy, which extend evenly over the entire field. Negatives made with this lens are susceptible of great enlargement. It is absolutely free from distortion, a quality possible only to unsymmetrical lenses. Its color corrections of high order adapt this lens for color photography on autochrome plates from nature.

The advantage of speed in a lens need not be argued. It is always a desirable and ofttimes an indispensable quality, especially to the press photographer and home portraitists. Tessar Ic is recommended for all cameras to which it can be fitted, for it has the great advantage of being four times as fast as the ordinary camera lens and twice as fast as the Tessar IIb, and yet when stopped down to F:6.3 possesses the same definition and depth of focus on the various size plates for which it is rated. Unusually good results are obtainable with this lens under poor light conditions because of its speed and definition.

Tessar Ic is being successfully used in studios for portraiture and group work, for which its speed and excellent corrections render it valuable. We recommend it in the three larger sizes as being especially adapted for this purpose.

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 DEN"

Made with Tessar Ic by Wm. I. Starr, Bridgeport, Ct.
F:8 1-800 Second

PRICE LIST

Code Word	No.	Size of Plate Covered with Stop F:4.5* Inches	Equivalent Focus Inches	Diameter of Lens Inches	Lens and Barrel with Iris Diaphragm Price	Fitted with Aluminum Volute Shutter Price	Fitted with Aluminum Compound Shutter Price
Hack	† 1	¾ x 1	2	$\frac{9}{16}$	$ 28.80		
Hade	† 1a	1¼ x 1¼	3	$\frac{27}{32}$	36.00		
Haema	13	2½ x 3½	4½	1	36.00	$53.00	$50.50
Hafter	14	3¼ x 4¼	5	$1\frac{3}{16}$	40.50	57.50	56.75
Hagdon	15	4 x 5	6	$1\frac{5}{16}$	47.00	65.50	63.25
Haggle	15a	5 x 7	$7\frac{1}{16}$	$1\frac{9}{16}$	57.50	76.00	77.50
Hail	16	5 x 8	8¼	1⅞	72.00	92.00	92.00
Hairen	17	6½ x 8½	9⅞	2¼	115.50	135.50	137.50
Hakim	18	8 x 10	11⅞	2⅝	162.00		
Halberd	18a	10 x 12	14⅝	$3\frac{5}{16}$	210.00		
Halfer	19	11 x 14	15¾	$3\frac{9}{16}$	252.00		
Halicore	20	14 x 17	19¾	$4\frac{7}{16}$	360.00		

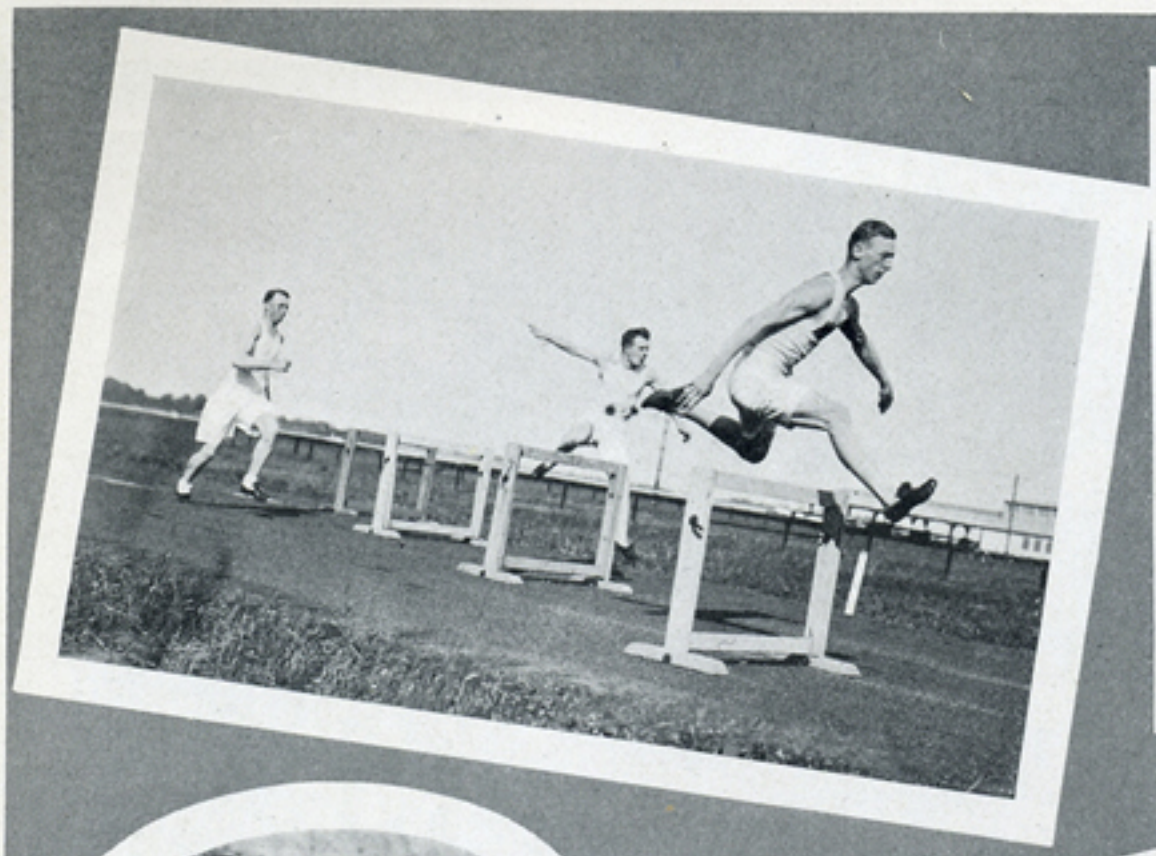
*Larger Plates are covered with smaller stops.

†For use on Moving Picture Cameras. Speed F:3.5.

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.

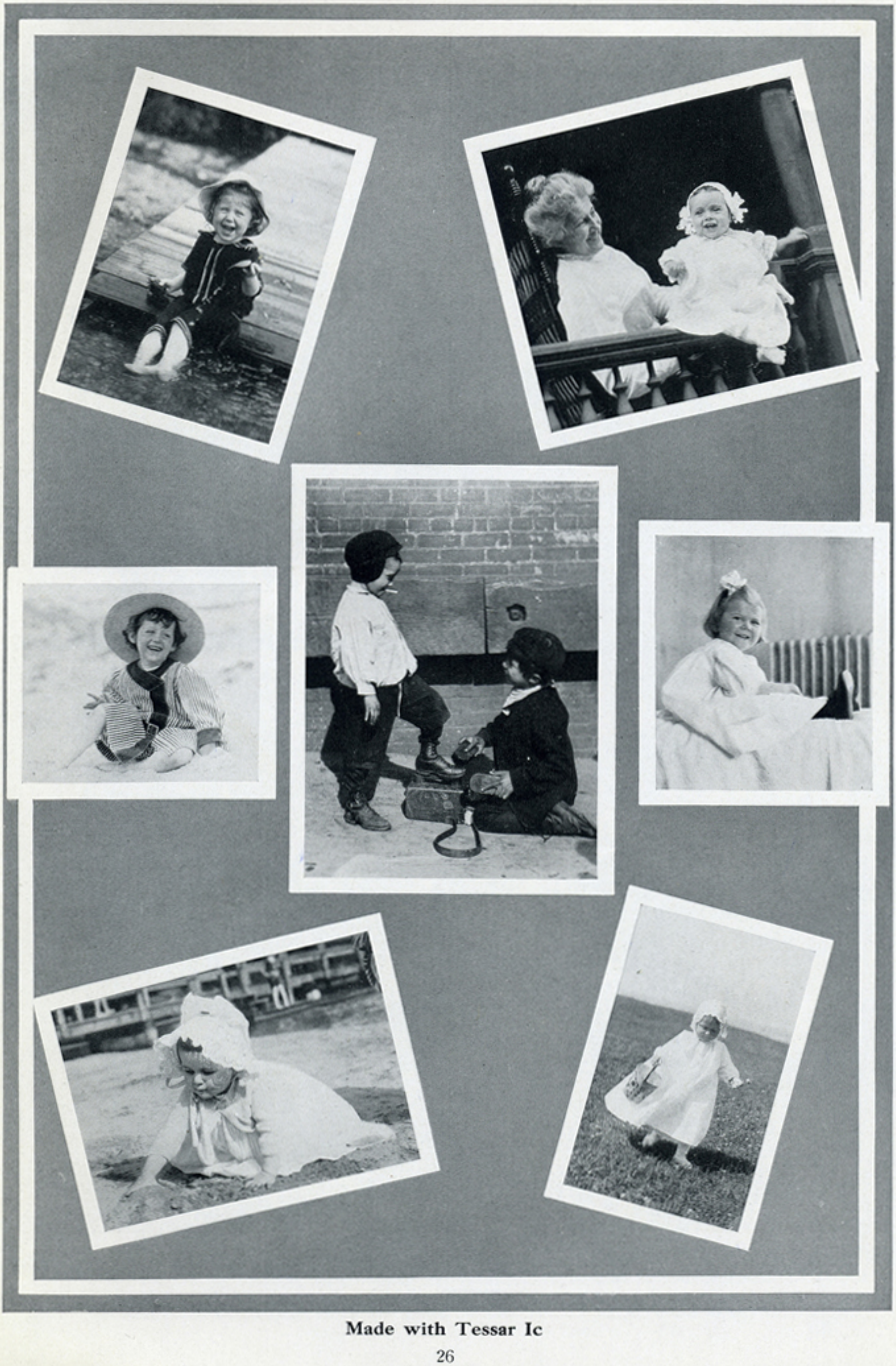
When ordering lenses to be fitted with shutter, by telegraph, specify *Volute* or *Compound* in addition to the code word for the size of lens.



Made with Tessar Ic and Graflex Camera

"CAVALRY CHARGE"
Made with Tessar Ic and Graflex Camera, full opening, 1/700 second, by R. A. Knowles, Ft. Oglethorpe, Ga.

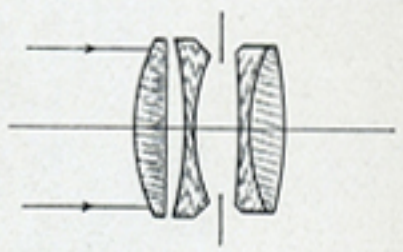
"BENDING RACE"
Made with Tessar Ic and Graflex Camera, Stop F:11, 1/300 second, by R. A. Knowles, Ft. Oglethorpe, Ga.



Made with Tessar Ic

"WRIGHT'S AEROPLANE"
Made with Tessar Ic, by C. H. Claudy, Washington, D. C.

"THE COUNTY FAIR"
Made with Tessar Ic and Graflex Camera



Three-Fourths Actual Size

Bausch & Lomb-Zeiss TESSAR

Series IIb. F:6.3

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

TESSAR IIb is light and compact and is particularly adapted for use on hand-cameras of fixed extension for all ordinary exposures, its speed (it is twice as fast as the ordinary camera lens) being equal to all requirements but those of ultra rapid work.

It possesses unusually brilliant illumination, together with remarkable definition and these qualities adapt this lens for industrial and reproductive photography where such characteristics are pre-eminently desirable. It is used with success for half-tone work and line engravings, and its excellent color corrections enable its use for three-color photography from nature. Here we would call attention to our Apochromat Tessar Series VIII, which was specially computed for three-color reproductions, and than which for Photo-Engravers' use there is none better.

The striking characteristic of Tessar IIb is the precision and sharpness of the image on the plate from center to margin, and hence it is especially recommended for use when the negatives are to be subsequently enlarged. It covers a field of 60° at F:6.3 on 6½ x 8½ plates, and 66° at F:32 on 8 x 10 plates.

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 cannot be utilized. Moreover, the simpler construction and hence, lower price of the Tessar, make it preferable wherever the universal applicability of the VIIa is not required.

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-the-lens shutters to be fitted to the lens.

"AMONG THE NAVAJO INDIANS"
Made with Tessar IIb by Frederick I. Monsen

PRICE LIST

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

*Larger Plates covered with smaller stops.

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

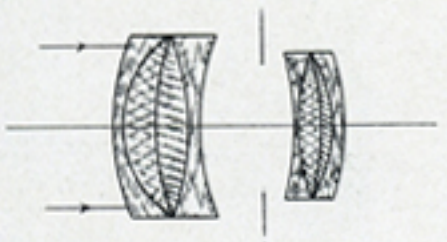
Each lens is furnished in a case which protects it from injury. Lens cap is included.

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

"HUDSON-FULTON CELEBRATION"
Made with Tessars Ic and IIb, by A. K. Hanks

"MT. VERNON"
Made with Tessar IIb, F:16, 2/5 second, by A. K. Hanks

"THE CAMERIST"
Made with Tessar IIb, by A. K. Hanks



Actual Size

Bausch & Lomb-Zeiss PROTAR

Series VIIa F:6.3

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

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

While not absolutely rectilinear, for no lens with the diaphragm in front can be, the results obtained from their use are entirely satisfactory. They 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. They give excellent results where a long focus lens is required for perspective, and where the plate used is small for the covering power of the lens. Landscapes, for example, may be taken with the single Anastigmat from a considerable distance, 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 far greater.

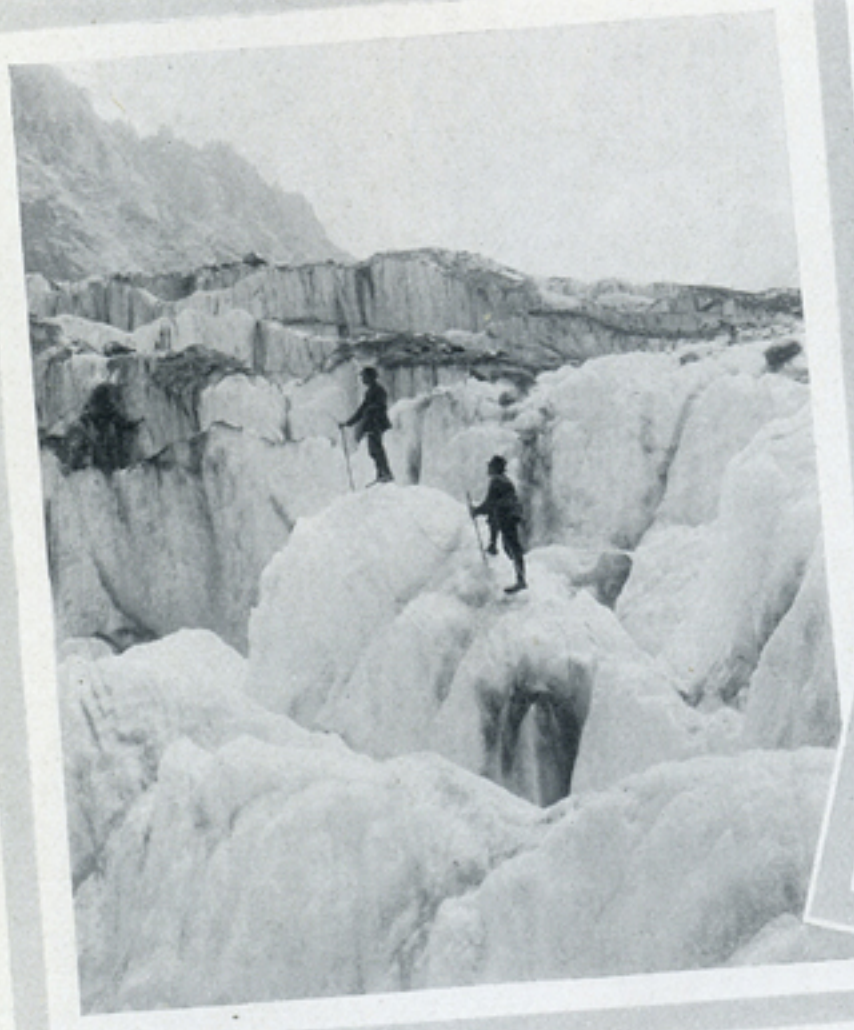
Inasmuch as the component lenses can be used singly or together, it is evident that we have in the VIIa a **convertible lens,** which, as will be shown, is universal in application.

If in forming our Series VIIa doubtlet 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

"PHILADELPHIA BLIND INSTITUTE"
Made with Protar VIIa by J. B. Rich. F:16, ½ Second.

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°.



"GLACIER DU GÉART"

"THE MATTERHORN"
From Riffelalp

Made with a Protar VIIa by H. G. Ponting.

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 doubtlet 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 $11\frac{3}{16}$ inches and $13\frac{3}{4}$ inches focus respectively, listed to cover $6\frac{1}{2}$ x $8\frac{1}{2}$ and 8 x 10 plates with an opening of F:12.5, which is sufficient for instantaneous work under normal light conditions. We have, in other words, three Anastigmat lenses in one—two single Anastigmats and a doublet. Now let us add to this equipment a No. 2 Series VII which covers a 5 x 7 plate and has a focal length of $8\frac{3}{4}$ inches. The addition of this lens forms the C set of Convertible Protars listed on page 39. We have now three single lenses which we may combine as follows: our original doublet of 7 inches focus; we can form a doublet with our $13\frac{3}{4}$ inches and $8\frac{3}{4}$ inches with a resulting focal length of $6\frac{1}{8}$ inches covering a $4\frac{1}{4}$ x $6\frac{1}{2}$ plate and a speed of F:7.7; or we can form one of $8\frac{3}{4}$ inches and $11\frac{3}{16}$ inches having $5\frac{5}{8}$ inches focus, covering a $4\frac{1}{4}$ x $6\frac{1}{2}$ plate and having a speed of F:7. In other words, we have three single Anastigmats and three

"JENNIE DICKIE BROOK, DERRY, N. H."
Made with Protar VIIa by John Alden, Lawrence, Mass.

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.

Do 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 37.

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.

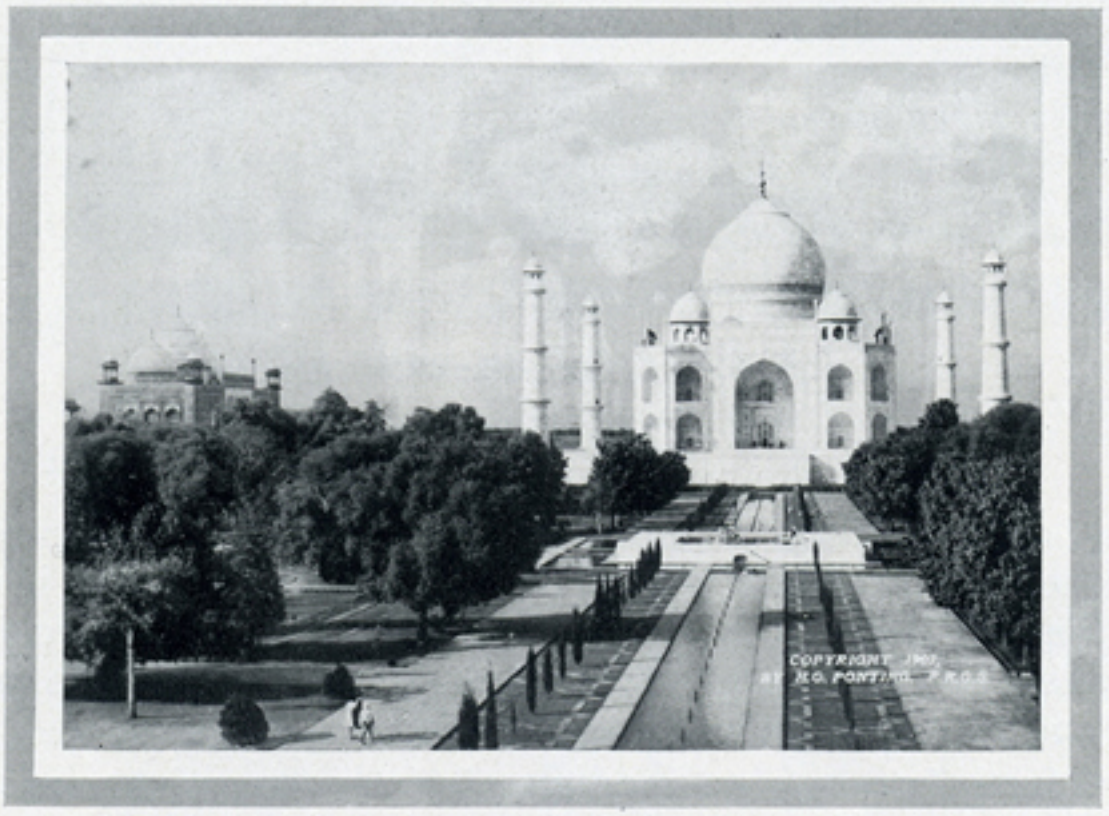
The fewest parts to lose or wear out.

When lenses of unequal foci are combined, the larger focus lens should be used in the front to obtain the largest possible aperture and hence, the greatest speed.

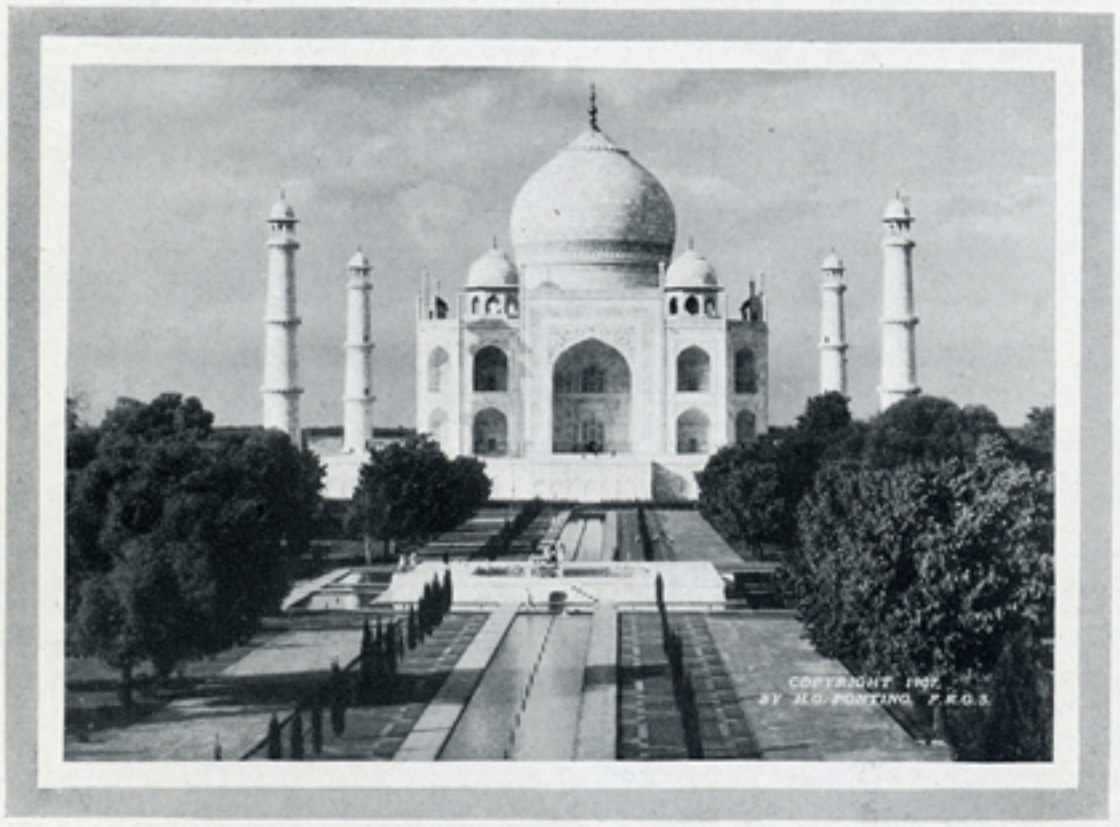
Construction. The Series VIIa is composed of two single Series VII lenses, each of which consists of four elements cemented together. The single Anastigmat is mounted in a separate adapter of standard size which fits into either end of the lens mount. *If used alone, the single lens is screwed in the rear of the lens mount and always has the diaphragm in front.*

THIS series of three negatives of the loveliest and most famous of all the world's buildings, the Taj Mahal at Agra, India, was made on 5x7 plates, with a No. 8 Convertible Protar, Series VIIa, 13¾-inch, 11 3/16-inch, 7-inch, one negative each with the separate combinations

Made with a No. 8 Convertible Protar, Series VIIa, 7-inch Open Lens



Made with Rear Combination of a No. 8 Convertible Protar, Series VIIa, 11 3/16-inch Open Lens



Made with Front Combination of a No. 8 Convertible Protar, Series VIIa, 13¾-inch Open Lens

and the two combined, at the *full opening* of the lens. They give an idea of how pictorial subjects can be got from a certain spot with the different combinations. The camera was not moved from the balcony from which the pictures were in turn taken.

Series VII

PRICE LIST

Code Word	No.	Size of Plate Covered with Stop F:12.5* Inches	Equivalent Focus Inches	Back Focus Inches	Diam. of Lens Inches	PRICE		
						Lens Only	Fitted with Aluminum Volute Shutter	Fitted with Alum. Compound Shutter
Hector	1	4¾ x 6½	7 3/16	8	¾	$ 27.00	$ 44.00	$ 41.50
Hederic	2	5 x 7	8¾	9¾	15/16	30.50	47.50	45.00
Hedonic	3	6½ x 8½	11 3/16	12 7/16	1 3/16	36.00	53.00	50.50
Heelless	4	8 x 10	13¾	15¼	1½	43.50	62.00	59.75
Hegge	5	10 x 12	16⅛	17¾	1¾	56.00	74.50	76.00
Heiress	6	11 x 14	18⅞	20⅝	2	77.50	97.50	97.50
Helena	7	12 x 16	23⅛	25¾	2⅛	99.00	119.00	121.00
Helican	8	13 x 16	27	30	2½	129.50	149.50	
Heliotype	9	16 x 18	30¾	34	2¾	180.00		
Helix	10	16 x 20	33⅞	37½	3¼	234.00		
Helmet	11	18 x 22	39¼	43½	3¾	306.00		

Series VIIa

Code Word	No.	Size of Plate Covered with Full Aperture* Inches	Combinations of Single Protars Focus Inches		Combined Equival't Focus Inches	Speed	PRICE		
			Front Lens	Back Lens			Lens Only	Fitted with Aluminum Volute Shutter	Fitted with Aluminum Compound Shutter
Hem	1	3¼ x 3¼	7 3/16	7 3/16	4⅛	F:6.3	$ 48.50	$ 65.50	$ 63.00
Hematin	2	3¼ x 4¼	8¾	7 3/16	4½	F:7	52.50	69.50	67.00
Hematite	3	4 x 5	11 3/16	7 3/16	5	F:7.7	57.50	74.50	72.00
Hemin	4	4 x 5	8¾	8¾	5 1/16	F:6.3	56.00	73.00	70.50
Hemipter	5	4¼ x 6½	11 3/16	8¾	5⅝	F:7	61.50	78.50	76.00
Hemisect	6	4¼ x 6½	13¾	8¾	6⅛	F:7.7	68.50	87.00	84.75
Hemitone	7	4½ x 7¼	11 3/16	11 3/16	6⅜	F:6.3	66.50	83.50	82.75
Hemlock	8†	5 x 7	13¾	11 3/16	7	F:7	73.50	92.00	89.75
Hempen	9	5 x 8	16⅛	11 3/16	7½	F:7.7	86.00	104.50	106.00
Henbane	10	5 x 8	13¾	13¾	7⅞	F:6.3	80.50	99.00	96.75
Henotic	11	6½ x 8½	16⅛	13¾	8½	F:7	93.00	111.50	113.00
Hepar	12	6½ x 8½	18⅞	13¾	9⅛	F:7.7	114.50	134.50	134.50
Hepatica	13	6½ x 8½	16⅛	16⅛	9¼	F:6.3	105.00	123.50	125.00
Heptad	14	7 x 9	18⅞	16⅛	10	F:7	127.00	147.00	147.00
Heptane	15	7 x 9	23⅛	16⅛	10⅞	F:7.7	148.50	168.50	170.50
Heptoic	16	7 x 9	18⅞	18⅞	10 3/16	F:6.3	147.50	167.50	167.50
Heraldic	17	8 x 10	23⅛	18⅞	11⅞	F:7	169.00	189.00	191.00
Herand	18	8 x 10	27	18⅞	12¾	F:7.7	199.50	219.50	221.50
Herbage	19	8 x 10	23⅛	23⅛	13¼	F:6.3	186.00	206.00	208.00
Herbar	20	10 x 12	27	23⅛	14 5/16	F:7	217.00	237.00	
Herd	22	10 x 12	27	27	15½	F:6.3	243.00	263.00	
Herdic	25	10 x 12	30¾	30¾	18¼	F:6.3	340.50		
Hereon	28	11 x 14	33⅞	33⅞	20¼	F:6.3	444.50		
Heresy	30	12 x 16	39¼	39¼	23⅜	F:6.3	585.00		

*Larger Plates covered with smaller stops.

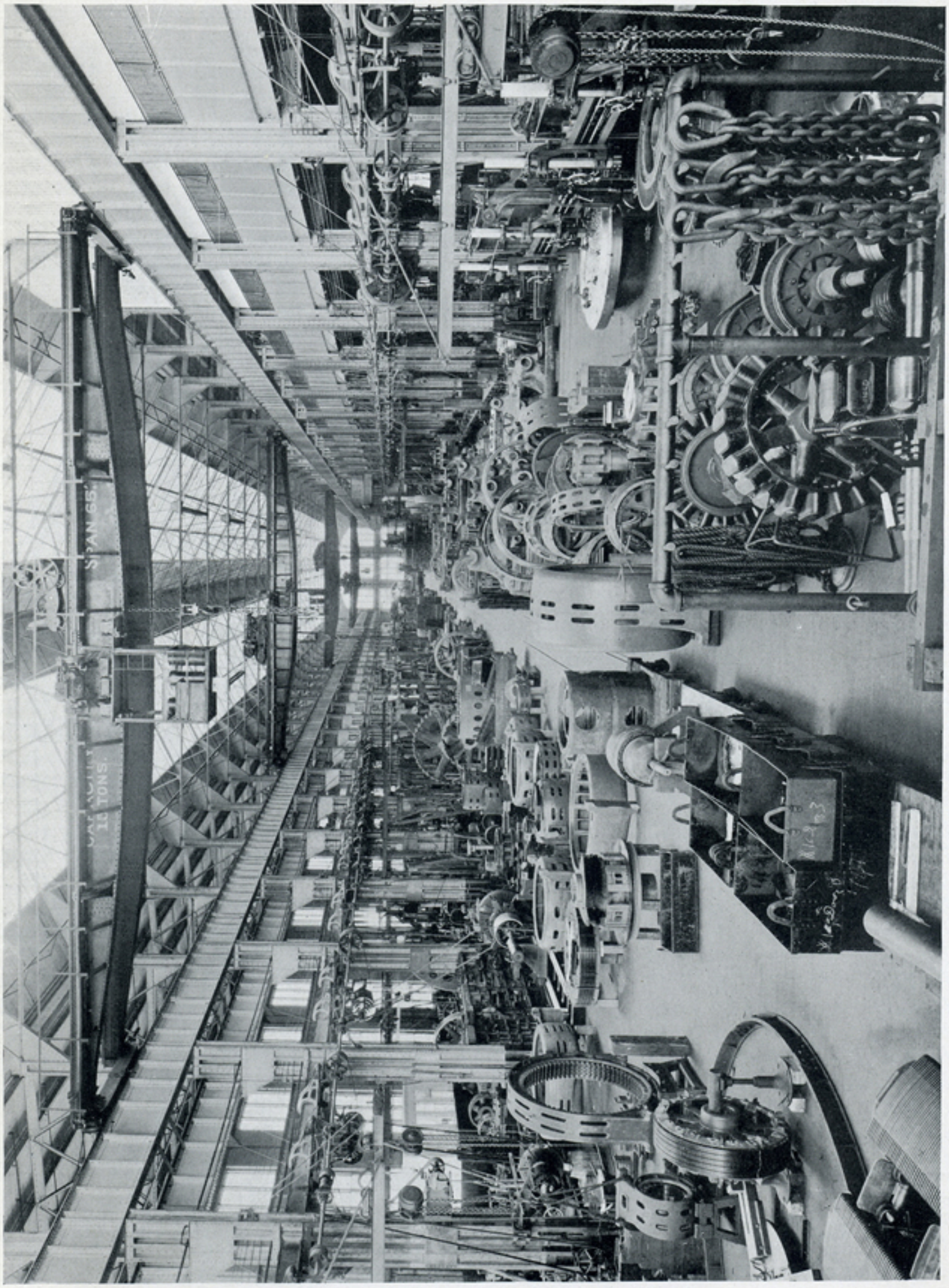
†No. 2 Volute is here regularly supplied. If it is desired to use the lens on a hand camera and No. 2 Volute is not wanted, we can adapt the Volute No. 1 by reducing the diameter of the lens. This in no way affects the speed of the combination. In ordering, kindly specify whether No. 1 or No. 2 Volute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

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 is included.

The diaphragm scale is graduated for each focal length.



"GENERAL ELECTRIC CO., SCHENECTADY, N. Y."
Made with Protar VIIa.

Bausch & Lomb-Zeiss Convertible Protars

In Sets

WE have listed a large number of doublet combinations, and as has been shown in the description of Series VIIa lenses, any one of them can be added to, thus increasing proportionately the usefulness of the lens. We offer, however, two sets complete with the lenses mounted interchangeably, each set consisting of: one lens mount with iris diaphragm, cap and flange, 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.

C Set—Bausch & Lomb-Zeiss Convertible Protars

Complete in case, $101.00. Code word, *Hermes*.

Fitted with aluminum Volute Shutter, $119.50; fitted with aluminum Compound Shutter, $117.25.

The six lenses which may be formed with the C-set of Protars, together with their covering power and speed, are shown in the accompanying table.

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:7.0

*Larger Plates covered with smaller stops.

D Set—Bausch & Lomb-Zeiss Convertible Protars

Complete in case, $197.50. Code word, *Heriot*.

Fitted with aluminum Volute Shutter, $217.50; fitted with aluminum Compound Shutter, $217.50.

The lenses of this set are the numbers 3, 4, 5 and 6 of Series VII.

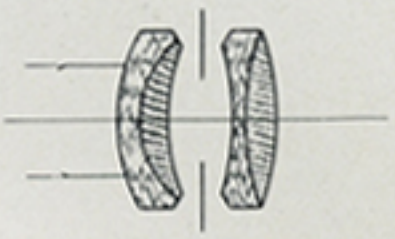
The following table shows the ten lenses which may be formed with this set, together with their covering power and speed.

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.

Made with Medium Wide Angle, by H. Fuerman, Chicago, Ill.

Actual Size



Bausch & Lomb-Zeiss Medium Wide Angle

Series IV. F:12.5

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

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

The first six numbers cover an angular field of about 80°; the others, of 70°.

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.

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

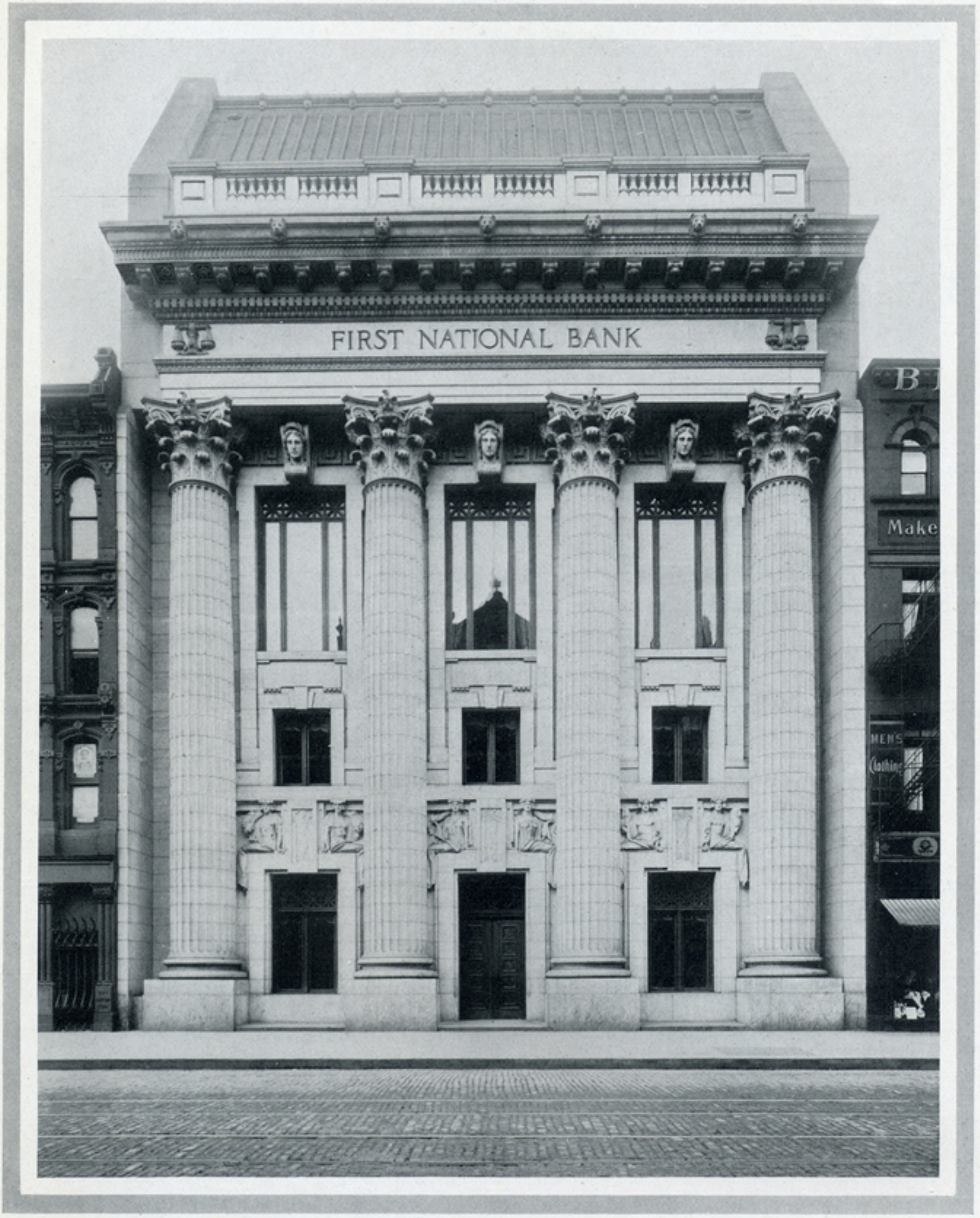
PRICE LIST

Code Word	No.	Size of Plate Covered with Stop F:12.5* Inches	Equivalent Focus Inches	Diameter of Largest Lens Inches	Lens Only	Fitted with Aluminum Volute Shutter
Harden	1	3¼ x 4¼	2 7/16	¼	$ 17.50	
Hardock	2	4 x 5	3⅜	⅜	17.50	$ 34.50
Harem	3	4¼ x 6½	4 11/16	½	21.00	38.00
Hark	4	5 x 8	6 1/16	⅝	24.50	41.50
Harmel	5	8 x 10	7 11/16	13/16	31.50	48.50
Harmonic	6	10 x 12	10¼	1	47.00	64.00
Harness	7	12 x 15	15 3/16	1 5/16	71.50	90.00
Harpoon	8	16 x 20	23 3/16	2	125.50	145.50
Harrow	9	20 x 24	35 11/16	2 5/16	282.50	
Hart	10	24 x 30	48⅜	3⅞	631.00	

*Larger Plates covered with smaller stops.

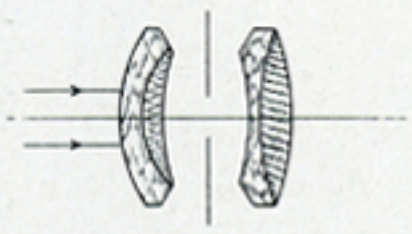
When ordering lenses fitted with shutter, by telegraph, specify *Volute* or *Compound* in addition to the code word for the size of lens.

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



"FIRST NATIONAL BANK, CLEVELAND, OHIO"
Made with Extreme Wide Angle Lens, by L'Clifford Norton

Actual Size



Bausch & Lomb-Zeiss Extreme Wide Angle

Series V. F:18

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

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.

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 than as listed. A 6½ x 8½ lens will give a 90° angle on a 6½ x 8½ plate, but on an 8 x 10 plate an angle of 110°, and will cover the plate clear to the edge.

The speed F:18 is sufficient for outdoor instantaneous photography under favorable conditions of light.

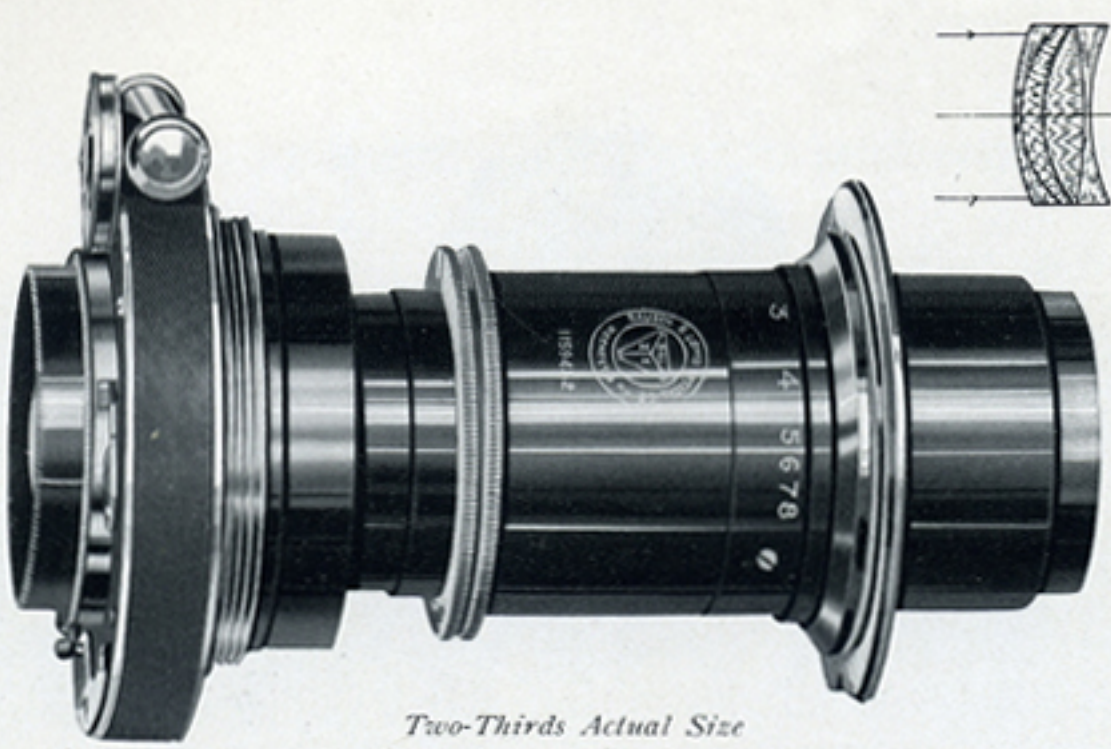
Construction. An unsymmetrical lens and hence can only be used as a doublet.

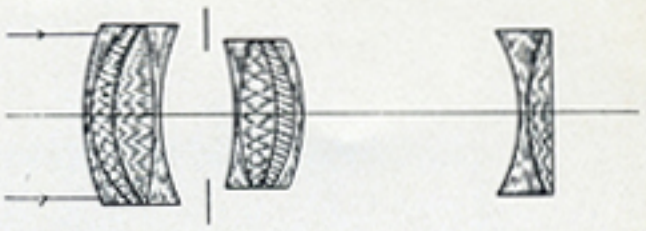
PRICE LIST

Code Word	No.	Size of Plate Covered with Stop F:18* Inches	Equivalent Focus Inches	Diameter of Largest Lens Inches	Lens Only	Fitted with Aluminum Volute Shutter
Hauteur	1	4¼ x 6½	3⅜	5/16	$ 23.00	$ 40.00
Havildar	2	5 x 7	4 7/16	⅜	23.00	40.00
Hawk	3	6½ x 8½	5 9/16	½	29.00	46.00
Haybote	4	8 x 10	7 3/16	9/16	36.00	53.00
Haytian	5	10 x 12	8⅜	11/16	45.00	62.00
Hazle	6	11 x 14	10½	13/16	56.00	73.00
Health	7	12 x 15	12⅜	15/16	66.50	83.50
Heard	7a	16 x 18	15⅜	1	88.50	105.50
Heathen	8	12 x 15	18⅛	1	88.50	105.50
Heave	9	16 x 18	24⅞	1⅜	129.50	148.00
Heben	10	20 x 25	37 5/16	2⅛	255.50	275.50

*Larger Plates covered with smaller stops.

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.





Two-Thirds Actual Size

Telephoto Attachment

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.

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 magnifications 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 inner tube at the end opposite the Telephoto.

We list Telephotos suitable for use with lenses of from 6 to 12 inches equivalent focus.

PRICE LIST

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.

San Antonio Peake (Old Baldy)

Made with a Tessar IIb, 12-inch focus, from exactly the same point, one of the windows in the Laboratory on Mt. Wilson, Pasadena, Cal. The large one made with Telephoto Attachment, and about two years after the first one.—*By Ferdinand Ellerman.*

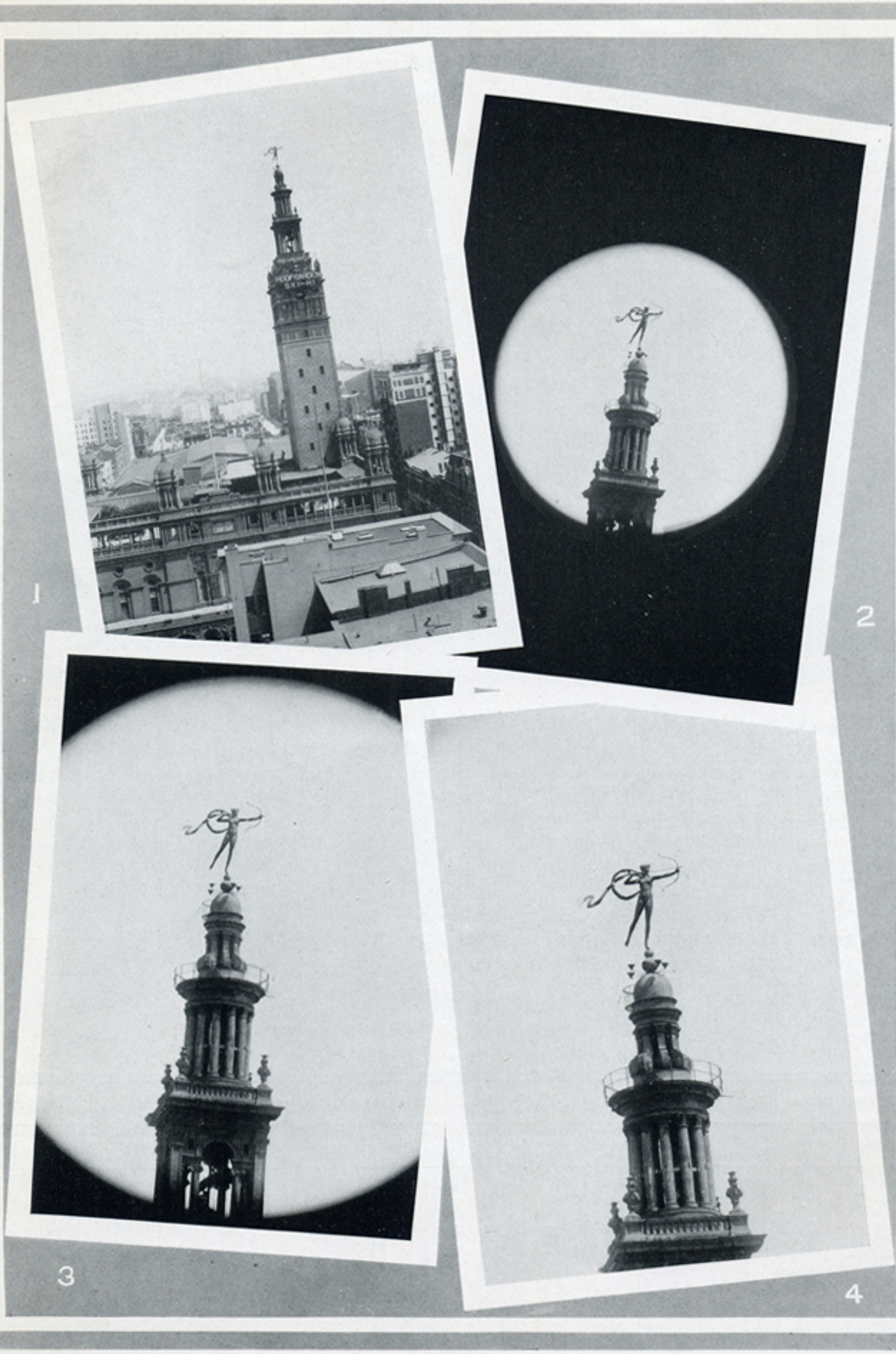
THE time of exposure required for Telephoto combinations can be found by multiplying the time that would be required by the positive element alone, with the square of the magnification.

For instance: the exposure for No. 15 Tessar Ic with stop F:8 may be ½ second; with a magnification 3 x, the exposure would have to be 3 x 3 = 9 times longer, *i. e.*, 4.5 seconds, and with a magnification 8 x, an exposure of 8 x 8 x ½ = 32 seconds.

POSITIVE LENS		TELE-PHOTO	AT THREE MAGNIFICATION		AT EIGHT MAGNIFICATION	
Number	Equival't Focus Inches	Negative Element	Image Circle Inches	Bellows Draw Inches	Image Circle Inches	Bellows Draw Inches
15 Ic . .	6	2	5¼	4⅝	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 . .	6⅜	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	19⅜
7 IIb . .	10	3	5½	5⅝	17	20⅛

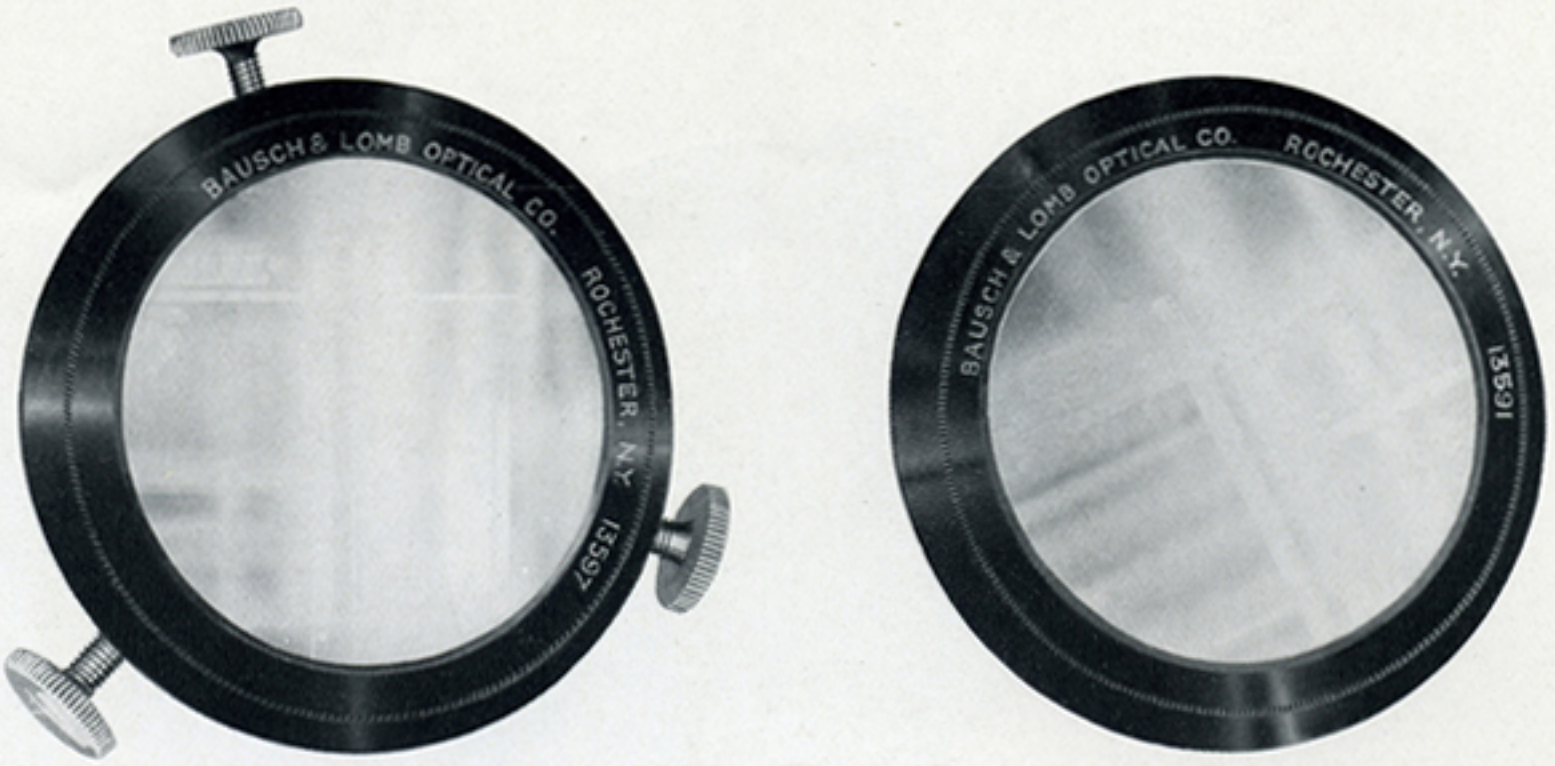
POSITIVE LENS		TELE-PHOTO	AT THREE MAGNIFICATION		AT EIGHT MAGNIFICATION	
Number	Equival't Focus Inches	Negative Element	Image Circle Inches	Bellows Draw Inches	Image Circle Inches	Bellows Draw Inches
10 VIIa .	7⅜	3	5½	5⅝	17½	19⅞
11 VIIa .	8½	3	5½	5½	16	20¼
12 VIIa .	9⅛	3	5¼	5 7/16	15½	19¾
13 VIIa .	9¼	3	5½	5 9/16	17¾	19¾
14 VIIa .	10	3	5¼	5½	16	19⅝
18 Ic . . .	11⅜	4	9	7¼	24	26⅛
8 IIb . .	12	4	8¼	7½	21½	26¼
15 VIIa .	10⅞	4	8½	7⅞	22½	27⅝
16 VIIa .	10 1/2	4	8	7 5/16	21½	26¼
17 VIIa .	11⅜	4	7¾	7⅞	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.



Made with Tessar IIb from Same Postition

No. 1. No Telephoto, F:22, ½ second.
No. 2. Telephoto, 3-Power, F:22, 1½ seconds.
No. 3. Telephoto, 6-Power, F:22, 3 seconds.
No. 4. Telephoto, 8-Power, F:22, 4 seconds.



Three-Fourths Actual Size

Ray Filters

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 without.

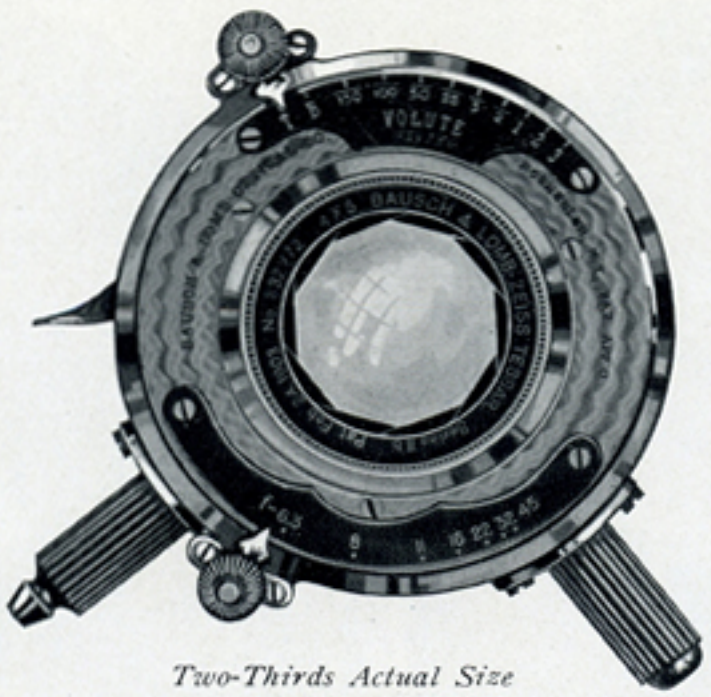
Orthochromatic plates must be used to secure the best results. Style A has a cork lining to fit over the lens mounting. It can be used with any of our regular mounts. Style B has three adjusting screws and can be attached to lenses varying in size from the diameters given to ½ inch smaller.

We furnish a reduced adapter for Ray Filters to be used on hand-cameras fitted with Unicum or 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.

PRICE LIST

Code Word	Catalog No.	Inside Diameter Inches	Price
Hilt	**A1**	1¼	**$4.00**
Himpne	**A1p**	1¼	**4.00**
Hindoo	**A2**	2	**6.00**
Hinge	**A3**	2¾	**9.00**
Hippa	**B1**	1¼	**4.00**
Hircic	**B2**	2	**6.00**
Hirudo	**B3**	2¾	**9.00**



Two-Thirds Actual Size

Volute Shutter

THEORETICALLY and practically the proper place for a shutter is at the diaphragm point 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, the entire picture impressing itself upon the plate from the moment the shutter begins to open until it closes.

It gives bulb and time exposures and works automatically at varying speeds, very closely approximating from 3 seconds to 1/150, 1/100 and 1/75 second respectively in Nos. 1, 2 and 3. 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.

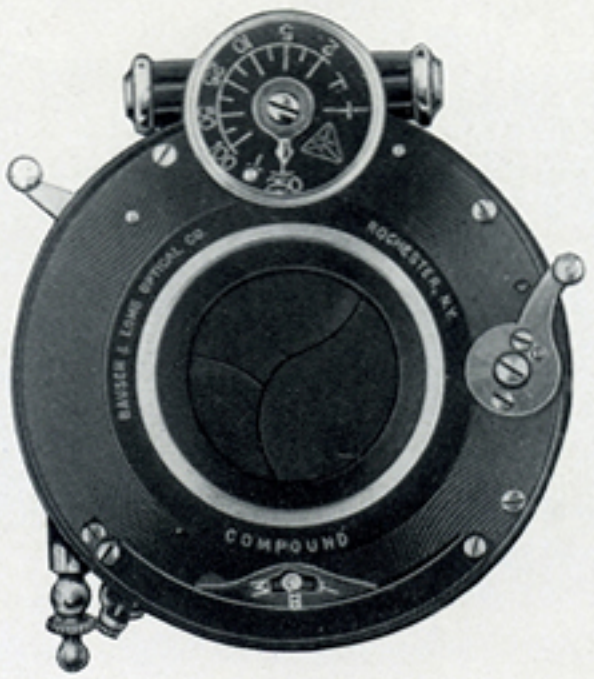
Exposure is made either by pneumatic bulb or by depressing the setting lever.

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 lenses up to and including those having an aperture of 52 mm. It can be fitted to any lens and is supplied on all makes of cameras.

PRICE LIST

Code Word	No.	Will Take Lenses with Opening of	Automatic Exposure	Fitted to Lenses of our Manufacture	Fitted to Lenses of other Manufacture
Hitch	**1**	1 in.	1 sec. to $\frac{1}{150}$ sec.	**$17.00**	**$18.00**
Hitter	**2**	$1\frac{7}{16}$ in.	1 sec. to $\frac{1}{100}$ sec.	**18.50**	**20.00**
Hive	**3**	2 in.	1 sec. to $\frac{1}{75}$ sec.	**20.00**	**22.00**

Prices include bulb and hose.



Two-Thirds Actual Size

Compound Shutter

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, as will be seen from the list below.

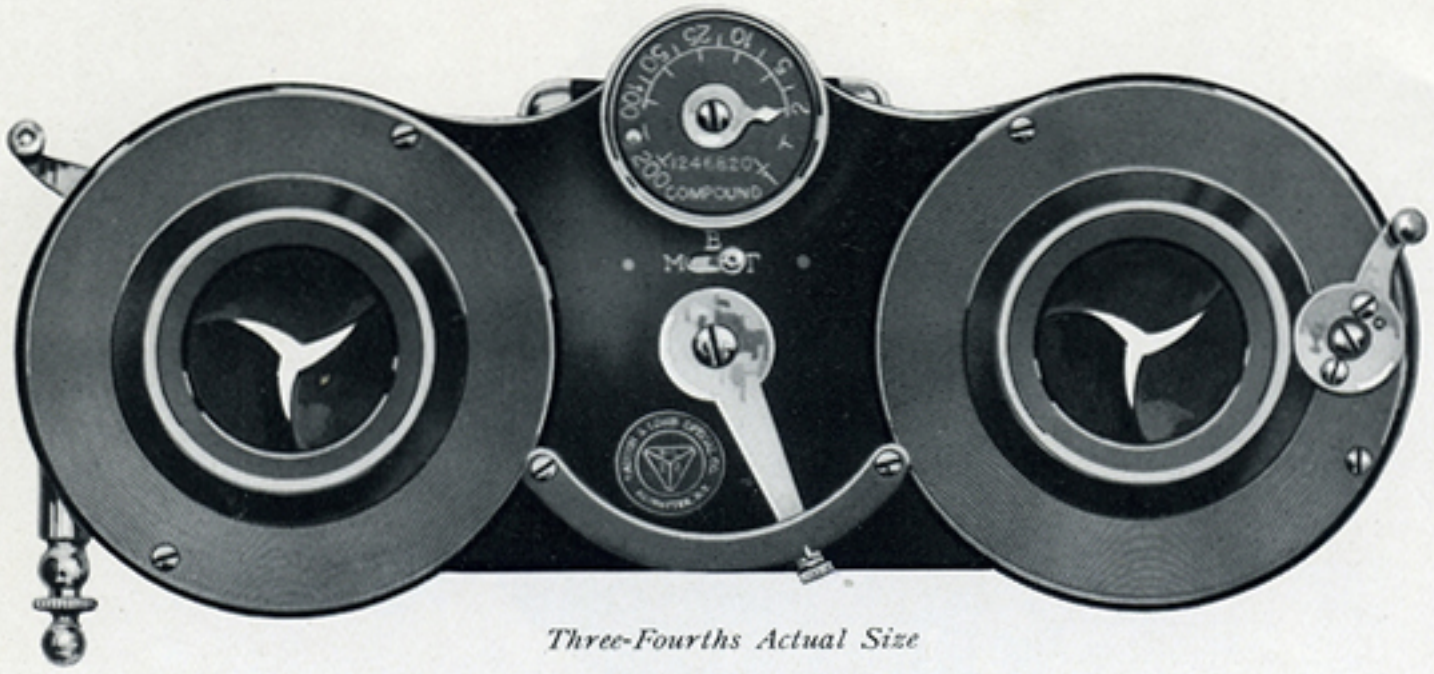
The mechanism is accurate and little liable to derangement. An iris diaphragm is employed for stopping down, and segments of steel form the shutter leaves. The opening of the segments is star-shaped, giving even illumination over the entire plate from the instant the exposure is started. In size 0 there 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.

PRICE LIST

Code Word	No.	Will Take Lenses with Opening of	Maximum Speed Seconds	Fitted to Bausch & Lomb Lenses	Fitted to Lenses of other Manufacture
Hoard	0	$\frac{13}{16}$ in.	$\frac{1}{250}$	$12.00	$13.00
Hoozin	1	$\frac{15}{16}$ in.	$\frac{1}{200}$	14.50	15.50
Hob	2	$1\frac{3}{8}$ in.	$\frac{1}{150}$	16.25	17.75
Hobble	3	$1\frac{9}{16}$ in.	$\frac{1}{100}$	20.00	22.00
Hobit	4	2 in.	$\frac{1}{100}$	22.00	24.00

Prices include bulb and hose.



Three-Fourths Actual Size

Stereo Compound Shutter

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.

PRICE LIST

Code Word	No.	Will take Lenses with Opening of	Maximum Speed Seconds	Fitted to Bausch & Lomb Lenses	Fitted to Lenses of other Manufacture
Hobnail	**0 Stereo**	$\frac{13}{16}$ in.	$\frac{1}{150}$	**$22.00**	**$24.00**
Hobnob	**1 Stereo**	$\frac{15}{16}$ in.	$\frac{1}{100}$	**27.00**	**29.00**

Prices include bulb and hose.

Brass Flanges for Bausch & Lomb Lenses

Number	1	2	3	4	5	6	7	8	9	10	11
Diameter, inches	1½	1¾	2	2¼	2½	3	3½	4	5	5½	6
Price, each	$ .50	.50	.75	1.00	1.00	1.25	1.50	1.75	2.00	2.50	3.00

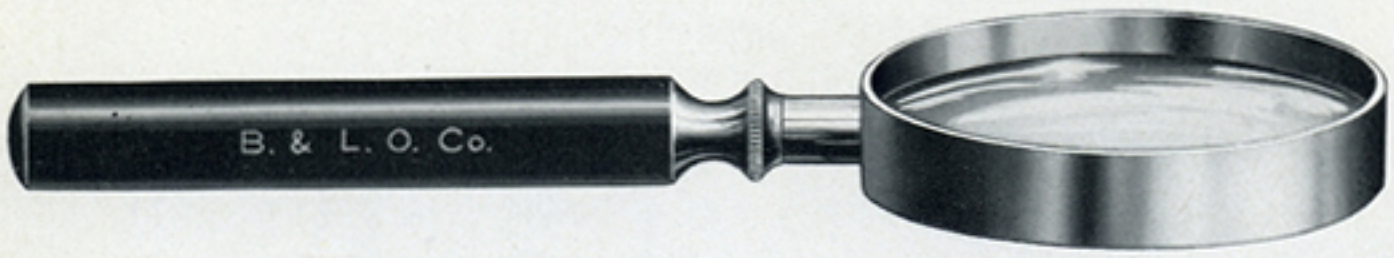
Morocco Caps for Bausch & Lomb Lenses

Number	1	2	3	4	5	6	7	8	9	10	11	12
Diameter, inches	1½	1¾	1⅞	2 1/16	2 3/16	2½	2¾	3 1/16	3 9/16	4 1/16	4 9/16	5 9/16
Price, each	$ .60	.60	.65	.70	.70	.75	.80	.90	1.00	1.10	1.20	1.25

Grained Leather Caps for Bausch & Lomb Lenses

Number	1	2	3	4	5	7	8	9	10
Diameter, inches	1⅜	1½	2 1/16	2 11/32	2¾	3 7/32	3 9/16	4 9/16	5½
Price, each	$ .40	.45	.50	.55	.60	.70	.80	.90	1.00

Focusing and Retouching Glasses

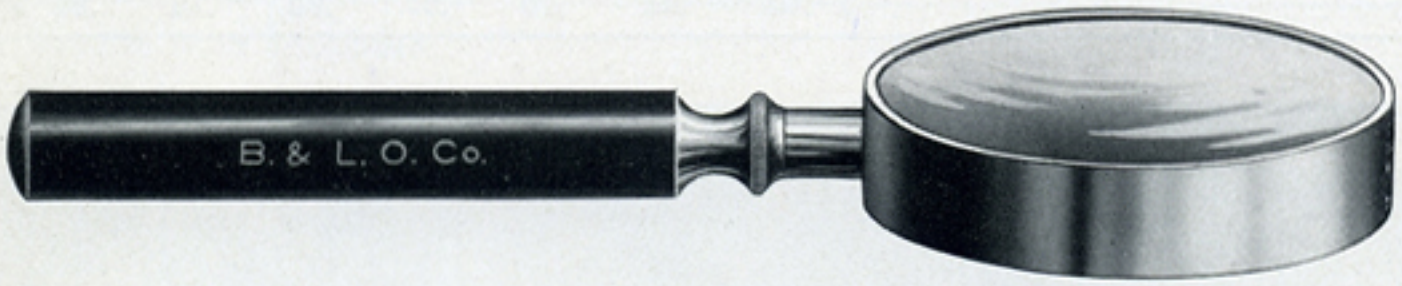


Large field of view and magnifying power particularly adapt these lenses for this class of work. They are our own production in their entirety. The lenses are carefully ground and the mountings are neat and durable, with nickeled rim and ebonized wood handle.

PRICE LIST

Catalog No.	Diameter		Price
	Inches	Millimeters	
200	2	50	**$0.60**
202	2½	62	**.80**
204	3	75	**1.00**
206	3½	87	**1.50**
208	4	100	**2.00**
210	5	125	**2.50**

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.

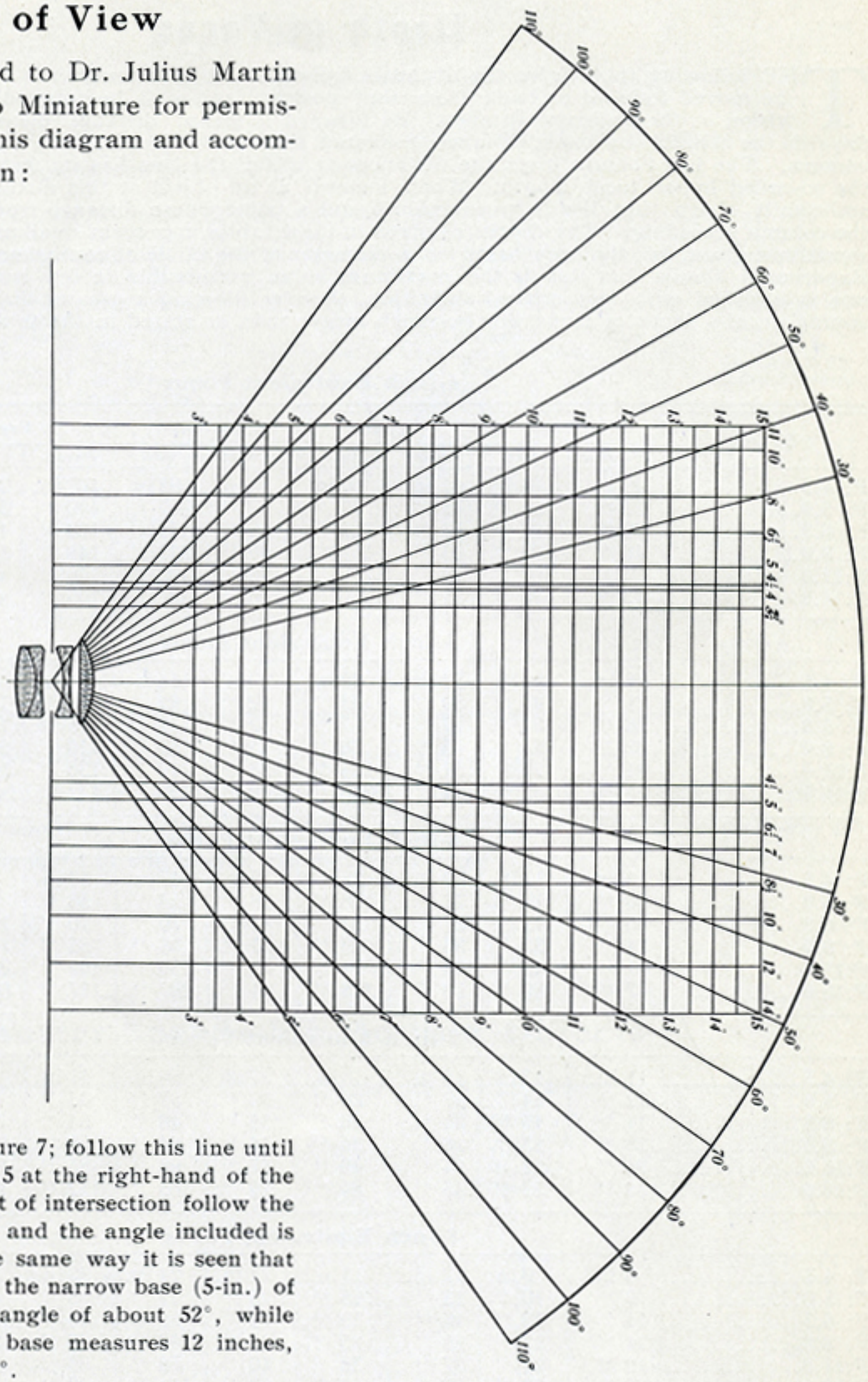
PRICE LIST

Catalog No.	Diameter		Price
	Inches	Millimeters	
200 c. c.	2	50	**$1.00**
202 c. c.	2½	62	**1.50**
204 c. c.	3	75	**2.00**
206 c. c.	3½	87	**3.00**
208 c. c.	4	100	**4.00**
210 c. c.	5	125	**5.00**

Angle of View

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

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 vertical line, which indicates the base measurement of the plate to be used, until it intersects the horizontal 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 top 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 topmost horizontal line find the figure 7; follow this line until it cuts the line figured 5 at the right-hand of the diagram. At the point of intersection follow the angular line to the arc and the angle included is seen to be 70°. In the same way it is seen that the same lens, used on the narrow base (5-in.) of the plate, includes an angle of about 52°, while used on a plate whose base measures 12 inches, we get an angle of 100°.

Table Showing Angular Field Covered with Different Focal Lengths

Plate Inches	Image Circle = Diagonal of Plate	ANGULAR FIELD WITH FOCUS					Plate Inches	Image Circle = Diagonal of Plate	ANGULAR FIELD WITH FOCUS				
		90°	80°	70°	60°	50°			90°	80°	70°	60°	50°
3¼ x 3¼	4.6	2.3"	2.74"	3.29"	3.98"	4.93"	6½ x 8½	10.7	5.35"	6.38"	7.64"	9.27"	11.47"
3¼ x 4¼	5.3	2.65	3.16	3.78	4.59	5.68	8 x 10	12.4	6.2	7.39	8.85	10.74	13.30
4 x 5	6.4	3.2	3.81	4.57	5.54	6.86	10 x 12	15.6	7.8	9.30	11.14	13.51	16.73
4¼ x 6½	8.0	4.0	4.77	5.71	6.93	8.58	12 x 15	19.4	9.7	11.56	13.85	16.80	20.80
5 x 7	8.6	4.3	5.13	6.14	7.45	9.22							

Depth of Focus

THE following tables give the distances by which an object which is sharply in focus might be moved forward or back from that position and still be imaged sufficiently sharp for vision at the ordinary distance. By forward is meant distance measured from the object towards the camera; by back, distance measured from the object in the direction away from the camera. The last column gives the distances at which the lens has its maximum depth of focus, the so-called hyper focal length. When focused at an object at this distance everything will be sufficiently sharp that lies between infinity and a point whose distance from the lens is given in the column preceding. The depths as given in these tables may seem small as compared with those sometimes given, but they are based on a diameter of the circle of confusion of 0.1 mm or $\frac{1}{250}$ inch. Experiment shows that this is the maximum value permissible in fine lens work. If, however, one is satisfied with less critical definition, thereby allowing a greater diameter of the circle of confusion, the depth of focus will be much larger than as stated in the tables.

4-Inch Equivalent Focus

STOP	15 Feet		18 Feet		24 Feet		30 Feet			Hyper Focus
	Forward	Back	Forward	Back	Forward	Back	Forward	Back	Forward	
F: 4.5	29 in.	44 in.	41 in.	67 in.	53 in.	92 in.	102 in.	236 in.	37.5 ft.	75 ft.
F: 5.0	32 "	50 "	45 "	77 "	57 "	107 "	109 "	283 "	34 "	68 "
F: 6.3	38 "	68 "	53 "	107 "	68 "	152 "	128 "	450 "	27 "	54 "
F: 8.0	46 "	97 "	63 "	157 "	80 "	233 "	148 "	866 "	21 "	42 "
F:11.0	58 "	167 "	78 "	298 "	98 "	498 "	176 "	∞	15 "	30 "
F:16.0	73 "	428 "	97 "	1200 "	120 "	∞	209 "	∞	10.5 "	21 "

5-Inch Equivalent Focus

F: 4.5	16 in.	20 in.	23 in.	29 in.	39 in.	54 in.	59 in.	90 in.	74 ft.	148 ft.
F: 5.0	21 "	29 "	30 "	43 "	52 "	82 "	78 "	139 "	53 "	106 "
F: 6.3	26 "	38 "	37 "	57 "	62 "	112 "	95 "	196 "	42 "	84 "
F: 8.0	32 "	51 "	45 "	78 "	75 "	160 "	110 "	292 "	33 "	66 "
F:11.0	41 "	78 "	57 "	125 "	93 "	279 "	136 "	582 "	24 "	48 "
F:16.0	54 "	143 "	74 "	248 "	118 "	738 "	171 "	∞	15 "	30 "

6-Inch Equivalent Focus

F: 4.5	14 in.	17 in.	20 in.	25 in.	35 in.	47 in.	53 in.	76 in.	84.5 ft.	169 ft.
F: 5.0	16 "	19 "	22 "	28 "	38 "	53 "	58 "	87 "	76 "	152 "
F: 6.3	19 "	25 "	27 "	37 "	47 "	70 "	70 "	117 "	60.5 "	121 "
F: 8.0	24 "	33 "	33 "	49 "	57 "	95 "	85 "	163 "	47.5 "	95 "
F:11.0	31 "	48 "	43 "	74 "	72 "	150 "	107 "	285 "	34.5 "	69 "
F:16.0	42 "	80 "	58 "	128 "	94 "	287 "	137 "	602 "	24 "	48 "

7-Inch Equivalent Focus

F: 4.5	11 in.	12 in.	15 in.	18 in.	27 in.	59 in.	41 in.	53 in.	115 ft.	230 ft.
F: 5.0	12 "	14 "	17 "	20 "	29 "	37 "	45 "	60 "	103.5 "	207 "
F: 6.3	14 "	16 "	21 "	26 "	35 "	48 "	54 "	79 "	82.5 "	165 "
F: 8.0	18 "	23 "	26 "	34 "	44 "	64 "	66 "	106 "	65 "	130 "
F:11.0	24 "	33 "	34 "	49 "	57 "	96 "	85 "	165 "	47 "	94 "
F:16.0	33 "	52 "	45 "	80 "	76 "	165 "	112 "	304 "	32.5 "	65 "

8-Inch Equivalent Focus

F: 4.5	8 in.	9 in.	12 in.	13 in.	21 in.	24 in.	32 in.	39 in.	150 ft.	300 ft.
F: 5.0	9 "	10 "	13 "	15 "	23 "	27 "	35 "	44 "	135 "	270 "
F: 6.3	11 "	13 "	16 "	19 "	28 "	35 "	43 "	57 "	107.5 "	215 "
F: 8.0	14 "	17 "	20 "	25 "	35 "	46 "	53 "	76 "	85 "	170 "
F:11.0	19 "	24 "	27 "	36 "	46 "	68 "	69 "	113 "	61.5 "	123 "
F:16.0	26 "	37 "	36 "	56 "	62 "	111 "	92 "	193 "	42.5 "	85 "

10-Inch Equivalent Focus

F: 4.5	5 in.	6 in.	8 in.	9 in.	14 in.	15 in.	21 in.	24 in.	235 ft.	470 ft.
F: 5.0	6 "	7 "	9 "	10 "	15 "	17 "	24 "	27 "	211.5 "	423 "
F: 6.3	7 "	8 "	11 "	12 "	19 "	22 "	29 "	35 "	168 "	336 "
F: 8.0	9 "	11 "	14 "	16 "	24 "	29 "	36 "	46 "	104.5 "	209 "
F:11.0	13 "	15 "	18 "	22 "	32 "	41 "	48 "	66 "	96 "	192 "
F:16.0	18 "	23 "	25 "	34 "	44 "	64 "	66 "	105 "	85.5 "	171 "

Exposure Tables

(From British Journal Photographic Almanac)

The following table based on that of Burton gives a rough idea of the exposures for various subjects and diaphragms under the following conditions:

(*a*) Best lighting; midday sunshine in May, June and July.

(*b*) With the most rapid commercial plates. See below for factors applying to other conditions.

F No.	Average Subject with Objects in Foreground Street Scenes, Outdoor Figure Studies	Landscapes with Light Foregrounds Lake, River and Beach Scenes	Sea Clouds and Sky	Subjects with Extra Heavy Foreground e. g. Dark Trees, Doorways, Groups	Under Trees, Woods, Avenues, Glades, etc.	Portrait in Average Well Lighted Room
F:4	1/250	1/300	....	1/120	1/20	1/8
F:4.5	1/200	1/400	....	1/100	1/15	1/6
F:5.6	1/150	1/250	....	1/64	1/10	1/4
F:6.3	1/100	1/200	1/1000	1/50	1/8	1/3
F:7	1/80	1/150	1/800	1/40	1/6	1/3
F:8	1/64	1/120	1/600	1/30	1/5	1/2
F:11	1/30	1/60	1/300	1/15	1/2	1
F:16	1/15	1/30	1/150	1/8	1	2
F:22	1/8	1/15	1/80	1/4	2	4
F:32	1/4	1/8	1/40	1/2	4	8
F:45	1/2	1/4	1/20	1	8	16
F:64	1	1/2	1/10	2	16	30

In weather other than bright sunshine the above exposures are multiplied as follows:

(Bright diffused light, the sun behind a cloud) x 1½. (Light clouds over whole sky, but light able to cast a visible shadow) x 2. (Heavy clouds over whole sky, absence of distinct shadows) x 3. (Very dull, whole sky covered by still heavier clouds) x 4 to 5.

Shutter Speeds for Moving Objects

Distance of Object, 25 Feet	Objects Moving Directly Toward Operator	Objects Moving Obliquely Toward or From Camera	Objects Moving Directly Across the Field
Street group (no rapid motion)	1/5 to 1/10	1/5 to 1/10	1/5 to 1/10
Pedestrians (two miles per hour)	1/20	1/40	1/60
Animals grazing	1/20	1/40	1/60
Pedestrians (three miles per hour)	1/30	1/60	1/90
Pedestrians (four miles per hour)	1/40	1/80	1/120
Vehicles (six miles per hour)	1/60	1/120	1/180
Vehicles (eight miles per hour)	1/80	1/150	1/250
Cyclists and trotting horses	1/160	1/300	1/500
Foot races and sports	1/240	1/500	1/700
Divers	....	1/600	1/800
Cycle races and horses galloping	1/300	1/750	1/900
Yachts (10 knots per hour) at 50 feet	1/60	1/120	1/180
Steamers (20 knots per hour) at 50 feet	1/120	1/240	1/360
Trains (30 miles per hour) at 50 feet	1/150	1/300	1/450
Trains (60 miles per hour) at 50 feet	1/300	1/600	1/900

Table Showing the Sizes of Lenses and Shutters which can be Adapted to Various Cameras

Number	CAMERA	Size Inches	Longest Draw of Camera, In.	Ic Tessar No.	Volute Shutter No.	Compound Shutter No.	IIb Tessar No.	Volute Shutter No.	Compound Shutter No.	VIIa Protar No.	Volute Shutter No.	Compound Shutter No.
1a	Folding Pocket Kodak, Special	2½ x 4¼	5	...	...	...	4	...	0	.....	...	...
3	Folding Pocket Kodak	3¼ x 4¼	5	...	...	...	4	1	0	.....	...	..
3a	" " "	3¼ x 5½	6	...	...	...	5k	1	1	.....	...	...
4	" " "	4 x 5	6	...	...	...	5k	1	1	.....	...	...
4a	Folding Kodak.....	4¼ x 6½	8	...	...	...	6	2	2	.....	...	...
4a	Speed Kodak.....	4¼ x 6½	8	...	...	...	6	...	.....	.....	...	...
1a	" "	.....	...	14	...	...	4	...	.....	.....	..	...
1a	Folding Hawk-Eye, Model No.1	2½ x 4¼	4	...	...	...	3	...	0	.....	...	..
3	" " " No.6	3¼ x 4¼	5	...	...	...	4	1	0	.....	...	...
3a	" " " No.4	3¼ x 5½	6	...	...	...	5	1	1	.....	...	...
4	" " " No.3	4 x 5	6	...	...	...	5	1	1	.....	...	...
4	Stereo Hawk-Eye, Model No.4	3½ x 3½	5	...	...	...	4	...	0 Stereo	.....	...	..
...	Folding Hawk-Eye, Model No.4	4 x 5	13	...	...	...	.....	...	1	7	1	1
...	Century, Model No. 46	4 x 5	11	...	2	2	5	1	2	7	1	2
...	" " No. 46	5 x 7	17	...	2	3	6	2	2	10	2	2
...	" " No. 46	6½ x 8½	21	...	3	4	7	2	3	13	2	3
...	Century Grand Senior	4 x 5	17	...	2	2	5	1	2	7	...	2
...	" " "	5 x 7	23	...	2	3	6	2	2	10	...	2
...	" " "	6½ x 8½	28	...	3	4	7	2	3	13	...	3
...	Petite Grand	3¼ x 5½	13	...	...	...	5	...	2	7	...	2
...	Revolving Back Cycle Graphic	4 x 5	17	15	...	2	.....	...	.....	7	...	2
..	" " " "	5 x 7	22	16	...	4	.....	...	.....	10	..	2
...	" " " "	6½ x 8½	26	17	...	4	.....	...	.....	13	...	3
...	" " " "	8 x 10	30	...	...	...	.....	...	.....	17	...	..
1a	Graflex.....	2¼ x 4¼	6½	14	...	...	4	...	.....	.....	...	..
3a	"	3¼ x 5½	10	15a	...	...	5a	...	.....	7	...	4
...	Auto Graflex	3¼ x 4¼	7	15	...	...	4	...	.....	4	...	...
...	" "	4 x 5	8½	15	...	...	5	...	.....	7	...	..
...	" "	5 x 7	12	16	...	...	6	...	.....	10	...	..
...	Revolving Back Auto Graflex ..	3¼ x 4¼	15	16	...	...	6	...	.....	10	...	...
...	" " " " ..	4 x 5	18	17	...	...	7	...	.....	13	...	...
...	Press Graflex.....	5 x 7	14	16	...	...	6	...	.....	13	...	...
...	Stereo Auto Graflex	3½ x 3½	8	...	...	...	2 of No. 5	...	.....	.....	...	...
...	Naturalists' Graflex	4 x 5	26	...	...	...	.....	...	.....	19	...	...
...	Stereoscopic Graphic	.....	12¾	...	...	...	2 of No. 4	...	.....	2 of No. 7 2 of No. 10	...	...
3	Film Premo	3¼ x 4¼	8	...	...	...	4	1	0	.....	...	...
...	" "	3¼ x 5½	9	...	...	...	5	1	1	.....	...	...
...	" "	4 x 5	8	...	...	...	5	1	1	.....	...	...
...	Filmplate Premo	3¼ x 4¼	7	...	...	...	4	1	0	.....	...	...
...	" "	3¼ x 5½	8	...	...	...	5	1	1	.....	...	...
...	" "	4 x 5	8	...	...	...	5	1	1	.....	...	...
...	" "	5 x 7	12	...	...	...	5a	2	2	.....	...	...
4	Pony Premo	4 x 5	11	...	...	...	5	1	1	3	1	1
...	" "	5 x 7	15	...	...	...	5a	2	2	8	1	2
6	" "	4 x 5	14	...	...	...	5	1	1	3	1	1
...	" "	5 x 7	19	...	...	...	5a	2	2	8	2	2
...	" "	6½ x 8½	24	...	...	...	7	2	3	11	2	3
7	" "	4 x 5	13	...	...	...	5	1	1	3	1	1
...	" "	5 x 7	19	...	...	...	5a	2	2	8	1	2
...	" "	6½ x 8½	22	...	...	...	7	2	3	11	2	3
1	Premoette Special	2¼ x 3¼	5	...	...	...	3	...	0	.....	...	...
1a	" "	2½ x 4¼	6	...	...	...	4	...	0	.....	...	...
4	Stereo Premo.....	5 x 7	15	...	...	...	2 of No. 4	...	.....	2 of No. 2	...	...
6	" "	5 x 7	19	...	...	...	"	...	.....	"	...	...
7	" "	5 x 7	19	...	...	...	"	...	.....	"	...	...

Lenses

CONDENSED PRICE LIST

No.	Tessar Ic	Tessar IIb	Series VII	Series VIIa	Series IV	Series V
1	.....	.....	No. 1 V No. 1 C $27.00	No. 1 V No. 1 C $48.50	$17.50	No. 1 V $23.00
2	.....	.....	No. 1 V No. 1 C 30.50	No. 1 V No. 1 C 52.50	No. 1 V 17.50	No. 1 V 23.00
3	.....	No. 1 V No. 0 C $32.50	No. 1 V No. 1 C 36.00	No. 1 V No. 1 C 57.50	No. 1 V 21.00	No. 1 V 29.00
4	.....	No. 1 V No. 1 C 34.50	No. 2 V No. 2 C 43.50	No. 1 V No. 1 C 56.00	No. 1 V 24.50	No. 1 V 36.00
5	.....	No. 1 V No. 2 C 36.00	No. 2 V No. 3 C 56.00	No. 1 V No. 1 C 61.50	No. 1 V 31.50	No. 1 V 45.00
5a	.....	No. 2 V No. 2 C 50.50	.....	.....	.....	.....
5k	.....	No. 1 V No. 1 C 46.00	.....	.....	.....	.....
6	.....	No. 2 V No. 3 C 61.50	No. 3 V No. 3 C 77.50	No. 2 V No. 2 C 68.50	No. 1 V 47.00	No. 1 V 56.00
7	.....	No. 2 V No. 3 C 83.00	No. 3 V No. 4 C 99.00	No. 1 V No. 2 C 66.50	No. 2 V 71.50	No. 1 V 66.50
7a	.....	.....	.....	.....	.....	No. 1 V 88.50
8	.....	No. 3 V No. 4 C 122.50	129.50	No. 2 V No. 2 C 73.50	No. 3 V 125.50	No. 1 V 88.50
9	.....	158.50	180.00	No. 2 V No. 3 C 86.00	282.50	No. 2 V 129.50
9a	.....	193.00	.....	.....	.....	No. 3 V 255.50
10	.....	252.00	234.00	No. 2 V No. 2 C 80.50	631.00	.....
11	.....	324.00	306.00	No. 2 V No. 3 C 93.00	.....	.....
12	.....	.....	.....	No. 3 V No. 3 C 114.50	.....	.....
13	.....	.....	.....	No. 2 V No. 3 C 105.00	....	.....
14	No. 1 V No. 2 C $ 40.50	.....	.....	No. 3 V No. 3 C 127.00	.....	.....
15	No. 2 V No. 2 C 47.00	.....	.....	No. 3 V No. 4 C 148.50	.....	.....
15a	No. 2 V No. 3 C 57.50	.....	.....	.....	.....	.....
16	No. 3 V No. 3 C 72.00	....	.....	No. 3 V No. 3 C 147.50	.....	.....
17	No. 3 V No. 4 C 115.50	.....	.....	No. 3 V No. 4 C 169.00	.....	.....
18	162.00	.....	.....	No. 3 V No. 4 C 199.50	.....	.....
18a	210.00	.....	.....	.....	.....	.....
19	252.00	.....	.....	No. 3 V No. 4 C 186.50	....	.....
20	360.00	.....	.....	No. 3 V 217.00	.....	.....
22	.....	.....	.....	No. 3 V 243.00	.....	.....
25	.....	.....	.....	340.50	.....	.....
28	....	.....	.....	444.50	.....	.....
30	.....	.....	.....	585.00	.....	....

V and C refer to Volute and Compound Shutters; the number preceding the letter shows the shutter which can be fitted to the lens.

No.	0		1		2		3		4	
	Fitted to B. & L. Lenses	Fitted to Other Lenses	Fitted to B. & L. Lenses	Fitted to Other Lenses	Fitted to B. & L. Lenses	Fitted to Other Lenses	Fitted to B. & L. Lenses	Fitted to Other Lenses	Fitted to B. & L. Lenses	Fitted to Other Lenses
Volute	.....	.....	$17.00	$18.00	$18.50	$20.00	$20.00	$22.00	.....	.....
Compound	$12.00	$13.00	14.50	15.50	16.25	17.75	20.00	22.00	$22.00	$24.00
Stereo-Compound	22.00	24.00	27.00	29.00	.....	.....	.....	.....	.....	.....
Telephoto	.....	.....	.....	.....	22.00	26.00	28.00	32.00	37.00	42.00

	A1	A1p	A2	A3	B1	B2	B3
Ray Filter	$4.00	$4.00	$6.00	$9.00	$4.00	$6.00	$9.00

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Searchlight Mirrors
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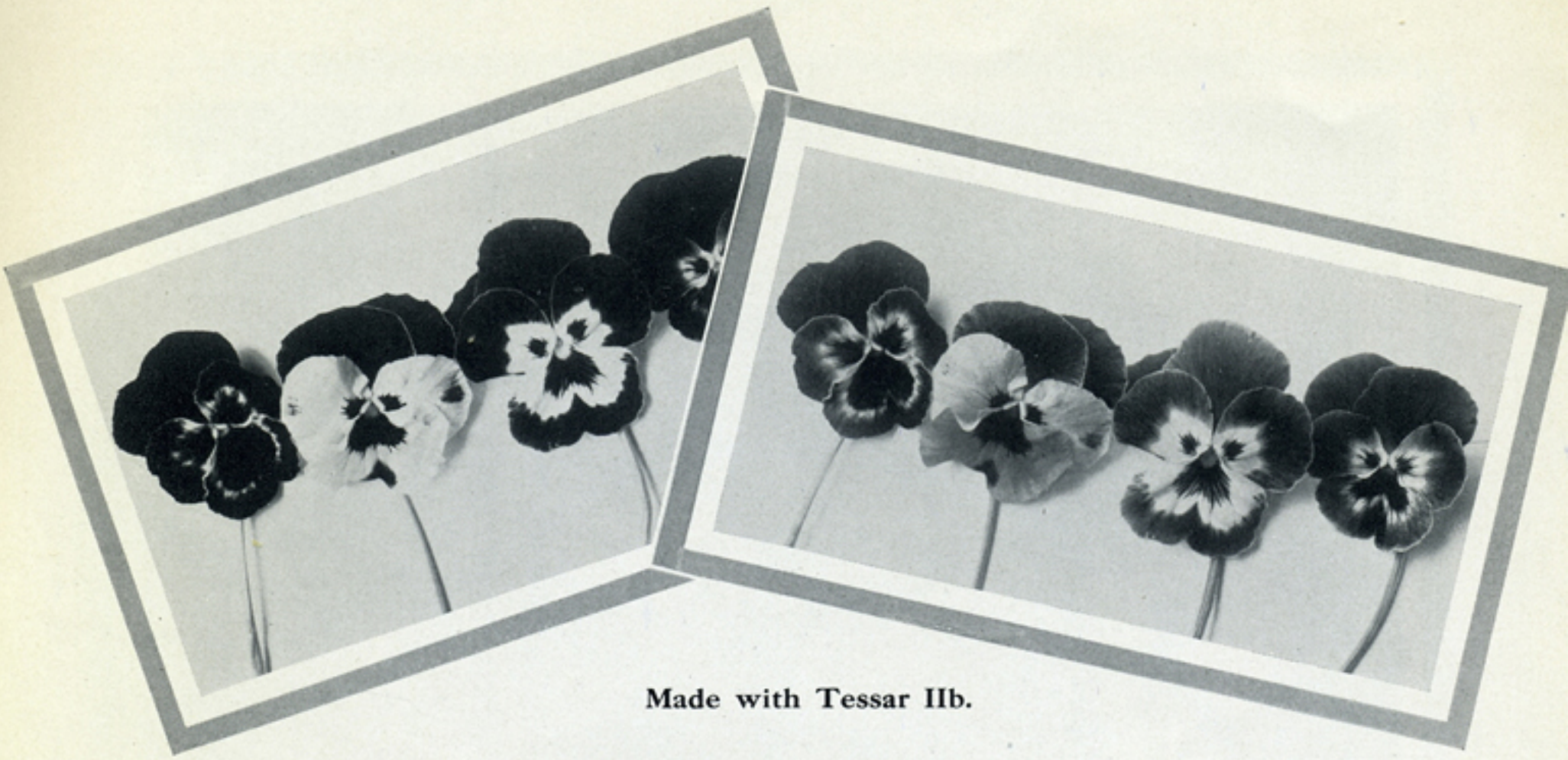

Made with Tessar IIb.

Without Ray Filter, 15 seconds

With Ray Filter, F:32, 35 seconds

Made with Tessar IIb and Ray Filter, by F. M. Lock, Victor, N. Y.

Made with Tessar Ic, by A. R. Stone, Rochester, N. Y.