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The Photo Miniature

PRACTICAL TELEPHOTOGRAPHY

What It Means: Its Uses and Advantages in Every-day Work and for Special Purposes. The Telephotographic Lens: Its Make-up: Apparatus and Manipulation. Notes and Comment.

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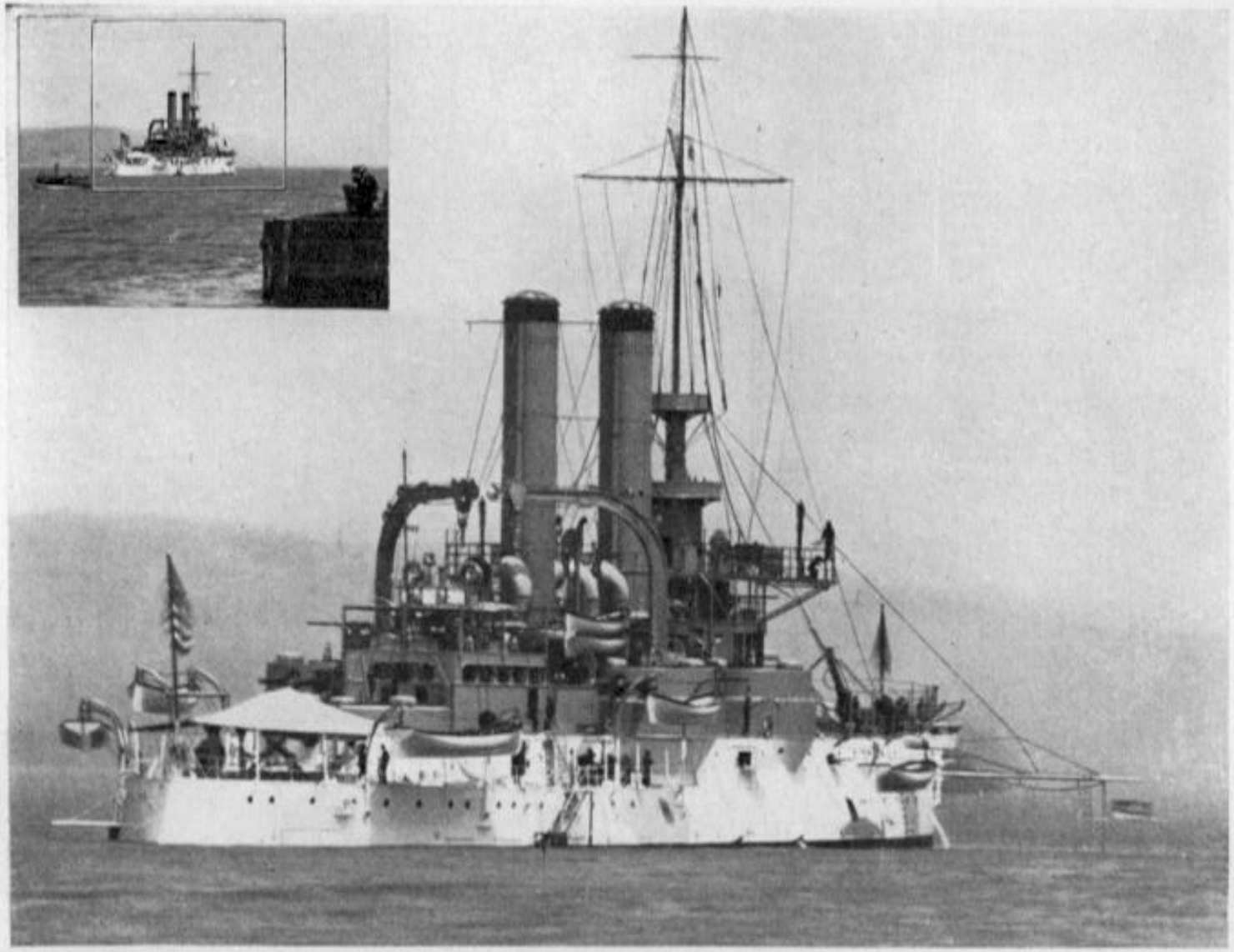

Two views of U. S. S. Iowa made from the same standpoint, showing relative sizes of image obtained. Small view made with Goerz Dagor No. 8. Lower view made with same positive lens and Goerz Telephoto lens. Magnification, 8 diameters.

The Photo-Miniature

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Practical Telephotography

A photographer of natural history subjects was once walking in the country with an inventor of lenses, when the former drew the latter's attention to a bird on a tree some distance away. "Can you not make a lens," said the photographer, "which will give me a good-sized picture of that bird from this distance, without involving the use of a big camera and its cumbersome bellows extension—a small and compact instrument which can be managed without much trouble?" The optician said it was an easy thing to do, and done it was in due course—in the telephotographic lens introduced by Dallmeyer about 1891–2. On another occasion, a photographer and a journalist were touring in the Highlands of Scotland, and the talk was about lenses. "What I want," said the photographer, "is some sort of telescopic lens for getting a large picture of yonder distant hill from this view-point." Acting on this suggestion, the journalist subsequently made from the window of his own home an enlarged view of a distant house (as substitute for "yonder hill") with an opera glass attached to an ordinary camera possessing the usual limited bellows extension. These are bits of unrecorded history touching the beginnings of telephotography as we know it today. The four *dramatis personæ* in order of mention were Dr. P. H. Emerson, Thomas R. Dallmeyer, John Stuart, of Glasgow, and J. Traill Taylor. Of these, Dr. Emerson alone survives to witness the present widespread popularity and use of telephotog-

raphy, himself the author of the first telephotographic portrait ever made.

In this brief dismissal of the historical side of our subject, it is only fair to state that, almost simultaneously with the introduction of the Dallmeyer telephoto lens in England, similar objectives were brought forward by Miethe and Steinheil in Germany and Duboscq in France, not forgetting mention of the "parent of all telephoto lenses"—the Barlow lens of 1834—which, of course, antedates photography itself. Add to this, the appearance a few weeks ago of a quarterly periodical exclusively devoted to telephotography, and our history is right up to the moment.

Distance is no obstacle to success in this class of work. The telephotographic lens supplies a method of photographing objects much larger in scale than an ordinary lens will do, without increasing the size of the camera, or lengthening the bellows, for the work. It is immaterial whether the object photographed is situated ten miles away from the camera, or only ten yards; the practical gain is the same. The apparent size to the eye of the particular object is rendered in the negative by telephotography; with an ordinary lens, its dimensions may be so small that the print is disappointing. As we have seen, it was to overcome this drawback in photography that telephotographic lenses were introduced, and their extending use is proof that photographers appreciate the extra power placed in their hands. Telephotography calls for comparatively little extra expense and the actual photographic work necessary does not differ much from negative-making in the usual way. The photographer who takes up the subject, therefore, need not fear that he will meet difficulties which he cannot easily overcome. The aim of this monograph is to point out that telephotography is comparatively simple when once its fundamental principles are understood.

Uses of Telephotography

Besides amateur and professional photographers, many other classes appreciate the practical value of telephotography in making direct enlargements, in the camera, of near and distant objects. Naval and military officers, engineers, surveyors, architects, astronomers, naturalists, are but

a few of the many that might be cited in proof of this statement. Early work in telephotography was chiefly directed toward showing what very fine long-distance views could be made with the lens; in more recent times, however, its uses for photographing near objects on a large scale have attracted notice, and it is to this branch of work that we wish to direct particular attention. For the lens exercises a three-fold function: It is, first of all, a long-focus lens; secondly, a lens of variable foci, that is, a number of lenses in one; and, thirdly, it gives correctness of drawing in near objects, such as portraits and buildings; or, in other words, it suppresses the distortion or exaggerated perspective seen in photographs taken with lenses of too short focal length, by enabling the photographer to interpose what amounts to a greater distance between the camera and the subject photographed, or between the lens and the sensitive plate, which, in practice, amounts to much the same thing as increasing the focus of the lens.

Size of Image

To understand how a telephotographic lens does all this, let us first see how an ordinary lens acts in taking a photograph. We will suppose the reader to have a camera with a bellows extension of eleven or twelve inches; a five-inch lens on its front, and a focusing screen at the back. Open the stops of the lens; focus it upon some prominent object a few yards away, and measure its size on the ground glass. The image of the object measures, we will assume, one inch. Now, for the five-inch lens on the camera front suppose one of ten inches focus to be substituted, and the same object focused and measured. The size of the image will now be two inches, or exactly double that given by the five-inch lens. From this it is plain that the size of an object in a photograph is purely a matter of the focal length of the lens used, a fact which is an underlying principle in telephotography. We must next find out what is meant by the term focal length as applied to a lens.

Focal Length

The focal length of a lens is, roughly, the distance from the back surface of the lens to the ground glass of the camera; strictly, it is not so, the distance being properly

measured from the optical center of the lens, a position which varies with the particular type of lens. It may either be within the lens itself or quite outside it. The optical center of a lens is best defined as an imaginary point in a lens, simple or compound, arrived at by calculation, from where its actual or equivalent focus is measured. The meaning of the term equivalent focus is easy to understand if we realize that all lenses of the same foci, or focal lengths, give images of the same size, but as the optical centers of the lenses vary in position, so also do the necessary camera extensions. For example, the optical center of a double convex lens is in the middle of that lens; in a plano-convex lens it is just outside the convex surface; in a meniscus or concavo-convex it is well outside the convex side; in a double lens, such as a rectilinear or anastigmat, it is conveniently, though perhaps not quite accurately, assumed to be at the stop opening; whilst in a telephotographic lens it is far outside the first surface of the front lens. This variation in the position of the optical center of a lens tells us, amongst other things, why, with a camera of comparatively short extension, it is possible to get, with a telephotographic lens, the image of an object as large as we should obtain with an ordinary lens of great focal length in a camera of considerable extension. To put it objectively: Suppose that with a positive lens of seven inches focus and a suitable negative lens we obtain an image of an object magnified eight times, we shall be using the telephoto lens at an equivalent focus of fifty-six inches, which means that with an ordinary long-focus lens that would be the extension of camera required to get the same-sized image as the telephotograph. In the latter case, however, the camera extension would not be anything so great, as we shall proceed to show.

Positive and Negative Lenses

To arrive at the explanation of this striking fact, however, it is necessary to enquire yet more closely into the action of simple lenses in the formation of an image. A double convex lens, if mounted on a camera front, will pass rays of light to form an image on the focusing screen, but the picture will not be sharp, because one

Examples by Ernest Marriage, showing magnifications of moderate and high powers, advantageous in photographing architectural details.

1. North Door, Rheims Cathedral. Beck-Steinheil lens, 7-inch focus.
2. Detail of No. 1, moderate power magnification—4.82. Beck-Steinheil Telephoto lens.
3. Detail ot No. 1, high power magnification—11. Beck-Steinheil Telephoto lens.

simple lens cannot bring the rays, which are of unequal length, to a sharp focus on the picture plane; to get such a result a compound lens is necessary, and then the longer rays will come to a focus at the same points as the shorter rays, and so the image will be sharp. The necessary correction is effected by placing a concavo-plano lens in perfect optical contact with the double convex lens, a combination resulting which will produce a well defined photograph. This effect is produced by opposing one defect by another, or, as it is otherwise described, by combining a positive lens with a negative. A positive or convex lens produces a real image of an object placed in front of it by converging the rays of light on to the sensitive film surface; a negative lens has only a virtual focus and will not produce a photographic image; positive lenses converge the rays; negative lenses diverge them: it is a case of bending them in and bending them out. It will now be more clearly understood how, if a positive lens converges or bends rays of light unequally, the juxtaposition of a negative lens will diverge or bend them outwards, and the sum of the matter is that the rays are united to form a common focus. This is what is meant by achromatism in lens construction: a simple positive lens shows color fringes on the focusing screen, being non-achromatic, or uncorrected for color; but, by combining with it a negative lens, an achromatic lens results and there will be no color fringes in the picture, which will be sharp. The terms "positive" and "negative" have important meanings in telephotographic lens construction, and it is essential that those meanings should be plainly understood from the foregoing brief explanation. Any lens which gives a sharp image on the ground glass is properly a positive lens. If such a lens is placed at one end of a suitable tube, while at the other end there is fixed a negative or diverging lens, the latter will intercept and enlarge the image formed by the front or positive lens, and the practical advantages of the combination will be a considerable increase of the focal length of the telephoto lens as compared with the positive lens alone; the displacement of the optical center of the telephoto lens to a point outside the positive lens; a shorter camera extension

than would be necessary with an ordinary positive lens of the same equivalent focal length as the telephoto; and the combination in the one lens of a series of lenses of different focal lengths. Thus, the addition of a negative lens to a positive provides the photographer with what has been termed a battery of lenses of variable foci, so that he is not limited to one particular kind of work or size of negative. In former works on telephotography not sufficient stress has been placed on this important fact; and it is only of recent years that photographers have become alive to the valuable range of powers which the telephotographic lens places in their hands. It is not one lens, but many lenses varying in focal length.

Angle of view

The telephoto, being primarily a long-focus lens, is of course subject to the limitations of other long-focus lenses. It suffices to mention one of those limitations here, viz, the included angle of view. Briefly it may be laid down that the greater the equivalent focal length of the telephoto lens the narrower becomes the angle of included subject. If we refer back to the comparison made between the five- and ten-inch lenses in estimating the relative sizes of objects as influenced by focal length, we shall remember that, though the size of the object focused on was doubled by the longer-focus lens, yet the amount of subject included in the picture was less than in the instance of the five-inch lens. In the latter case we got more of the subject but smaller in size all over; in the case of the ten-inch lens less of the subject but larger in size. Enlargement of image therefore in telephotography is accompanied by compressing the field or area of the subject. It is necessary that this point should be made clear and grasped by the reader. The unthinking sometimes regret that long distance telephotographs do not exhibit a more panorama-like effect; the reason will now be obvious. But though the angle of view with a telephoto lens is necessarily narrow, it is nevertheless constant for all magnifications. It varies in size directly with the magnification or length of focus of the lens, being precisely the same at 2, 4, and 8 magnifications. The lens acts by forming a circle of illumination on the plate; and the following table shows what the diameter

of the circle of illumination must be in order that a plate of a certain size must be covered.

Size of plates	Circle of illumination
3¼ x 4¼	$5\frac{4}{10}$ inches
4 x 5	$6\frac{4}{10}$ inches
5 x 7	$8\frac{6}{10}$ inches
8 x 10	$12\frac{3}{4}$ inches

If a certain part of a subject, such as a view or a building, is included in the complete circle of illumination, an increase or decrease of the magnification will also increase or decrease the size of the image and the circle of the illumination, but it will not alter the total amount of the subject that is included; consequently, while the angle is small it is constant for all foci of the telephoto. A size of plate should be chosen which receives the whole of the circle of illumination; if too small a plate is chosen, then obviously the outer parts of the circle or picture will be lost. The limitation and constancy of this angle of view or field brings out what is one of the best features of the telephoto, namely, its pleasing rendering of the drawing of near or distant objects, which are thus shown in true perspective. A common fault in ordinary photography is the use of too short focus lenses, with the consequent result that the picture is shown distorted or in too violent perspective. Nowhere is this more convincingly shown than in many studio portraits of seated figures, in which the hands and feet are sometimes shown disproportionately large. The reason for this is that the lens was of too short focal length; a longer-focus lens of the ordinary, or of the telephotographic kind, would give a more natural and proportionate rendering of the parts of the figure. This point, of special importance to the portraitist, is fully developed in an illustrated chapter of Dallmeyer's "Telephotography."

Depth of Focus

It will be useful for the beginner in telephotography to bear in mind that the depth of focus (or depth of definition) in the negative is dependent on the aperture or stop used in the positive lens. For example, if the positive has an aperture of *f*/6, and the magnifying power of the telephoto is 4 times, then it will have one-fourth of the depth of

Photographs by H. G. Ponting

Lower view made with Bausch & Lomb Zeiss VIIa, 8½-inch focus. Focal-plane shutter, exposure 1-100th second, *f*11.

Upper view made from same standpoint with Bausch & Lomb Series VIIa and Bausch & Lomb Telephoto attachment. Magnification – 5. Exposure ½ second.

focus for distant objects possessed by the positive alone; the higher the magnification the less the depth of focus. This depth can be increased by stopping down the original positive; but of course this means diminishing the power of the illumination and consequently prolonging the exposure. This is a matter which the photographer must settle for himself by a little practical experience; obviously where a long exposure can be given, say, in the case of an interior, where for photographic purposes the worker has the place to himself, then the smaller the stop the finer the definition and the greater the depth of focus will also be.

How Negative Lenses Act

We should now be in a position to consider what governs the size of the picture in telephotography. It must be remembered that the telephoto besides being a lens of great focal length is also one of variable foci, and consequently the photographer has a choice of size. This is determined by the negative lens, which is a movable factor and can be racked nearer to or farther from the positive lens at will. There is a relationship between the positive and negative lenses which has an important bearing on the point; that relationship is their respective focal lengths. A proportion that will serve to make the point clear at this stage is as 2:1—in other words the use of a 6-inch positive with a 3-inch negative. Suppose a distant object, a building a mile away for instance, be focussed upon the screen with the 6-inch positive alone, and the size of the image measured. With the 3-inch negative lens attached to the positive at a distance from it equal to its own focus, in other words 3 inches, measure the image again, the bellows of the camera extending to 12 inches. It will be found that the image has been magnified five times; now separate the negative 4 inches from the positive; refocus and remeasure the image, it will be found to be magnified only three times; at 4½ inches, twice, at 5 inches, one and one-half times. Thus the nearer the negative lens is to the positive the greater is the magnification, and that the farther it is removed from it the less is the image magnified. Consequently, in telephotography the size of the picture, or its degree of magnification,

depends chiefly upon the focal length of the negative lens, upon its distance of separation from the positive, and upon the relative foci of the two. The separation between the positive and negative lenses varies between the focal length of the positive and that of the negative, the latter being the range of separation; in other words, the negative is placed at a distance equal to its own focal length from the positive, and its focal range lies between that range of distance.

Magnifications and Powers

These two terms are much used in telephotography; a few experiments by the worker will determine their exact meaning. First, as to magnifications: Focus the positive lens alone upon the house a mile away, and then mark the position of the camera front, or the back, if it racks to and fro, on the baseboard. At the same time mark the exact size of the house on the focusing screen. Then add the negative attachment to the positive, and then refocus the camera until the house is twice the size on the screen, and mark the second position of the camera front or back on the baseboard; three, four, five and six magnifications can also be marked in the same way. These magnifications are sometimes called linear magnifications, which merely means that the size of the image on the screen is magnified so many times. But the magnification is not merely linear or in one direction only: it extends over the whole superficial area of the image, so that if a part of the picture occupies a square inch with the positive lens alone, a magnification of four times means that it has been enlarged four times all over, or increased in size to four square inches, and the exposure increased accordingly. Magnification and power are convertible, if not synonymous, terms, for when we speak of low-, moderate-, or high-power work in telephotography we mean proportionate degrees of magnification. The term "power" is more particularly applied, however, to the negative lens and the ratio of its focal length to that of the positive. The shorter the ratio the lower the power; the longer the ratio the higher the power. Thus a 6-inch positive and 3-inch negative ranks as a moderate power; a 9-inch positive and a 3-inch negative, as a high power. As applied to

A—View made with Voigtlander Collinear Lens, Series III, No. 4
Note the portion enclosed in black lines

B—View made from same standpoint as A with Voigtlander Collinear, Series III, No. 4 and Voigtlander Telephoto-attachment No. 4

actual magnifications, anything up to six might be looked upon as moderate; above six as high. There are, however, no fixed standards of classification in the matter.

Working Aperture

An examination of the telephoto image on the ground glass reveals the fact that, in comparison with the picture shown by the positive lens alone with a large stop, there is not the same brilliancy of illumination. The reason is simple: the telephoto lens works with a much smaller stop and so passes proportionately less light. The great advantages of the telephoto are not obtained without some corresponding sacrifices; as we have seen, narrowness of angle is one of them; and smallness of aperture, or stop, is another. But neither in practice interferes with successful work. It is only necessary to know what the actual working stop of the telephoto is, to be able to calculate out the correct exposure. The information is arrived at in this way: The working aperture of a telephoto lens equals the *f*/ number, or the stop that is used, of the positive lens, multiplied by the times of magnification. Thus, to take the case of our 6-inch positive and 3-inch negative, giving 5 magnifications: if the stop of the positive when making the exposure is *f*/8, then 8 multiplied by 5 equals 40, and the telephoto lens is consequently working at *f*/40. To the photographer accustomed in ordinary work to using much larger stops this comparative smallness of working aperture in telephotography may seem to be a very great disadvantage indeed; in practice, however, it will be found not to be the case. For one thing, the great rapidity of modern plates and films allows of the use of comparatively small stops; and the nature of most telephoto work is such that extremely rapid exposures are not required—focal-plane-shutter exposures of $\frac{1}{1000}$ of a second and the like, although as we shall subsequently see it is available for some kinds of hand-camera photography. The comparative smallness of the aperture prevents the use of the telephoto-lens in studio work, where great rapidity of exposure is essential in most cases; but the high sensitiveness of modern plates should compensate for this. Portrait lenses with negative attachments can be used at an equivalent focal

aperture or stop of *f*/ 10, which is not much smaller than many portrait photographers already use.

Definition

One valuable property of telephotographic negatives should be mentioned, viz., the excellence of their definition. In making an enlargement from a negative taken by an ordinary lens, the granularity of the original deposit is also reproduced in the finished picture, which shows a greater or less amount of structural coarseness. Theoretically, a photographic negative should be an impalpable stain; in these days of rapid emulsions it is frequently a granular deposit. By telephotography one avoids the granularity of subsequent enlargement, for we enlarge the principal object in our view direct, and so we obviate the intermediate operation, which coarsens the structure of the image. This feature of a telephotograph is worth noting by those who appreciate fine definition in photographs. Something, of course, depends upon the condition of grain of the plate that is used and the method of development. Extremely fast plates and rapid development favor the production of coarse-grained images. Slower plates and careful development give finer-grained negatives.

Summary of Points

Summing up the introductory points of our subject we first of all see that the size of an object in a photograph is determined by the focal length of the lens used; that the focal length of a lens, or combination of lenses, is measured from its optical center, which is a varying position, and that this focal length decides the necessary extension of the camera. Next we see that a telephoto lens is a lens of compound construction, consisting of (*a*) a positive lens to form an image, and (*b*) a negative lens to enlarge it; that the combination necessarily works at a small stop, and why; that while it gives pictures of near or distant objects on an enlarged scale it includes a comparatively small angle of view in the negative, and that, most important of all, it is the negative lens which influences the magnifying power of the telephoto, converts it either into a long-focus lens pure and simple, or into a battery of lenses of varying foci. If these points are quite clear in the reader's mind, he may safely turn

his attention to the concrete aspect of his subject and set about the making of negatives by telephotography. His first step will be to obtain a telephoto lens and camera and learn their adjustment.

Apparatus

Most probably he already owns a camera and lens; in that case all that he will require is a suitable negative lens or attachment, as it is sometimes called. In exercising this choice the photographer may draw from a wide field, as all the chief manufacturing opticians make lenses for telephotography. Complete telephoto lenses consisting of properly mounted positive and negative elements are listed by Zeiss, Dallmeyer, Beck, Goerz, Steinheil and Voigtländer. Ross makes a special telephotographic tube to which the photographer can attach his own positive and negative lenses. The catalogues of these houses give much information on the subject, and we recommend the photographer to obtain copies of them for perusal. For the positive lens of the telephoto a good objective of the rectilinear or anastigmat type answers all requirements, so that it is not necessary to describe such lenses; the negative element, however, is of greater definite importance from our view-point, and we must, therefore, devote a little special thought to it.

Negative Attachments

The Bausch & Lomb negative lens gives a magnification of from three to eight diameters; it can be used with any good positive lens. The front of the barrel is threaded to receive the positive and the rear end has a flange for attachment to the front board of the camera. The main tube is marked with the degrees of magnification. A similar form of negative attachment, known as the Turner-Reich, is made by the Gundlach Manhattan Optical Company. Voigtländer & Sohn make a tele-negative lens with a fixed tube, which gives a magnification of about two and one-half diameters. The focusing is done either with the camera or the focusing jacket of the positive lens. This firm also attaches a tele-negative, giving two and one-half magnifications to the Heliar Reflex Camera, working at an equivalent focus of seventeen and three-fourth inches, for long-distance work. The positive lens for these attachments is the

Voigtländer Collinear. C. P. Goerz supplies tele-negative lenses of simple form for use on cameras of fixed extension, such as the Goerz Anschutz. With a magnification of seven, the attachment of three inches focus and a No. 1 Celor positive lens covers a whole plate sharply at the fullest aperture. See Frontispiece.

Tele-adapters

Zeiss, of Jena, supplies two kinds of tele-adapters for attachment to an ordinary positive lens. No. 1 is intended for hand-cameras of fixed extension; No. 2 for cameras of varying extension. No. 1 gives an invariable magnification of about four times; No. 2, with bellows extensions of from six to seven inches, gives a range of magnification of from four to eight times. The same firm sends out a simple telephotographic lens of a fixed definite focal length, made in one size only, at a relative aperture of about *f*/14 and a focal length of seventeen and three-fourths inches. It requires a camera extension of six inches only. The lens is for use on near objects only, such as portrait studies, and on a quarter plate includes an angle of 15°.

Choice of Negative Lenses

The beginner may at first be somewhat bewildered by the choice and variety of telephotographic apparatus at his disposal, but with the accumulation of his experience that difficulty will disappear, and he will feel more confidence in picking and choosing his powers or attachments. In selecting an attachment, it is a good plan to have one with an extension tube which will allow of several tele-negatives of various foci to be used in it. If he already owns a 6- or 7-inch positive lens, it is well to commence with a low-power negative, say 1¾- or 2-inch focus. It is preferable to avoid long camera extensions, which is another argument in favor of short-focus negative lenses. It is to be borne in mind that an increase of magnification can be obtained by the use of negative lenses of short focus. With low magnifications, a long-focus negative is requisite to cover the plate and evenly illuminate it. In practice it comes to this, that a short-focus negative will give as many magnifications at short camera extension as a long-focus negative with a more extended draw of the camera. The

ideal condition of things, of course, is a battery of negative lenses for use according to circumstances.

The Telephot

Telephotographs taken in the telephot, an apparatus of novel construction, have recently drawn attention to an instrument which differs somewhat in principle from an ordinary telephoto lens. Externally the telephot resembles a double camera, one instrument being superposed on another. The lower one has the lens mounted in the usual place on the camera front. This lens passes rays of light to an inclined plane mirror in the rear of the camera; this mirror in its turn sends the image to a second mirror, also angularly inclined to the first, and situated in the top camera above the lens beneath. The second mirror reflects the image to a third mirror which is placed in the focal plane at the back of the upper camera. The apparatus is constructed by Boissonnas, Geneva, Switzerland.

Low-power Lenses

When the back combination of an ordinary rectilinear or anastigmatic lens is used for making photographs, we get a single lens of about double the focal length of the entire lens and half its normal working aperture. Thus, if we have an eight-inch lens of which we use the back half, then the focal length of this latter becomes sixteen inches, and with it we can take a photograph of an object twice the size of that produced with the complete eight-inch lens. The stop or working aperture of the lens is also halved in value and so our *f*/8 becomes *f*/16, and so on. This property of double lenses may be regarded in some respects as telephotographic, as it gives a low magnification. In such cases, however, the bellows extension must be sufficient to permit the use of the longer focal length thus gained. Taylor, Taylor & Hobson improve somewhat on the principle. By removing the back glass of a Cooke lens and substituting a special extension lens, the focal length of the lens is increased by rather more than half; at the same time the extra camera extension required is less than if the back combination of a rectilinear is used. Another lens which may be classed among low-power telephoto objectives is the Bis-Telar, made by the Emil Busch Optical

Upper—View made with a rectilinear of 5-inch focus
Lower—View made with a Bis Telar Lens from the same standpoint. Camera extension 5½ inches

Company. This lens is made in foci of seven, ten and fourteen inches; in appearance it resembles an ordinary doublet lens, the front and back combinations being of unequal size and curves. Its largest working stop is *f*/9 and the special characteristic of the lens is that with a short camera extension it gives large-sized images. For example the draw of the camera when using the 7-inch focus lens need be only 4⅛ inches; the explanation of this unusual-looking fact is probably that by the peculiarities of its construction the optical center of the Bis-Telar is well outside the surface of the front lens, the practical outcome being that as a long-focus lens is used at a short camera extension, a large-sized image is obtained. The lens doubles the size of a distant object as compared with a lens of shorter focus on the camera at the same extension—as shown in the accompanying comparative illustrations.

The Adon

The Adon is a complete telephoto lens in itself, but it can also be used in front of any positive lens of the anastigmatic type. It is composed of two combinations: the front a positive lens of 4½ inches focus; the back, a negative lens of 2¼ inches. The lens is suitable for folding hand cameras; its equivalent focal length in use is about twice the camera extension plus 4½ inches. The minimum camera extension at which any required size of plate is covered is about equal to the diagonal measurement of the plate: a 3¼x4¼ is covered at an extension of 5½ inches; a 4x5 at 6½ inches; a 5x7 at 8½ inches. The working aperture when the Adon is used in front of another lens of 5½ or 6 inches focal length, is about *f*/8; with an 8-inch positive about *f*/11. In the following table the *f* values refer to the aperture marked I on the iris of the Adon:

Camera extensions Inches	Focal length Inches	F/Value
5	14·5	13
6	16·5	15
7	18·5	17
8	20·5	20
9	22·5	22
10	24·5	24
11	26·5	26
12	28·5	28

Junior Adon

The Junior Adon, another form of the lens, is used with the back combination of an ordinary lens on cameras of the folding Kodak type, held in the hand. The front combination is removed from the mount and the Junior Adon screwed in its place. The camera bellows is then extended until the focusing pointer is opposite the special infinity point which has been marked for use with the Junior Adon. The exposure for distant objects is made in the usual manner; for near objects the camera extension need not be altered, but the focus is adjusted by rotating the front lens of the Adon until a number indicating the distance of the object, in feet, is opposite an arrow engraved on the outer tube. To adjust the Junior Adon to a camera, screw it into position on the front of the lens and extend the bellows of the camera as far as possible. Place a piece of finely ground glass in the position usually occupied by the surface of the film. Loosen the small screws which will be found at the back end of the outer tube, screw the tube itself in and out on the fine screw thread until the image of a distant object is sharp, the front lens being screwed home to its infinity point. The small screws on the outer tube are then returned to their original places as firmly as possible.

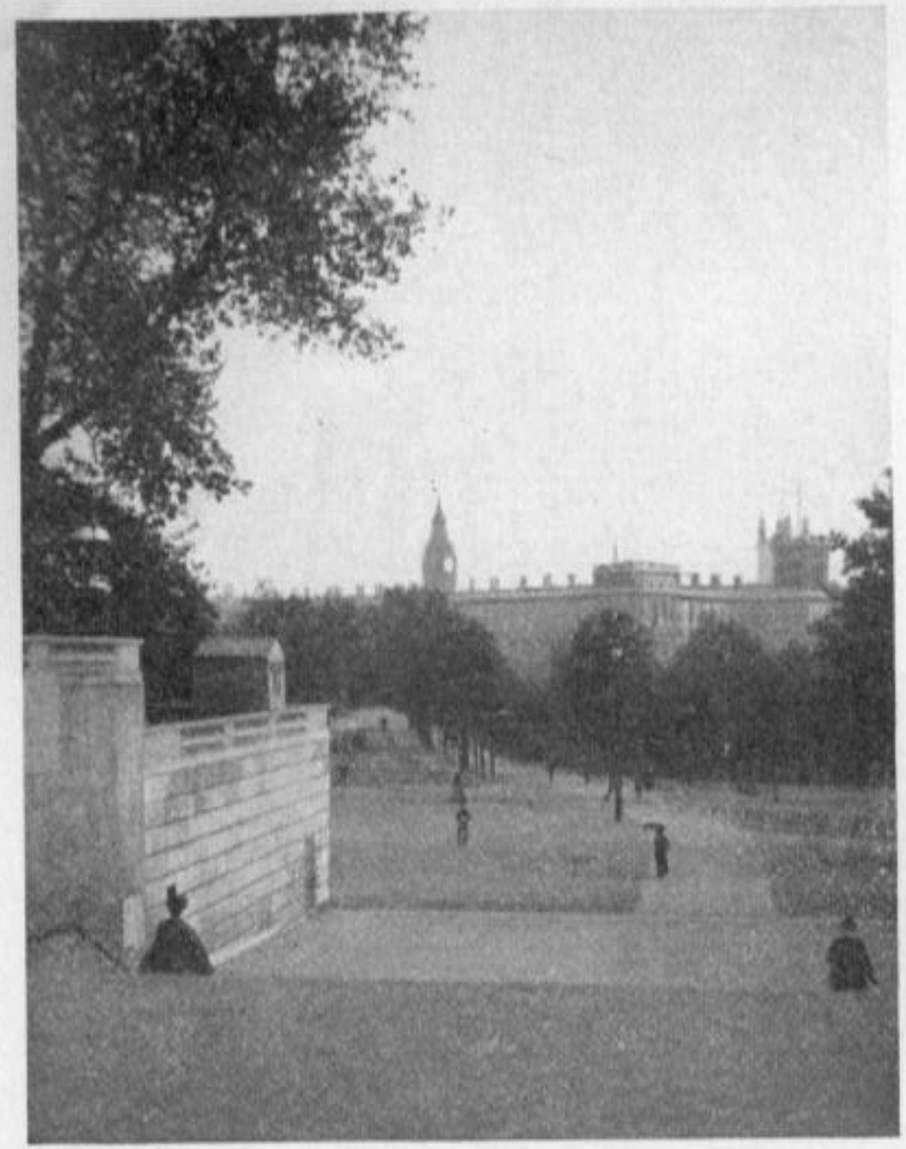
Tele-Cameras

Most stand-cameras and many hand-cameras are available for use with telephotographic work, and some of the manufacturers are responding to an evident desire on the part of the public for cameras specially constructed for telephotographic use. On the ordinary stand-camera, the protuberance of the telephotographic lens from the front is considerable, owing to the length of the tube. Voigtländer & Sohn remove this objection in their new Tele-partition stand-camera, which renders a tele-tube superfluous by attaching the negative lens to a partition wall in the body of the camera. This tele-partition board is controlled by rack and pinion movement, so that, instead of making the adjustment of the negative lens on an external mount in the ordinary way, the tele-partition itself is focused. Externally, therefore, this camera, which is of square form, looks like an ordinary

landscape camera with a positive lens on the front, the negative lens being mounted on the inner board inside the instrument. Zeiss, of Jena, introduce a tele-camera, especially for hand-camera telephotography. The camera is of magazine form, ten to eleven inches in focal length, with a focal-plane shutter and a double plate-holder taking plates of about 3½ x 4¾ inches. On the camera front is placed the tele-objective which racks in and out in the ordinary way. When not in use it is racked into the body of the camera; when making an exposure it is racked forward and fixed in position with a binding-screw. The lens has an equivalent focal length of thirty-two inches, with a relative aperture of *f*/ 10; it can be focused from infinity down to two and three-quarter inches. A feature of the instrument is that on the top of the camera, immediately above the focal plane, is fixed a prismatic ocular glass: the half of a prismatic binocular, which, in a small compass, performs the functions of an observing telescope, by the aid of which distant objects can be accurately sighted by the eye and focused in the camera. It is obvious that with a relative aperture of *f*/ 10, the size of this 32-inch equivalent focus lens must be comparatively great. So it is, for the lens is three to four inches in diameter, and, externally, looks like a portrait lens. The F. & S. Naturalist's Graflex, the Revolving Back Cycle Graphic and the Pony Premo No. 6 are all suitable for telephoto work. Shew, Marion, Houghton and Sinclair, of London, also make long extension stand- and hand-cameras especially for telephotography. For stand work, of course, any good field or copying camera with sufficient bellows capacity can be used.

Tripod Stays

For supporting the camera when at work, the tripod stand should be of such a size that it is capable of bearing a much larger size of camera than is being used. To give it further rigidity the use of Mellen's tripod stay is to be recommended; this handy device not only grips the legs and holds them firmly but prevents them from slipping or sliding on smooth and uneven floors. Once the convenience of a tripod stay is experienced, the telephotographer will never be without one.



A—View of clock tower, Houses of Parliament, from St. James' Park, London. Made with Beck-Steinheil Orthostigmat, 7⅞-inch focus

B—Same subject, from same viewpoint, with Beck-Steinheil Standard Power Tele-attachment fitted to the 7⅞-inch lens Magnification, 8 diameters

Plates

Plates of extreme rapidity are not essential to the work, generally medium-rapidity plates or films will be found the easiest to work with. For preventing halation, which appears more or less in all photographs of every kind, backed or non-halation plates should be used.

Simple Calculations

With a little experience, the calculations necessary in using telephotographic lenses are easily worked out. Nothing of a mathematical nature is necessary, the figuring in each case being not more difficult than a rule-of-three sum. In this section we enumerate all the factors of the calculations, and affix examples of the manner in which they are applied to the working of the lens. The factors are

f′. Focal length of the positive lens.
f″. Focal length of the negative lens.
a′. Aperture of the positive lens.
a″. Aperture of the negative lens.
s. Separation between the positive and negative lenses.
b. Bellows extension for any particular magnification.
m. Magnification of the image on the ground glass.
d. Diagonal of the plate to be covered.
t. Time of exposure.

1. What is the best focal length for the negative lens for use with any given positive? For moderate powers and cameras of short bellows the f″ should be about two-thirds that of f′. For example, with a positive lens of 7-inch focus and a bellows of 12-inch extension, the negative lens might well be of 5-inch focus. For higher powers and longer bellows the best f″ is about half that of the positive.

2. What is the necessary separation between the positive and negative lenses? This is variable. The minimum is equal to the difference of their focal lengths (f′ minus f″). The maximum is equal to f′. Between these limits the separation depends upon the degree of magnification. The formula is—

$$s = f'' + \frac{f''}{m}.$$

3. What length of bellows is required to give a desired magnification? The answer is in the next formula—

$$b = f'' (m-1)$$

For example, to magnify four diameters with a negative lens of 3-inch focus, we get—

$$b = 3 (4-1) = 9\text{-inch length of bellows.}$$

4. What is the magnification possible with any given length of bellows? In this case the formula is—

$$m = \frac{b}{f''} + 1.$$

For example, with a negative lens of f″, equal to 3 inches, and a bellows extension of 12 inches, what enlargement can be secured?

$$m = \frac{12}{3} + 1 = 5 \text{ diameters.}$$

5. What size plate can be covered with any combination at any bellows extension?

$$d = \frac{b}{f''}\left\{\frac{a' f'' + a'' f'}{f' - f''}\right\}$$

For example, with a positive lens of 7-inch focus and 1-inch aperture, and a negative lens of 3-inch focus and also 1-inch aperture, and a bellows length of 12 inches, what is the diagonal of the plate covered?

$$d = \frac{12}{3}\left\{\frac{1\times 3 + 1\times 7}{7-3}\right\} = 4\left\{\frac{10}{4}\right\} = 10 \text{ inches.}$$

This is obviously ample allowance for a 5 x 7 plate.

6. What is the increase of exposure in any case? The rule is, ascertain the correct exposure in the case at hand for the positive used alone, multiply this figure by the square of the magnification; $t = m$, times exposure for positive lens alone.

These formulæ are not so forbidding as they may look to the non-mathematical eye; they are merely so many simple ways of arriving at the data the telephotographer is sure to want in the course of his work, and they are inserted in this monograph because we think the reader will very often wish to consult them.

Practical Work

Getting to practical work, the first step the telephotographer must take is to provide a perfectly rigid stand for holding the camera and lens. He will make most of his exposures by time, with a small stop, so it is important that he should work from a firm base, not easily affected by tremor or vibration. Some photographers use a second stand for supporting the lens end of the outfit; others an arm which extends from the stand to the base of the camera; others a steel or brass rod which is secured to the top of the camera and the top of the lens, thus holding the entire arrangement firmly together. The camera must be strong and rigid, and firm both at the normal draw and its fullest extension. Parallel-bellows cameras are best for the work, as conical bellows sometimes cut off part of the image if the swing back is used on a vertical picture. The camera may often have to be tilted at an angle of 25° to 30° from the horizontal, so that there should be ample swing in the back. A tilting table is used by some workers for holding the camera, a ball and socket tripod top answers the same purpose and is simpler. Whatever means be adopted the end is the same, viz., when tilting the camera upward it should be held perfectly rigid and firm, or the outlines of the picture will be blurred.

Focusing

Let us suppose we are making an exposure on an outdoor subject: a house a mile off on a clear windless day. Set up the camera with the tripod legs widely separated, and attach the complete telephoto lens to the camera front. Rack out the camera fully and point it toward the house. Then with the positive lens at full aperture, using the rack and pinion on the mount, adjust the distance between the positive and negative until the house comes into focus. Bring the house into sharp focus in the center of the ground glass, placing the head under the focusing cloth in order to make the fine adjustment. A focusing magnifier is useful for the purpose, although a careful worker will not find it essential. After the focusing method has been mastered, variations in magnification and covering power of the lens with different camera extensions should be observed and noted. As the camera bellows is racked in and the image refocused,

the area of the picture will lessen and the corners of the screen become dark. Stop down the positive to *f*/11 or *f*/16 and watch the effect. The dark portions of the screen will decrease owing to the increase of covering power given to the lens by the smaller stop. A few trials will show at what particular extension the focusing screen is just covered, and the point marked on the base-board. At great distances and high magnifications much care is necessary in focusing. Three magnifications reduce the light passed by the positive lens alone to $\frac{1}{9}$; seven magnifications by $\frac{1}{49}$; ten magnifications to $\frac{1}{100}$. Light filters still further reduce it. In such circumstances the difficulty is possibly best overcome by throwing the image a little out of focus each way, and by means of the screw on the lens mount moving the negative lens a little each way, and striking a mean between the two extremes, with a little practice the photographer will get used to the work; some prominent or well-defined object in the view or subject will generally suggest itself as a focusing point on which to concentrate attention, and the adjustment will in time come easily and naturally.

Exposure

The rule for finding the exposure in telephotography is very simple. It is: multiply the exposure that would be given by the positive lens alone by the square of the magnification. For example, if with our 6-inch positive lens, the exposure, calculated by Wynne meter, or other means, is found to be 2 seconds, then with the 3-inch negative lens attached, giving a magnification of 5 times, the exposure would be $2 \times 25 = 50$ seconds. The rule is easily committed to memory. In calculating exposures, however, it is well to bear in mind that there are certain modifying factors, such as distance and intervening atmosphere, to be taken into account. Howard Farmer gives a table which shows the ratios of exposure at varying distances.

Distance of nearest shadow or nearest important object	Ratio of Exposure
10 ft. to 30 ft.	16
30 ft. to 100 ft.	8
100 ft. to 300 ft.	4
300 ft. to ¼ mile	2
Beyond ¼ mile	1

This, it is true, is only another way of emphasizing an old truth in photography; viz., the nearer the object the longer the exposure, the farther away it is, the shorter the exposure; Farmer, however, endeavors to reduce the rule to a matter of distance measurement, so as to give a definite guide in making the calculations. For near objects the calculation should always be made for the shadow parts of the picture (expose for the shadows and let the high lights take care of themselves). It is also advisable to bear the rule in mind for distant objects that may be of a dark color, that are surrounded by a large area of illumination; in such a case, there is risk of underexposure if the calculation be made for the lighter parts of the picture such as open water; or country, with no dark shadows. The intervention of atmosphere is also a factor that may influence the exposure very materially; a slight haze will reduce it. The matter will require some judgment on the part of the telephotographer. Generally, however, it may be said that long-distance photographs are only made successfully on clear, windless days. In normal circumstances the rule given is the best guide to follow, and if it is modified intelligently in accordance with Farmer's table it will answer well in practice. For figuring out the actual factors must of course be taken into account: these are subject, light value, lens aperture, and rapidity of plate. To work out the figures, a Wynne meter, or a similar instrument giving all the factors in convenient form, should be used; the influences of atmosphere, distance, and other causes must be weighed and considered by experience, when it has been gained by practical trial. One hint in respect of distant subjects is worth committing to memory. A brilliant light is not necessarily the best for the work: there may be scarcely visible haze in the air. If the distant shadows are very black, and sharply defined, it is a sign of clearness; grey shadows, on the other hand, indicate the presence of mist in the air. Some workers advocate reducing the theoretical exposures for distant subjects on account of the almost certain presence of mist in the air. This sort of thing is purely a matter of personal fancy upon which no reliance can be placed. In tele-

photography the exposures can be made by rule with the same success as in other branches of work.

Rapid Exposures

A word as to rapid exposures. The comparative slowness of an ordinary telephoto lens leads many to suppose that it can be used only for long exposures: and that rapid work cannot be done with it. This is an error. High-speed telephotography is in process of development. Marriage has photographed a train in motion at the rate of twenty miles an hour, the equivalent aperture of the telephoto lens being *f*/12.6, the exposure with a focal-plane shutter being $\frac{1}{80}$ of a second, time and date being four o'clock in April. The sun was in such a position that the train was in shadow. A stand-camera was used and the lens focused on the spot selected for the locomotive. This, it is true, is not very high-speed work, but it is sufficiently fast to show that the lens can be used for ordinary hand-camera photography. An aperture of *f*/12.6 means that a positive lens of *f*/4 approximately, was used, and that a magnification of three times was obtained. In this we are approaching the maximum of telephotographic rapidity—the lens, like all other lenses, having a limit of effective working aperture. For ordinary hand-camera work a low magnification, say three diameters, will be suitable on most subjects; with a positive of *f*/4.5 or *f*/6, exposure of $\frac{1}{100}$ of a second may be successfully attempted. This allows of the telephotography of moving figures—pedestrians, horses, vehicles; and, consequently, in the summer months, much outdoor work can be accomplished with the lens. Natural history subjects also admit of shutter exposures. A great future lies before the telephotographic lens for very rapid work; it is a field which has so far not been properly exploited. Its use with focal-plane shutters giving exposures as quickly as $\frac{1}{1500}$ of a second, is possible; and so, in the photographing of objects moving at great velocity, the camera could be worked at a greater distance from the object than at present. But this application of telephotography remains for future development.

The Telephoto Hood

The delicate focusing of a telephotographic image is facilitated by the exclusion of all light from the focusing screen

except that which passes through the lens to form the image. Captain Wheeler has devised a hood which helps this object. It consists of a square bellows fitted to two aluminum frames, which slide along an aluminum tube and clamp in any position. The back tube screws into the front of the positive lens and the bellows extends to such a position that all light is cut off entering the lens except that which goes to make the photograph. The hood also shields the plate from diffused and reflected light in the camera which degrades the image and impairs the quality of definition, especially in prolonged exposures. The hood therefore increases the brilliancy of the negative, as positive lenses admit a large angle of light, much of which is not necessary to form an image. The Beck-Wheeler Telephoto hood, as the piece of apparatus is called, is sold by R. and J. Beck, London.

Centering the Lens

As we have pointed out the telephoto lens gives a narrow angle of view; consequently it allows of little or no horizontal or vertical displacement. The lens should always be kept opposite the center of the plate and in photographing a lofty object the camera should be tilted until the object is properly placed on the screen, when the back should be swung to the perpendicular. By raising or lowering the lens a part of the picture may be cut off. Swinging the back to a great extent necessitates the lens being stopped down. The choice of a stop is governed by the depth of field wanted in the photograph, or the exposure that can be given. A large stop is best for figures and landscapes. A portrait lens at full aperture can be used for the positive if the principal object is sharply focused. For architectural detail a small stop such as *f*/16 or *f*/22 is to be preferred. The exposure can be prolonged at will and the finer details of the objects brought out.

Architecture

For architectural subjects and remote details in tall buildings, the photographing of which is difficult with the ordinary lens, the telephoto finds one of its most useful applications. A 6-inch rectilinear or anastigmat and a 3-inch negative is a convenient equipment for a 5 x 7 camera. The plate is well covered at an extension of nine to ten

inches. Rigidity of camera and stand are essential in this work. If the detail of the building to be photographed is high up, place the camera as far as possible away from it to avoid foreshortening. In order that the lens shall sharply cover the plate, it is sometimes necessary to go farther away from a comparatively accessible object, because the longer the draw the larger the size of plate covered, and an increase of distance between camera and object means the use of a longer extension to keep the image on the screen the same size as before. Before exposing on an architectural subject, see that the camera back is parallel with the principal plane of the object, or the lines will be distorted in the photograph. Another hint: use a spirit-level for ascertaining if the camera is properly leveled. The most successful telephotographs of architectural subjects are taken in diffused light; if the sun is shining, shield the lens from it. In the photography of interiors it is well to guard against prolonged exposure, on high lights that border on dark shadows, for then halation of the negative is more likely to result. The absence of light will increase the difficulty of focusing, especially if the lens is pointed toward the shadows. Large printed matter, temporarily lighted by gas, lamp or candle, will assist the worker in getting a sharp image on the screen. For interior exposures, the use of a meter in making the calculations is imperative; reliance upon the fallible factor judgment is not at all to be advocated. If the exposure can be prolonged it is as well to use a small stop in the positive, so as to increase the defining power and depth of focus of the lens, but a smaller aperture than *f*/70 must not be used, otherwise diffraction, i. e., blurring of outline will result in the negative.

Landscape

The principal difficulties to contend with in landscape work, and open view subjects, whether on land or sea, are haze; vibration of the camera through wind; and movement of the heated atmosphere which is not obviously hazy, a visually clear atmosphere not always being actually so. Haze in the atmosphere will produce fog in the negative. A color-sensitive plate, used with a suitable light filter is best for distant landscapes taken

under these conditions. To shield the camera from the wind choose the shelter of a wall or house. An umbrella held against the wind and close to, but not touching the camera, will be found useful. To avoid atmospheric vibrations early morning is best for telephotographic exposures, but in clear cold weather successful results can be got throughout the day. For very distant objects as high a magnification as 10 to 15 may be attempted, but in the greater number of ordinary outdoor subjects, those which in photography are known as open views, 5 magnifications will be found quite large enough.

Pictorial Work with the Telephoto

The practical advantages of the telephoto lens to the pictorial and view photographer will be obvious to any one who will consider it as simply a battery of lenses of variable focal lengths, putting aside its other uses for the moment. With size or scale of image and and angle of view (or amount of subject) included on the plate dependent on the focal length of the lens used, the possession of a telephoto combination gives practically complete control over these important factors in the composition or rendering of the subject, enabling the worker to exercise his selective capabilities to the utmost, foregrounds, amount of sky space, scale of object of principal interest and emphasis of any desired feature all falling within his enlarged lens capacity. An example of the range of power thus put into the hands of the photographer may be seen in the four accompanying views of a Jersey farm, by A. R. Dugmore, republished by the courtesy of the Goerz American Optical Company.

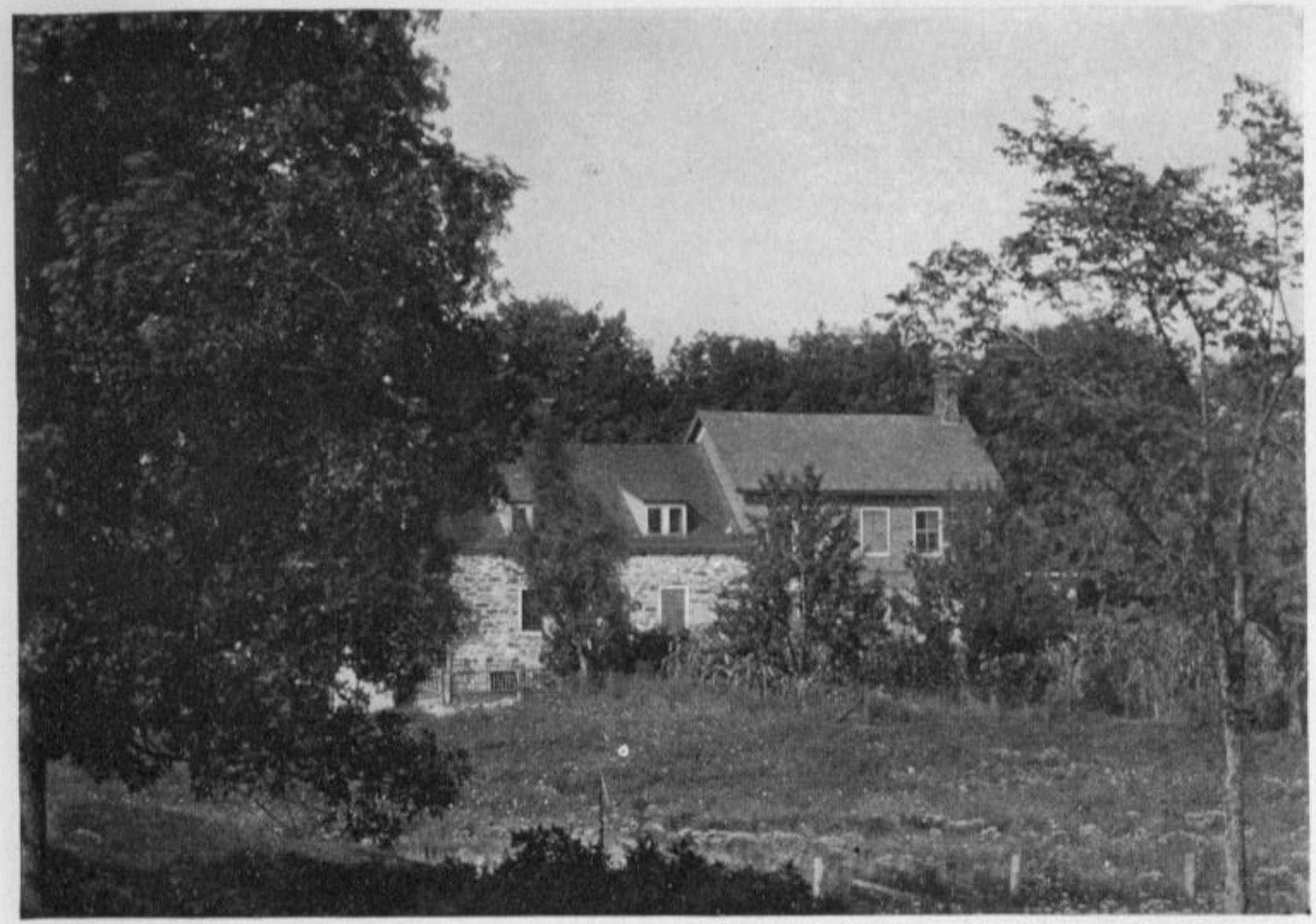
High Magnifications

According to Captain Wheeler, the limit of high power magnification in telephotographic work can be very considerably extended beyond the point usually reached. With the Staley-Wheeler lens, placed on the market by Staley & Co., London, Wheeler claims to get nearly 60 magnifications with a camera extension of about 16½ inches. This he does by using a negative lens of extremely short focus; a half-inch negative on a camera extension of about 14 inches extension giving 29 magnifications. The essence of the idea is the addition to the

A New Jersey Farm
By A. R. Dugmore
A—Taken with Goerz Dagor No. 2 (F.6.8). Focus, 7 inches

By A. R. Dugmore

B—Same subject, taken from same position as No. 1, with Goerz Dagor No. 2, and Goerz Telephoto lens. Stop, F.32. Exposure, 1⅓ seconds. Magnification, 4 diameters.



By A. R. Dugmore

C—Same subject, taken from same position as Nos. 1 and 2, with Goerz Dagor No. 2, and Goerz Telephoto lens. Stop, F.32. Exposure, 2 seconds. Magnification, 6 diameters.

By A. R. Dugmore

D—Same subject, taken from same position as Nos. 1, 2 and 3, with Goerz Dagor No. 2, and Goerz Telephoto Lens. Stop, F.32.

positive lens of a convertible negative combination of varying foci. Any of the lenses of the combination can be used singly; the standard set gives degrees of magnification up to about 30 diameters. Assuming the positive lens to be 7 inches focus the equivalent foci obtained with the Staley-Wheeler negative attachment ranges from 7 inches to about 18 feet! Wheeler states that he can focus sharply with a combination giving nearly 60 magnifications, the positive lens working at *f*/8. He states that at only 30 magnifications, with *f*/5.6, or *f*/4.5 positive lenses there is plenty of light in all ordinary cases. The Staley-Wheeler Telephoto appears to give remarkable results; but further experience with it is necessary before its claims can be finally passed.

Telephotographic Definition

A comparison of the definition of a telephotograph with that obtained with a good positive lens when used alone may and sometimes does show that the quality of the former is not so fine as the latter. The real test of the point is how far the telephotograph will stand subsequent enlargement. Telephotographs at nine magnifications have been produced which stood further enlargement by four diameters, without stopping the positive lens to a smaller opening than *f*/11 or *f*/16. The definition of the negative is good all over and, according to Captain Wheeler, a 5 x 7 will enlarge satisfactorily to about 19 x 26 inches. At very high magnifications the definition necessarily falls off, but even then it should be of a good quality; pictures of such a size are not viewed from so near a point as photographs taken with lenses of shorter foci, and consequently one does not look for the same quality of microscopic definition in them as in smaller prints.

Near Objects

The telephoto lens, as already pointed out, has the useful property of rendering near objects with a pleasing effect of drawing. In the case of flower studies, for example, the parts of the object lying in various planes are shown free from exaggerated differences in size, and isolation of the principal object against a simple background is more easily obtained. H. T. Malby gets an image of the same size as the original with a distance of seventy-

two inches between object and lens; to effect this it is necessary that the camera extension should be twice the equivalent focus of the telephoto lens, in accordance with the well-known rule applicable to the copying of objects same size. To give some idea of the value of the lens for photographing near objects let us suppose it necessary to take a flower an appreciable size on a 5 x 7 plate; we should have to get within three feet of the object; put a negative attachment on the positive lens which will give eight magnifications and the same-sized picture can be gotten with the camera twenty-four feet away. From what has been said it will be evident that the telephoto lens can be used for copying purposes where exposure is of secondary consideration.

Portraiture

A common defect seen in portraits taken with lenses of too short focal length is distortion of the features, hands and feet; the telephoto lens by virtually lengthening the distance between the objective and the focal plane gives a more natural drawing by preventing this exaggeration of rendering. The lens therefore finds a valuable field in studio portraiture, especially if the work has to be done in confined situations, or short studios. W. Cadby has experimented with the Adon telephoto lens for portraiture. Using the lens on a studio camera and in a room measuring 15 x 14 feet, he exposed the lens with full aperture and produced softly defined pictures at close quarters without distortion. He compares them with pictures obtained with the Dallmeyer–Bergheim lens, a lens which gives soft images without loss of structure. Robert Demachy made comparative results with a rectilinear lens and a telephoto, the subject being a lady standing in a garden on a gravelled path in front of a country house. The effect in the first photograph as if one looks down on the figure, the line of the gravel path being as high as the shoulder, a plot of grass looking "like an ugly slice of a big cake." In the telephotograph the gravelled path comes up only to some distance below the waist, one is looking up at the figure instead of down on it, the grass plot flattens out, and, although the house in the background appears much nearer to the figure than before, there is an illusion of

atmosphere which is wanting in the other photograph, with a softness and other subtle differences not to be found in it. The Dallmeyer-Bergheim lens, which by some workers is classified as a telephotographic lens, is a combination of single uncorrected positive and negative elements separated by a mount, with the aperture placed in front of the positive. Marriage has published some experimental results with it. The lens being uncorrected, the image seen by the eye on the screen is not what the plate records; upon racking the lens in and out, colored fringes are seen where the lights and shadows oppose. The definition appears sharpest to the eye when there is a blue halo round the high lights: In order to make a sharp impression on the sensitive plate, the lens should be altered until there is an appearance of red at those points. The sitter being about twelve feet from the lens and the camera racked out to its fullest extent, the distance between the negative lens and the screen was thirty inches. The exposure with a No. 2 lens on a rapid plate at full aperture—equivalent to *f*/16—was six seconds, and in the picture the detail was softly rendered and the distortion of the features and limbs of standing figures was suppressed. All this bears out what has been said of the telephoto lens as one which renders portraits in pleasing perspective. The hands, head, body and feet are shown to the eye in their proper proportions in the photograph, whilst the surrounding objects, if there be any, are subordinated in size to the central object of interest. In group, figure and portrait work it is unfortunately mostly the other way, as the reader can see for himself by taking up and examining the next commercially produced—or amateur—portraits that come his way.

Reflex Camera Work

In hand-camera telephotography some difficulty may be found in focusing the principal object; at moderate magnification it can be centered correctly on the plate by the use of an ordinary finder, but accurate focusing by scale if the object is near is out of the question. A reflex camera is essential for such delicate focusing as a telephoto lens necessitates. If the object advances towards or recedes from the lens, it is a good plan to anticipate a

little with the focusing and make the exposure when the position of maximum sharpness on the ground glass of the reflector is reached. Focus by altering the separation of the lenses; the milled head screw on the negative end of the tube should be large enough to allow of slow and steady movement of the rack and pinion. When using a reflex camera for this work C. S. Akerman finds that underexposure is a great danger. He uses a focal-plane shutter; a 5¼-inch positive lens with a working aperture of *f*/3 and a 2¼-inch negative, the equivalent aperture of the combination being *f*/15. He frequently works at *f*/24 with equivalent focal lengths varying 27 to 40 inches. In exposing he finds that the jerk given by the release of the mirror is no drawback; he makes a point of holding the camera more steadily than a hand-camera with an ordinary lens, and recommends an additional stay for the lens if the camera is used at long extension. When working, the camera should be slung from the shoulder in order to leave the hands free; adjustment of the focus is exceedingly difficult if the camera is held in the hand in the ordinary way of outdoor photography.

Stereo-telephotography

A modification of the telephot, as already described, can be used for making stereoscopic telephotographs, i. e., double photographs of distant objects which, when properly cut and mounted, show in a stereoscope the illusions of relief and solidity. Two lenses mounted on the camera front, separated by a distance of eleven and one-half inches and having focal lengths of twenty-seven and one-half inches, pass images of distant objects to inclined-plane mirrors situated at the back of the camera. These plane mirrors transmit the images to other inclined-plane mirrors situated in the same plane as the positive lenses, the images being finally reflected on to the focal plane at the back of the camera, which is virtually a double camera, one instrument being superposed on another. An alternative plan is the employment of a pair of telephoto lenses in a binocular camera. The work is difficult and only to be attempted by advanced practitioners interested in the stereoscopic rendering of remotely situated objects.

Development

In developing telephotographs of near objects the plan in ordinary use should be followed; good, clear negatives may, in normal circumstances, be looked for. In negatives of distant objects a certain amount of fog will usually be seen, due to the presence of haze in the atmosphere, a condition that prevails in the greater number of cases. Orthochromatic plates and a suitable light filter will cut out the haze in distant landscapes. On clear days slow, ordinary plates also give good results. Sometimes when a telephotographic negative is developing the image will be veiled and the photographer may be inclined to reject the plate as spoilt; this should not be done, as the veil or fog is simply the characteristic haze of the subject coming out under the influence of the developing solution. Let development be proceeded with and a good negative will be obtained.

Printing

High-surface papers are the most suitable for printing telephotographs, as the definition of the negative is not reduced, which would be the case if some of the rough-surface "pictorial" papers, now so much in favor, were used. Though telephotographs may be treated from the pictorial aspect, it is nevertheless true that their main value lies in their qualities of definition and the correct rendering of the delicate tones of the original subject, so that the worker is recommended to apply the recognized rules of "straight" negative-making and printing to their reproduction. In our experience telephotographs make excellent subjects for lantern slides and always deeply interest an audience in showing the remarkable results that can be made with the lens. We remember with pleasure the great effect produced upon our hearers when showing on the screen, in the course of a lecture, a lantern slide of Boissonnas' wonderful telephotograph of Mont Blanc, taken from a distance of forty-five miles. In more recent years the interesting telephotographs exhibited by Dr. Elmendorf and other professional lecturers have excited public admiration and comment. As a natural result of this publicity, progressive photographers here and abroad are turning to telephotography and its possibilities with new interest and enthusiasm.

As a comparatively unworked field it has many fascinations for the careful worker in photography. Those who enter upon it with an intelligent grasp of what we have set forth in these pages should quickly reach successful results with little or no difficulty.

BOOKS

Telephoto Work. By C. H. Deller. 1904. 63 pp.

Elementary Telephotography. By E. Marriage. 1901. 118 pp. Illustrated: with tables.

Telephotography. By T. R. Dallmeyer. 1899. 148 pp.

Apart from these works, of which that by Marriage is perhaps the most helpful, the reader will find much useful information in the telephoto booklets issued by the different lens makers here and abroad, a list of which we give here for the information of those interested: Dr. Rudolph's monograph on *Telephotographic Objectives*, and the Zeiss catalogues from E. B. Meyrowitz, New York; the *Adon and Adon Junior* booklets (Dallmeyer, Ltd.) from Burke & James, Chicago; *Practical Notes on Telephotography*, from R. & J. Beck, London; *The Bis-Telar*, from Busch Optical Company, London; *The Ross Telephoto Tubes*, from George Murphy, Inc., New York, and the catalogues of the Goerz American Optical Company, New York; the Voigtländer & Sohn Optical Works, New York; the Bausch & Lomb Optical Co., Rochester; Gundlach-Manhattan Optical Company, Rochester, and *The Steinheil Tele-Objectives*, from Herbert & Huesgen, New York.