HYPERCLOSE-UP PHOTOGRAPHY WITH THE EXAKTA

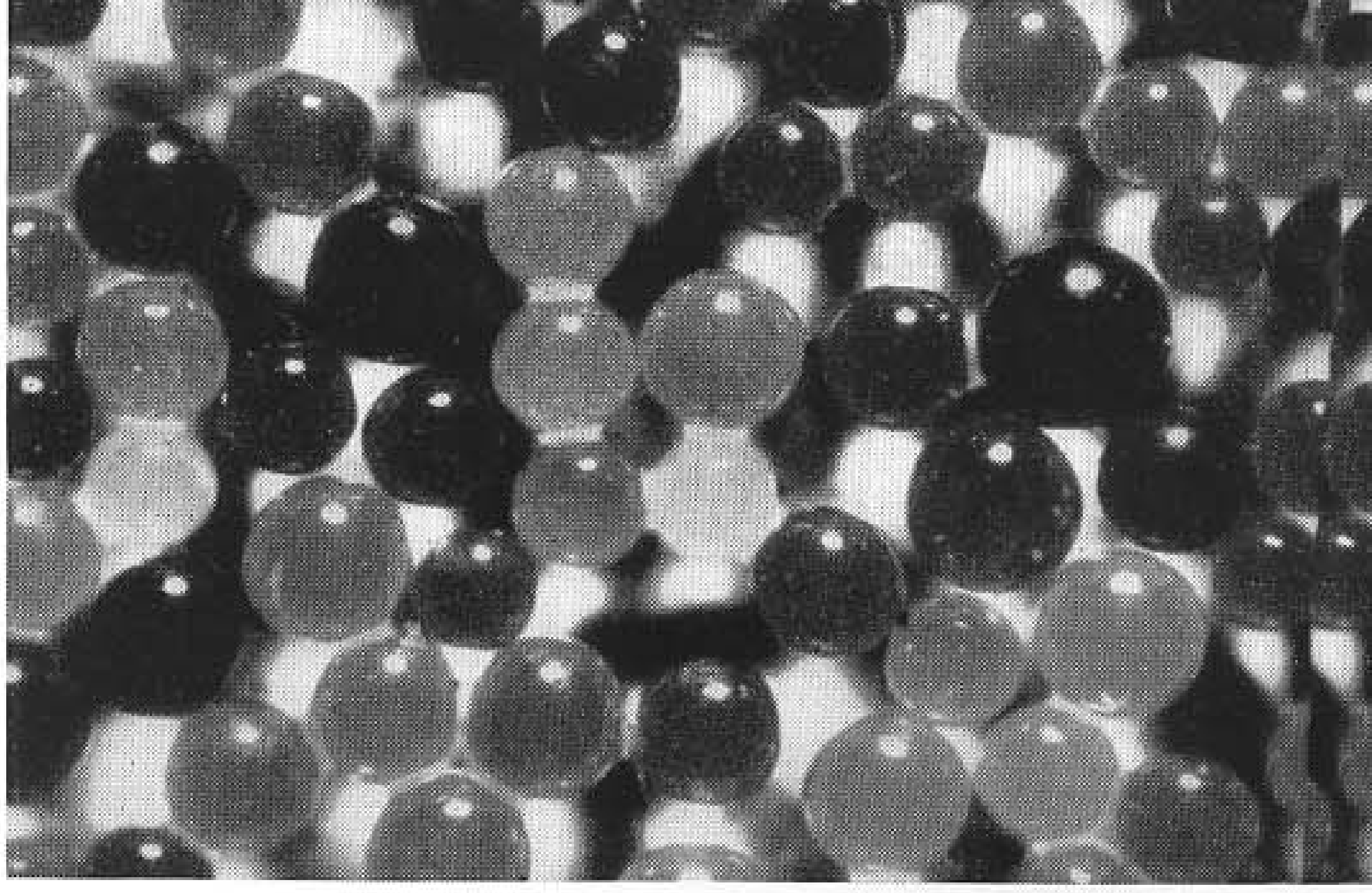
By George Berkowitz

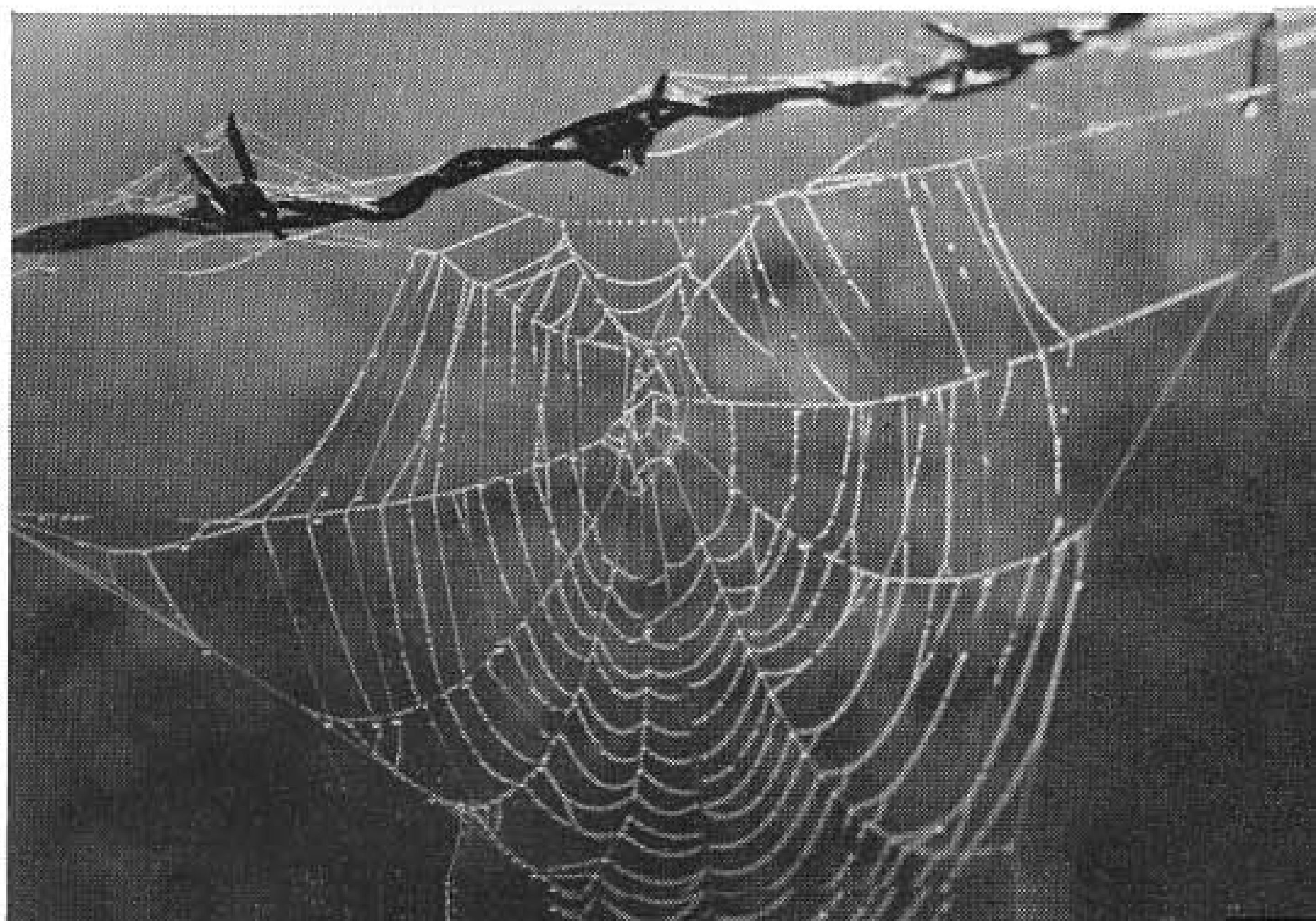
AT ONE TIME *or another, you probably have looked at a finger through a magnifying glass. You brought your eye close to the glass. There was a magnified image of a small portion of your finger. The lines and whorls resembled deep ruts, the callouses rough abrasions and the cuts sharp incisions. The unusual size of these familiar details was surprising. Even more surprising were the unfamiliar details that became visible for the first time to you through the magnifying glass.*

Hyperclose-up photography, in principle, is much the same as looking at an object through a magnifying glass, except that a camera is used. A hyperclose-up photo differs from an ordinary one in only one respect. The hyperclose-up is a magnified image. It reveals details that otherwise are not apparent.

Hyperclose-ups, by their very nature, are always intriguing, often provoking and occasionally astounding. They are more than visual stimuli, however. Because they reveal details not shown in other photos, they have become essential aids in medicine, dentistry and other scientific fields, in business and industry, and in education. They are indispensable tools in so many types of activities that there naturally is a steadily increasing interest in the technique of producing them.

This booklet is intended to serve as an introduction to the hyperclose-up technique. Although it is written for the 35-mm. Exakta owner, much of the technical data presented here applies to all cameras. Hyperclose-up photography, as it is usually defined and as it is discussed here, does not include photography with the microscope. Photomicrography, which is ultra-close photography with the aid of a microscope, is a separate, specialized field with a different technique.





SEVERAL YEARS AGO, a magazine published a fascinating photo of a well-known comedian's nose. The famous proboscis was greatly exaggerated in size. Every pore looked like a valley between mountains. The picture was an eye-stopper. It also was a stunning example of what hyperclose-up photography can do.

Not every hyperclose-up is sensational, of course. However, even a routine one has sure-fire impact. Hyperclose-ups have the lure of the unknown. They mirror a world that exists, so to speak, in front of our noses, yet is rarely seen because our vision is limited. It is this exciting world that the hyperclose-up photographer seeks to record.

The terms *hyperclose-up* and *hyperclose-up photography* are new to the field. They have been coined deliberately to avoid the confusion created by the use of the words *close-up* and *close-up photography*. The latter are familiar to all photographers, but definitions of them are always vague. It's easy to see why. Still and movie photographers for years have referred to portraits and similar photos as close-ups. Photographers in the close-up field, on the other hand, have used the term to mean pictures of subjects like the head of a pin.

The word usually is loosely used to mean any picture taken with the camera lens extremely close to the subject and magnifying the subject's image. Both a portrait and a picture of the head of a pin qualify if this definition is used. Yet one is within the normal range of a lens and the other is not. One requires a special technique, the other does not.

Even more confusing is the fact that the instant a lens is focused on a point closer than infinity, it is closer to the subject and the image is magnified. Broadly speaking, therefore, a picture taken with the lens focused on any point closer than infinity could be called a close-up. Even if this reasoning were rejected, to compound the confusion, there is no point within the normal range of a camera lens that could be logically named as the dividing line between ordinary and close-up photography.

Obviously, there is need for a new term and definition. Logically, it should be based on the normal range of the lens. This range can then be called ordinary photography, because it requires no change in equipment or technique, whether you focus at infinity or 20 inches away. When the normal range of the lens is extended, a change in equipment and technique is required, so we can call this hyperclose-up photography. A hyperclose-up, therefore, can be defined as a picture of a subject taken closer than the normal range of the lens permits.

Our definition must tell us more, however. We must know what a hyperclose-up looks like and how it differs from an ordinary picture. Then we must learn how to achieve it. A review of what we know about camera lenses and their function will help us get this information and understand it. To avoid confusion, this discussion about lenses is confined to those made for the Exakta, although it applies to almost all others.

A lens, used in the ordinary way, transmits a greatly reduced image of the subject to the film. Examine the Exakta's ground glass and you will find that the subject's image is a miniature, much smaller than life size. How much smaller depends upon two things.

The reduction depends, first, upon the distance bebetween lens and film, but here the effect is just the reduction (smaller the image is). The less distance, the less reduction (larger the image is). The image always will be much smaller than life size, however, unless the basic camera-lens set-up is changed.

Image reduction also depends upon the distance between lens and film, but here the effect is just the opposite. The less distance, the more reduction. The more distance, the less reduction. Once again, however, the image will always be much smaller than life size unless the standard camera-lens set-up is changed.

Disadvantage for Greater Benefit

Image reduction is one of the minor handicaps we incur to gain the benefits of smaller cameras and lenses and roll film. It is a cheap price to pay for the convenience and economy of modern equipment, since enlargement of a negative by projection printing usually is not very difficult. Nevertheless, there is no reason to create extra work and difficulties. If the largest possible image is obtained on a negative, then enlargement can be kept to a minimum. Consequently, photographers seek image magnification and try to minimize image reduction as much as possible.

We know that image reduction is decreased when a lens is moved closer to a subject and away from the film. Decreasing image reduction is another way of saying image magnification. Therefore, we can say that a lens will magnify an image if either one of two conditions is met—the distance between lens and subject is decreased or the distance between lens and film is increased.

One way to decrease the distance between lens and subject is to move the entire camera closer. If you want to see how this magnifies an image, focus your standard (50-mm. or 58-mm.) lens on a distant object. Then, slowly walk closer to the object, keeping it in focus continually by turning the focusing ring and inspecting the image on the ground glass. You will see progressively less and less of the subject's area, but the detail will grow larger and larger as you approach the subject.

For example, supposing you focus on a brick house 1,000 feet away. You undoubtedly will see all of it in the viewfinder frame at first. As you approach the house, however, progressively you will see less of it in the viewfinder. Finally, maybe only one brick will be visible. The brick will be indistinguishable in the finder when the camera is 1,000 feet from the house. When the camera is only a couple of feet away, however, the image of the brick will fill the finder frame.

Is this hyperclose-up photography? No, not if we are to avoid the loose definitions that have confused the field for years. This is normal, ordinary photography, utilizing a property common to every lens with a variable focus, including those made for the Exakta. This property is the ability to render a sharp image of a subject located at any distance within a range from the lens. Such a lens also has the ability to vary the image size when the plane of focus (the plane on which the lens is focused) is changed.

A fixed lens can focus on one plane only and only that plane can be sharp (the optical phenomenon of depth of field is discussed on pages 14-15). Variable focus, however, gives a lens a range; that is, it can be focused on an infinite number of points (one at a time, of course) within a limited distance and render a sharp image of them. The range is limited mechanically, not optically.

If a lens had unlimited range, hyperclose-up photography could be done with the basic camera-lens set-up and no special technique would be required. Unfortunately, lenses must be limited in range for practical physical reasons. This is why. Variable focus in a lens is achieved by means of a helical mount, a turning device that permits the two-part shell of the lens to telescope in and out. If the lens is focused on infinity, the shell is telescoped in and is at its shortest length. As the lens is turned to focus on closer objects, the front part of the shell extends, increasing the distance between the front and rear elements of the lens and, at the same time, the distance between the front and back of the lens.

It would be possible, theoretically, to design a lens that could be extended indefinitely, and, as a result, would have unlimited range. Such a lens, however, would not be practicable for reasons of weight, awkwardness and complexity of operation, and expense. Therefore, variable-focus lenses are designed with a limited range and additional mechanical or optical devices must be used to increase the range of such lenses so they can take hyperclose-ups.

Every variable-focus lens has a range, as we have said. This range marks the normal focusing limits of that lens. One end of the range always is infinity, the other end is some point close to the camera. The range of the lens always is shown by a focusing scale engraved on the shell. The ends of the scale mark the limits to which the lens shell can be turned in focusing.

It is certainly valid to consider any picture taken with the lens focused on any point within its range as normal, ordinary photography. Hyperclose-up photography, therefore, can also validly be thought of as any picture taken with the lens focused on a point outside the range of the lens (that is, *closer than its nearest focusing distance*).

But how can this be? We know from experience that when you get any closer with your lens than the nearest focusing distance engraved on the scale the image goes hopelessly out of focus. Moving the camera and lens closer to the subject does not bring the image back into focus and the lens shell cannot be turned any further. The image remains unsharp until you move the camera and lens back of the point where the image got unsharp. This being true, how can we obtain a sharp picture when the lens is focused on any point closer than the range of the lens permits?

Key to Hyperclose-up Photography

The answer to this question is the key to hyperclose-up photography. By means of the aforementioned special devices, we find it possible to increase the range of the lens, literally to push it into the extremely close areas so it can record sharp images. This, then, is the real key to hyperclose-up photography—extension of the normal range of the lens.

Recapitulating, any picture taken within the normal range of the lens, even if the lens is focused at the nearest distance, is not a hyperclose-up for the purposes of this booklet. There must be a sharp differentiation between a hyperclose-up and a picture taken with the lens closer than infinity. A picture taken with the normal range of the lens increased by some special device is a hyperclose-up.

The nearest distance upon which the lens normally can be focused varies with the focal length of the lens. Focal length is the distance between the film and optical center of the lens, *when the lens is focused at infinity*. The shorter the focal length, the greater the range and the closer the nearest distance upon which the lens can focus. The standard 50-mm. lens for the 35-mm. Exakta can be focused as close as about 20 inches without additional equipment. The 135-mm. lens for the same camera, however, cannot be focused any closer than about 4 feet without special equipment. Consequently, it is impossible to say specifically where hyperclose-up photography begins except with an individual lens. It is a varying point, but in most cases, within 2 to 4 feet of the subject.

The information we have been seeking now has emerged. A hyperclose-up is a magnified image of the subject, obtained by increasing the normal range of the lens with a special device. Functionally, this means merely increasing the distance between lens and film and decreasing it between lens and subject more than the lens ordinarily permits.

A hyperclose-up and an ordinary picture, both taken from the same location with the identical camera and lens and of the same subject, would show two marked differences. Less of the subject's image would appear in the hyperclose-up. On the other hand, subject details would be enlarged in the hyperclose-up. These differences would result from image magnification.

The objective of hyperclose-up photography is a picture that reveals details and structures not ordinarily distinguishable. Not much detail can be observed in a 24-by-36-mm. contact print, so it is usually necessary to enlarge miniature negatives by projection printing. It is logical to wonder why the intermediate step of hyperclose-up photography cannot be eliminated and the entire image magnification achieved by enlargement of an ordinary negative.

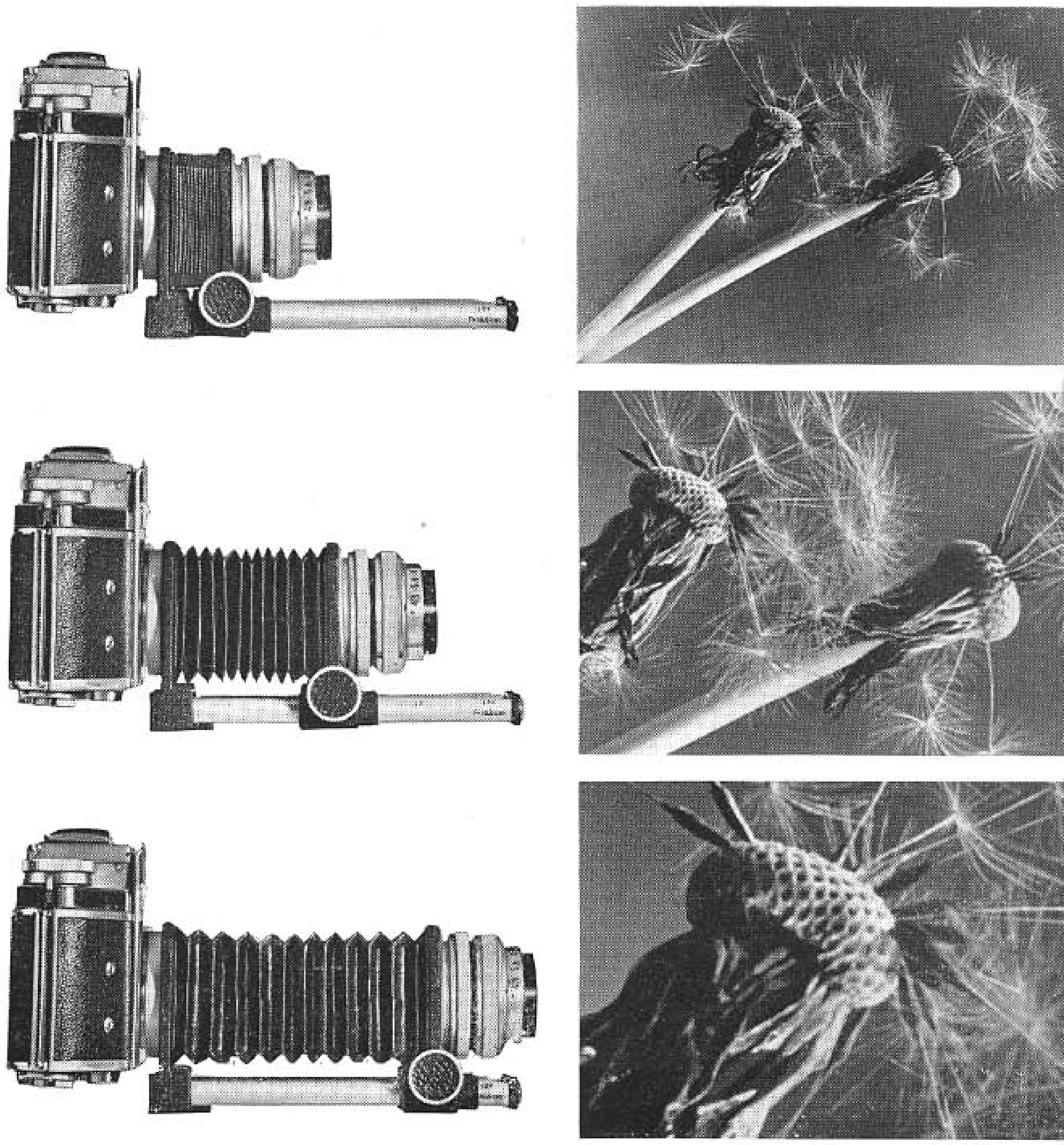
The answer lies in the limitations of projection printing. Photo quality suffers with this kind of enlargement. Loss of definition is slight, often unnoticeable, at low magnifications, but is very great and disturbing at high magnifications. If a detail were enlarged to the great magnification usually required in hyperclose-up photography, it would lose definition so badly it would become very fuzzy (unsharp). Consequently, it would be unsatisfactory for inspection and the main purpose of the picture would be defeated. As we have mentioned before it makes better sense to start with the greatest possible magnification in the negative and then do a minimum of enlargement.

Type of Camera

Before we turn our attention to the technique of hyperclose-up photography, we should consider the equipment required. A 35-mm. camera is unusually well-suited for such work because it offers the major advantages of convenience, adaptability and economy. It is light and easy to handle. It uses 35-mm. roll film, which is inexpensive compared to larger sizes, especially for color, and is available in 36-exposure lengths.

For many years, the 35-mm. Exakta has been the favorite of hyperclose-up photographers. There are many reasons for this. One of the most important is the Exakta's single-lens reflex system. This system assures the photographer that he will always get on film the exact image he sees on the viewfinder ground glass. It permits him to see the image continually up to the instant of exposure.

The Exakta's single optical system for both viewing and taking the picture eliminates the guesswork of photography. With it, the photographer is not handicapped by parallax, an optical problem of many cameras. Parallax is the technical name for the discrepancy in view of two optical systems in different locations. If one optical system is used for viewing the picture and another optical system, in a different



The above pictures illustrate hyperclose-up photography. The closer the lens to the subject and the farther the lens from the film, the more the image is magnified.

location, is used for taking the picture, the image of the subject in the viewfinder will not be identical with the one the film will record. Since the picture is composed according to the image in the viewfinder, the film obviously will record a different composition than the one the photographer thinks he is getting. Some unwanted parts of the subject will be recorded and other desired portions may be lopped off.

The object of hyperclose-up photography, of course, is to magnify the subject's image within a 24-by-36-mm. frame. Accuracy of composition, therefore, usually is vital. It often decides the success or failure of a photo. The Exakta's single-lens reflex design assures this accuracy. It is the acknowledged ideal camera for this work.

Several other features that make the Exakta an extremely versatile camera are of great significance to the hyperclose-up photographer. The waist-level viewfinder can be interchanged with the Penta Prism for convenient eye-level viewing. The Penta Prism provides an upright image with the sides unreversed.

The Exakta has built-in contacts for regular and electronic flash (see page 16). It is designed (VX models only) for cartridge-to-cartridge film feed so scratches can be avoided and film loading speeded. A built-in knife permits exposed portions of a roll to be cut off and removed in daylight (if cartridge-to-cartridge feed is used).

Of major importance, too, is the possibility of interchanging lenses. The Exakta's lens can be removed rapidly with a quarter-turn because the camera has a bayonet mount. This mount makes it possible also to use lenses other than the one that comes with the camera, broadening immensely the scope of hyper-close-up photography with the Exakta. Interchangeable lenses ranging in focal length from 35 mm. to 500 mm. are available for the Exakta. Any of them can be used for hyperclose-up work (see page 9).

The great range of lenses that can be used with the Exakta makes the camera an unusually valuable apparatus for inspecting specimens as well as photographing them. Specimens can be conveniently magnified up to approximately 20x and studied on the camera's ground glass. The Exakta can be utilized to advantage this way especially in medical and scientific work.

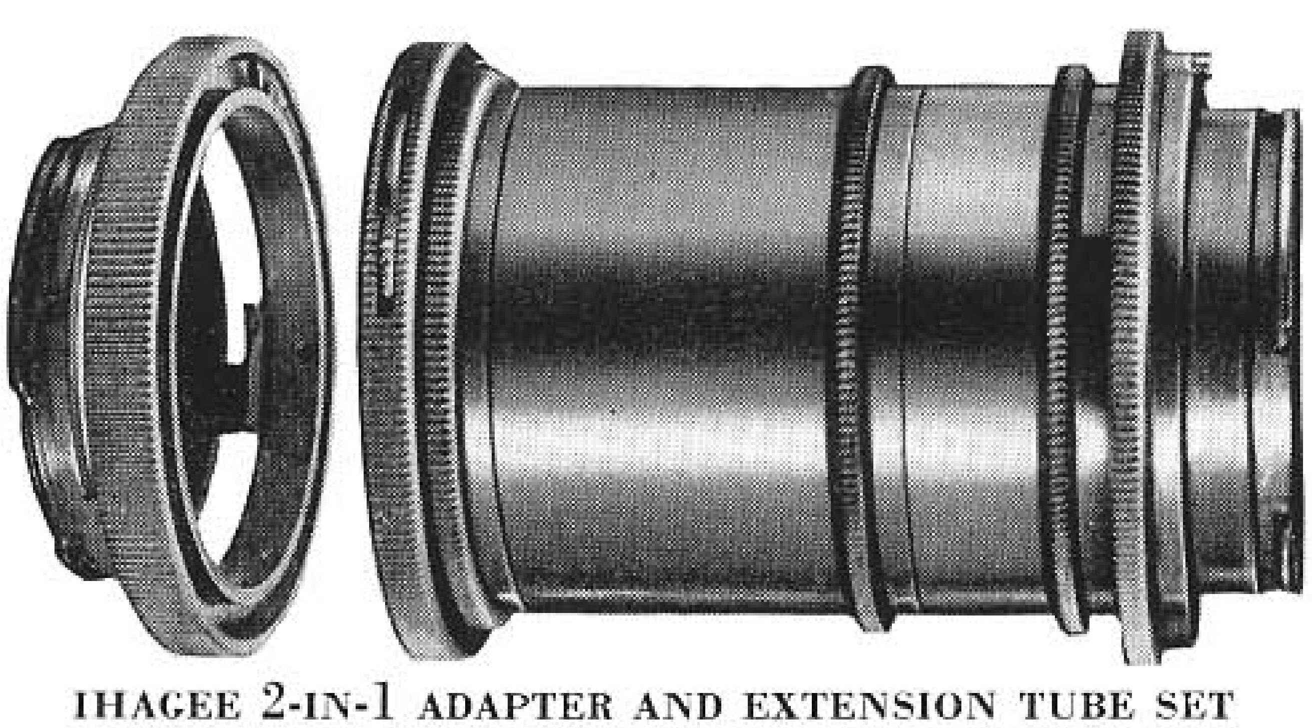
Hyperclose-up photography technique is merely applying what you already know to the subject you want to photograph. You know that the distance between lens and film must be increased and distance between lens and subject decreased to magnify the image more than normal. There are several ways to do this. You need only decide which way is most appropriate and convenient for you and gives you the results you want.

The easiest way to magnify an image is to use a telephoto or other long focal length lens. For the sake of clarity, we must understand that a telephoto is a long focal length lens but a long focal length lens is not always a telephoto. A true telephoto differs from a regular lens in the arrangement of the elements and requires less extension than a regular lens for the same effective focal length.

A long lens magnifies a subject image more and covers less of its area than a short lens. The reason is a familiar one. The distance between film and lens is greater with a long lens than a short one. The distance between subject and lens is less with a long lens than a short one. Both these conditions result in magnification, as we know.

Such a lens functions like a telescope, bringing the image closer and making it larger. If you use a 100-mm. lens instead of the standard 50-mm. lens on your Exakta, the image will be magnified 2x if both pictures are taken from the same spot. A 150-mm. lens will magnify the image 3x, etc. To figure out how many times a long lens magnifies the image given by the standard lens, divide focal length of the long lens by the focal length of the standard lens.

Long lenses can be used with the camera alone for low magnifications, but this is not hyperclose-up photography. You will see this immediately if you try to focus a long lens on a point closer than, say, 4 feet. You will be unable to get a sharp image. To take hyperclose-ups with a long lens, you must use a special device to extend the normal range of the lens, as with short lenses.



IHAGEE 2-IN-1 ADAPTER AND EXTENSION TUBE SET

Extension Tubes and Bellows

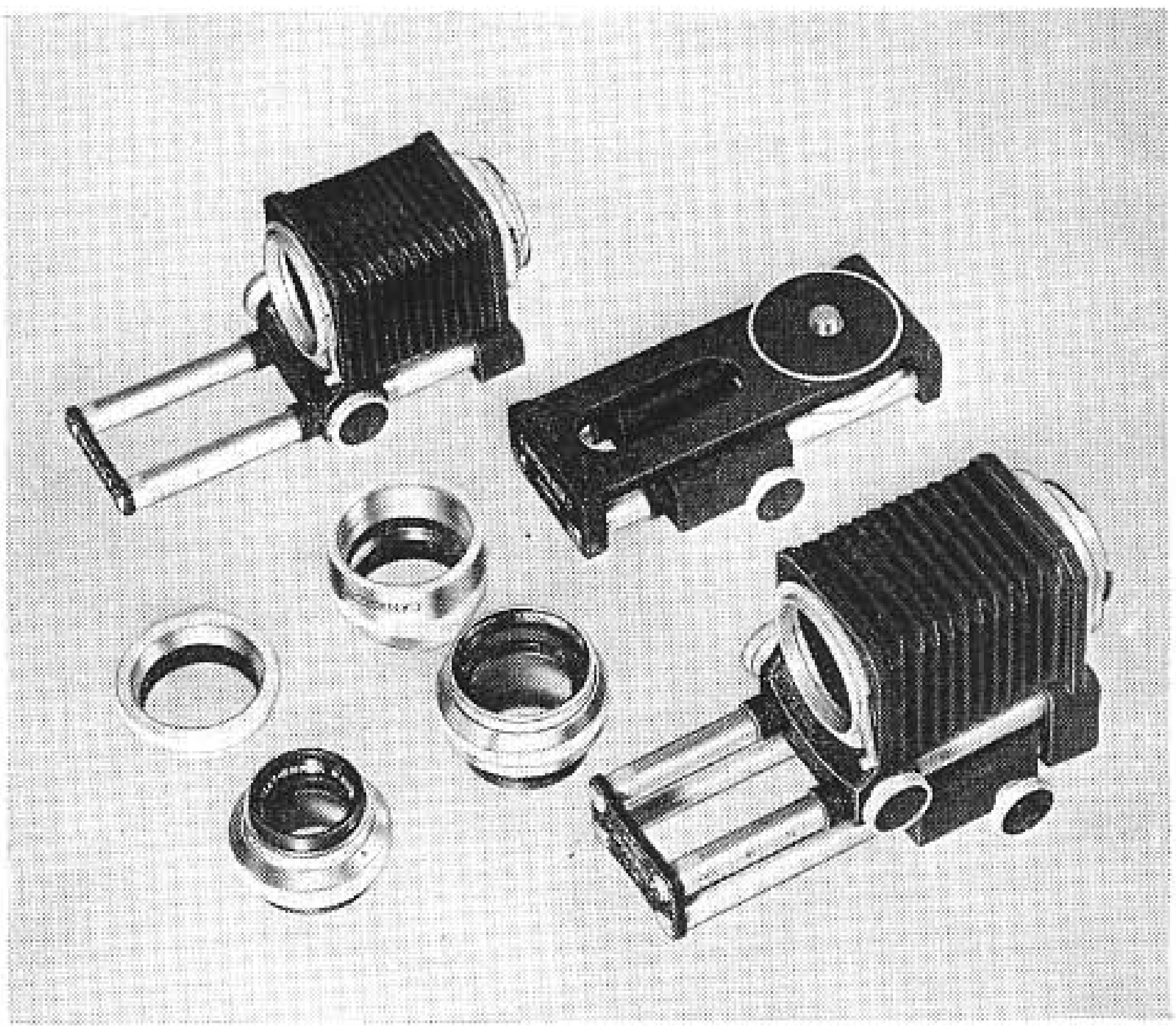
The preferred and usual method of adapting the Exakta for hyperclose-up photography is to insert an extension between the camera body and lens. The extension fulfills the requirements for hyperclose-up work. It increases the distance between lens and film and decreases it between subject and lens. The extension must be variable, naturally, so that the focal length and magnification can be increased and decreased over a range.

Inserting an extension between the lens and camera is easy to do because of the Exakta's bayonet mount. The extension must have on one side a mount complementary to the one on the camera body and on the other side a mount complementary to the one on the lens. Quarter-turns do the rest.

There are two types of extension available for the Exakta—tubes and bellows. They both serve the same purpose. They merely differ in design.

Extension tubes are simply circular metal tubes of varying length (usually 10, 15, 20, 30 and 50 mm.). They are painted black inside to cut down light reflection. One or more tubes can be used since they can be screwed together to form a single, rigid assembly. The tubes are combined until the total extension gives the required magnification.

Extension tubes usually come in sets, but are available in any amount. Ihagee, manufacturer of the Exakta, makes a standard set that includes three tubes (one each of 15, 20 and 30-mm. length) and two adapters. One adapter fits the camera bayonet mount, the other the lens mount. The tubes cannot be used without the adapters, but the adapters can be used



THE NOVOFLEX CLOSE-UP PHOTOGRAPHY EQUIPMENT

without the tubes. Combined the adapters provide an extension of 10 mm. When the adapters are used with tubes, the 10 mm. must be added to the extension of the tubes to get the total extension being used. There is no limitation on the number of tubes that can be used except practicability.

It is sometimes necessary to extend the lens only slightly. Such an extension is impossible with the tubes and adapter rings. For this purpose, however, Ihagee has provided a unique unit called the 2-in-1 adapter. It combines in one unit the necessary mounts for the camera body and lens. Because of its clever design, the 2-in-1 adapter extends only 5 mm. beyond the camera.

The bellows extension basically is an extension tube built on an accordion principle. It resembles the bellows of the familiar folding, press or view camera, but is smaller. It has the major advantage over the tubes that it can be extended or retracted in an instant, altering the distance between film and lens quickly. On the other hand, the bellows cannot be retracted completely, which leaves a definite gap in the coverage it offers equal to the width of the bellows. This eliminates the possibility of small extensions, a considerable handicap.

An extremely versatile bellows extension, called the Novoflex, has been designed for the Exakta. It has the proper mount on each end to fit the camera and lens and forms a single unit with them. The Novoflex will take any lens made for the Exakta as well as additional extension tubes. Therefore, while it theoretically can be extended only to the limits of its bellows, it actually can be extended with tubes or by means of long focal length lenses as far as wanted.

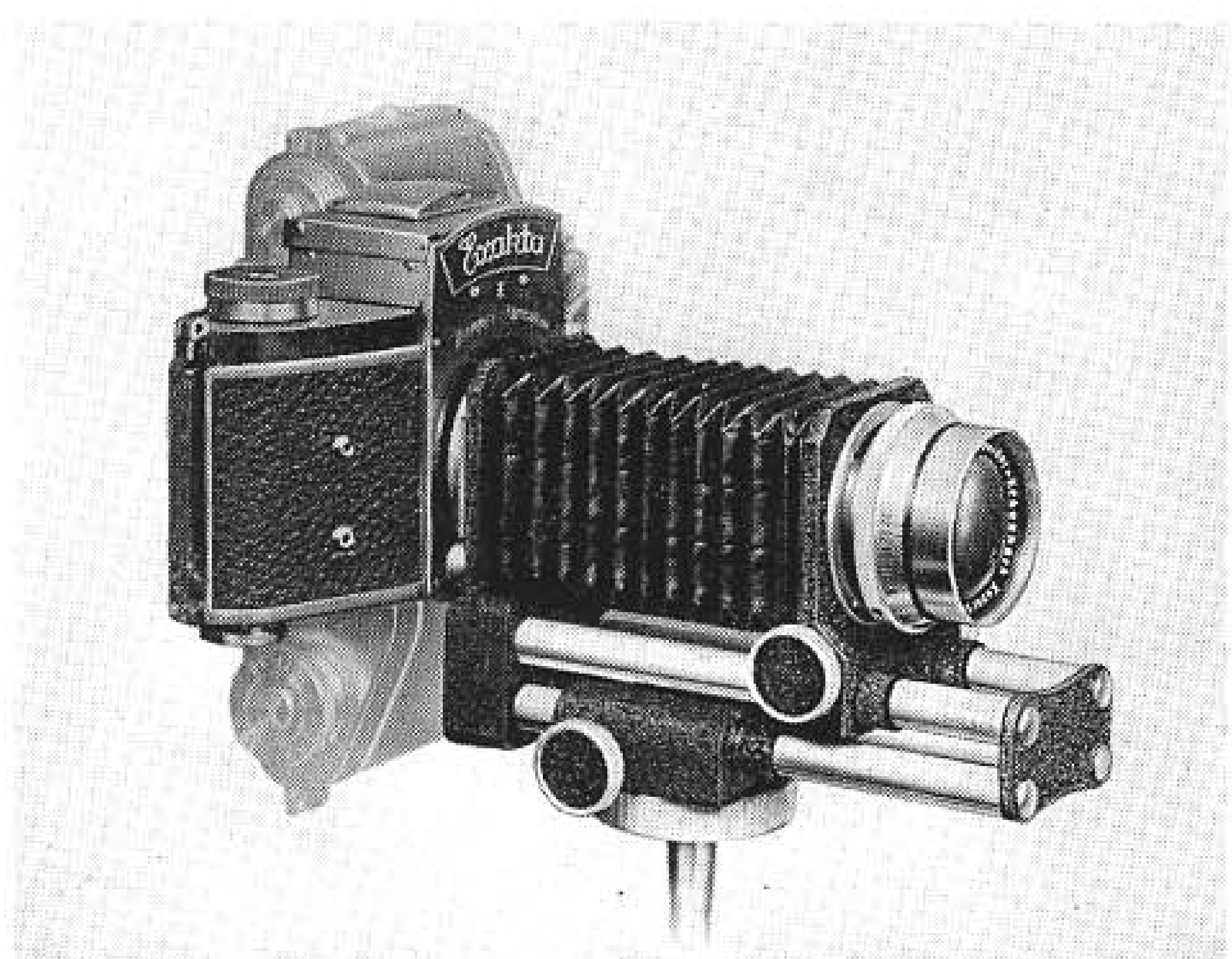
The Novoflex extension from the camera body to the end of its carriage is 125 mm., measured without a lens. The extension from the film plane to the end of the carriage is 165 mm., without lens.

The Novoflex bellows can be accordioned back to the limits of its own width. When the bellows is retracted as much as possible, it still extends 36-mm. beyond the camera body (measured without lens). This would limit the Novoflex if it were not for a special Steinheil lens that gives it remarkable range and versatility. This lens is a 105-mm. telephoto contained in a mount just long enough to cover the glass elements. The extension customarily built into the mount is eliminated, which makes the lens less expensive. The Novoflex bellows supplies the extension.

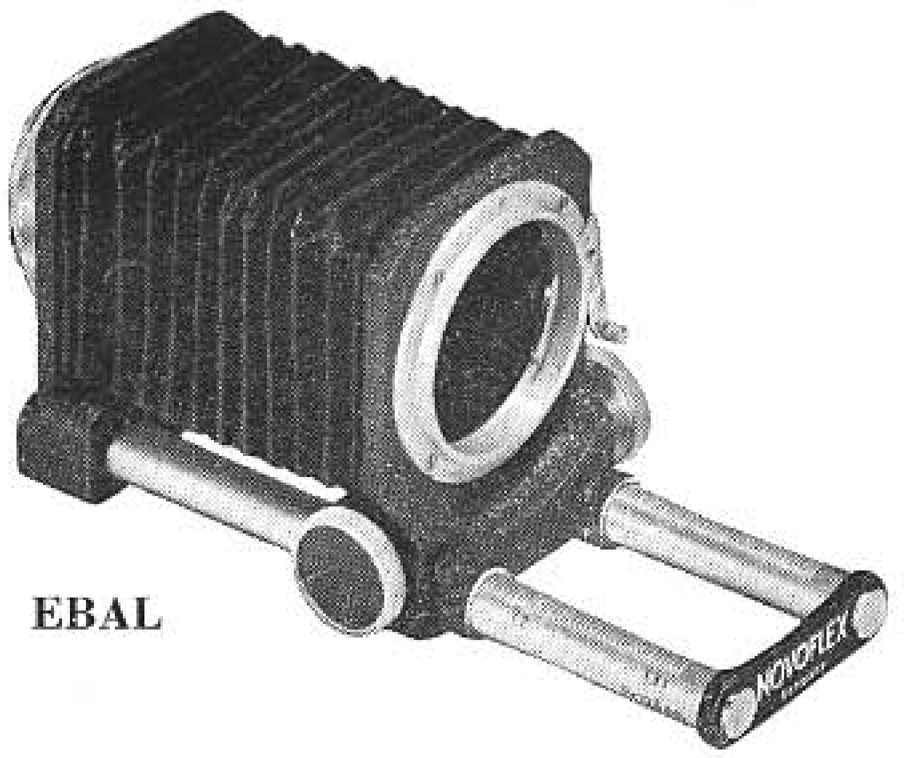
An astonishing thing happens when the lens is used with the Novoflex. When the bellows is racked out sufficiently to combine with the camera extension to form a distance of 105 mm. from the film to the center of the lens (a focal length of 105 mm., in other words), the lens is focused on infinity. If the bellows is racked out as far as it can go, you can focus on a point 9 inches away. The lens and Novoflex bellows, therefore, offer you a *continuous focusing range* without interruption from infinity to 9 inches, which is quite an advantage.

(The front element of the standard 135-mm. Steinheil Culminar can be unscrewed and adapted to the Novoflex also for continuous focusing. This combination offers a continuous range from infinity to 16½ inches.)

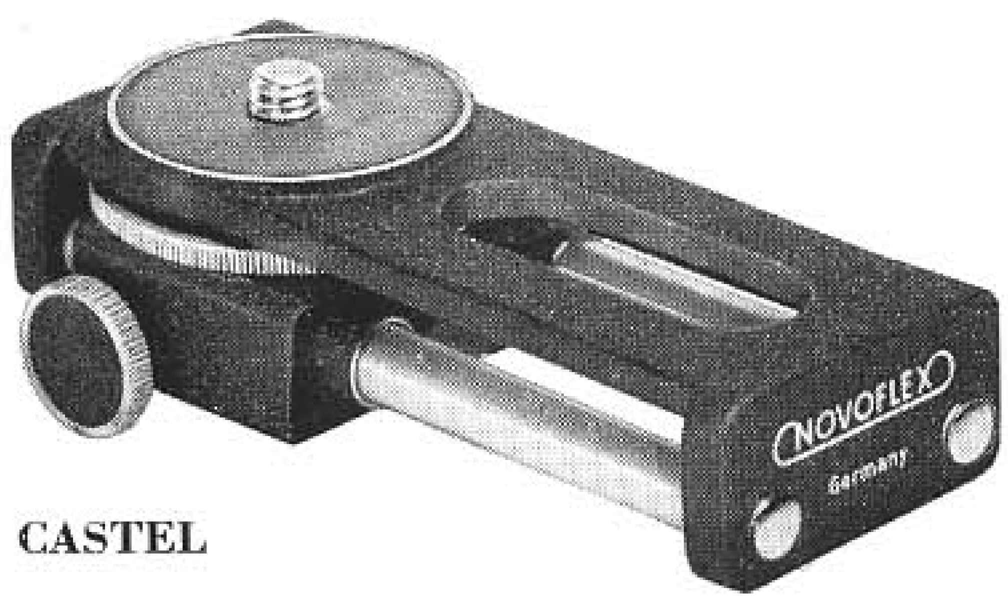
The Novoflex has been designed small purposely to minimize loss of light. It has a parallel-rod carriage, giving it stability and precision even with the hardest usage. It has a focusing knob on both sides so either hand can be used for altering the bellows extension.



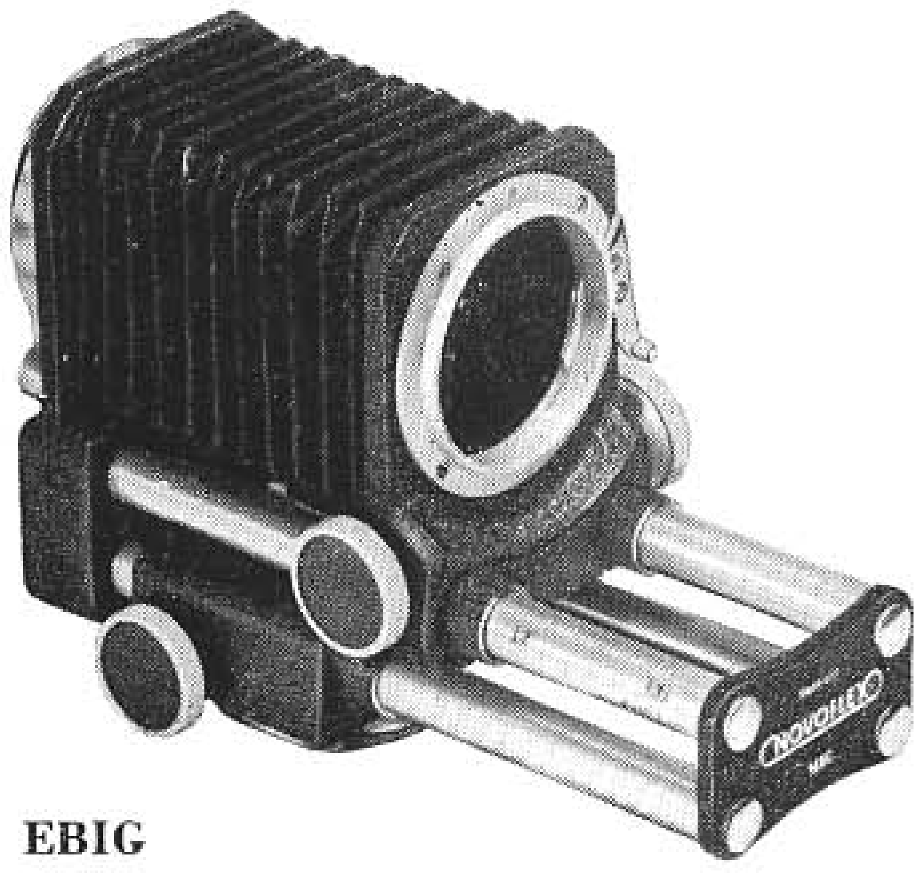
Novoflex Model EBIG has a swivel mount for taking pictures with a vertical as well as horizontal, format. After the camera has been attached to EBIG, a quarter-turn brings it into position for hyperclose-ups with a vertical format.



EBAL



CASTEL



EBIG

Two Novoflex models are available. The standard model, EBAL, has a single carriage, on which the bellows is racked in and out. The bottom of EBAL attaches directly to any tripod. The de luxe model, EBIG, is built with a double carriage. The first carriage operates as in EBAL. The second carriage, in addition to fitting any tripod, contains a movable rack for additional focusing. The rack is used to move the entire assembly—camera, Novoflex and lens—closer to or farther from the subject without moving the tripod, which is a great convenience for hyperclose-up photography.

EBIG, in addition, has a swivel mount (that fits the camera body) so pictures with a vertical format can be taken if desired. Vertical-format pictures can be taken with EBAL only if a 180° tilt-top is attached to the tripod before the camera is screwed on. If this combination is used, the camera then can be turned so it is vertical—and the Penta Prism finder used for composing the vertical-format pictures.

This procedure appears complicated when compared with the convenience and ease of operation of EBIG. With the latter, the camera is merely rotated a quarter-turn on the lens mount whenever you wish to switch from a vertical-format picture to a horizontal-format picture or vice versa. EBIG also has the additional convenience of an arrangement permitting the bellows to be locked in position. This is achieved by means of the focusing knob on the left side, top carriage.

A special unit, called CASTEL, which has many interesting possibilities, also is available. It can be attached to EBAL to convert it to double carriage operation. It can be attached to the Exakta, without EBAL or EBIG, for copying. CASTEL, attached to either EBAL or EBIG, can be used with the Exakta for either hyperclose-up or ordinary stereography. The tripod rack on CASTEL can be moved a maximum of 62 mm. which is the required separation for making ordinary stereo pictures (see pages 15-16).

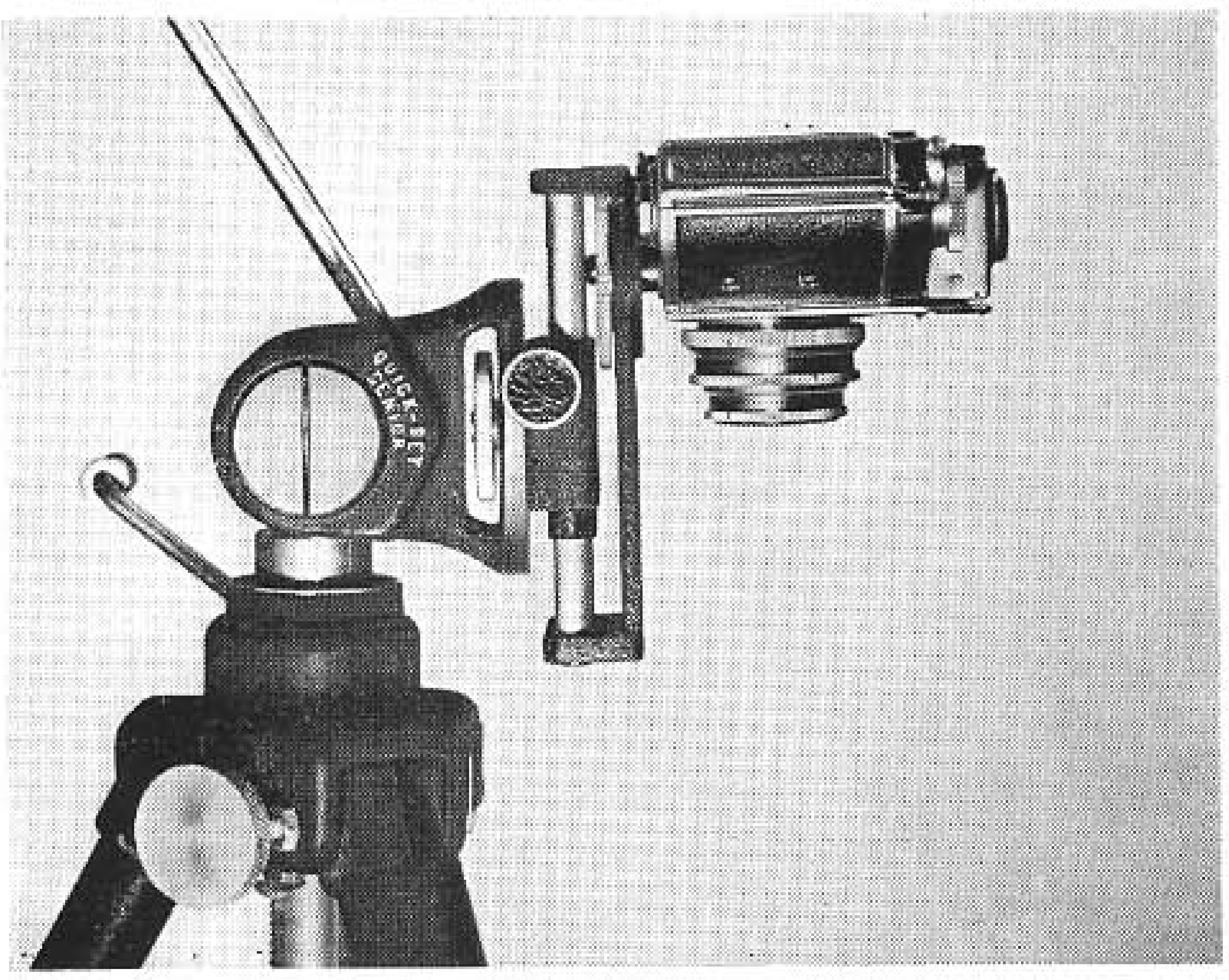
The versatility of the Novoflex equipment is even more surprising. Three methods of focusing are possible. First, the bellows can be racked in and out. Second the entire assembly—camera, Novoflex and lens—can be moved in and out by means of the tripod rack on the bottom of EBIG or CASTEL. Third, the lens being used for hyperclose-up photography can be focused by means of its helical mount.

Considering the variety of equipment available for hyperclose-up photography, it is natural to wonder when to use what. The problem, your available equipment and its adaptability are the deciding factors. The ideal situation, of course, is to use the proper thing for each subject.

A set of extension tubes and the 2-in-adapter are essential for short extensions. One of the Novoflex models likewise is important for rapid variation and longer extensions. These three units can be used as a splendid team to handle most of the problems you will encounter. If you need added extension at any time, you can always buy a long lens or additional tubes to give you the length you want.

The problem of which lenses to buy is more complicated. Ideally, a complete range of lenses would be the solution. However, this is not practicable for everyone. Therefore, the problem must be approached from the viewpoint of what each lens will do.

Every lens, no matter how fine it is, is limited in performance. It will do some things and will not do others. For instance, a long lens has a narrower angle of view than a short lens. Long lenses are slower than short lenses. They are often heavier than short lenses.



The special tripod rack, CASTEL, has several important uses. Attached alone to the camera, it is suitable for copy work. It also can be used to convert EBAL to double-carriage operation and for stereography.

On the other hand, if a subject is thick requiring considerable depth of field (see pages 14-15), if perspective is a factor or lighting a problem — because of intensity, possibility of flare or other interference — a long lens is preferable to a short one.

A long lens will not permit you to work as close to the subject as a short one, as we know from the discussion of the nearest focusing distance (page 4). This may or may not be an advantage. If your subject must be shifted continually and the lights moved, working at a distance can be inconvenient. On the other hand, when the intensity and heat of the lights make you uncomfortable, working at a distance is desirable.

A greater disadvantage of long lenses is that they cannot be used conveniently for higher magnification (see page 10). Despite the fact that they are easy to use—you remove one lens and put another in its place—long lenses are not the complete answer for hyperclose-up work.

So, it appears that two or three lenses are sufficient for most hyperclose-up needs. One of the standard lenses and the 105-mm. lens would be a good combination. If you can afford it, add the 135-mm. lens. You will be well equipped then.

Some photographers prefer to use supplementary lenses of high positive diopter strength to achieve the same results as extension tubes or a bellows. These lenses, sometimes known as close-up or portrait lenses, are mounted in front of the lens in the same way as a filter and increase the focal length. Supplementary lenses have the advantage that they require no increase in exposure, but some hyperclose-up photographers are reluctant to use them for fear the added glass will cause diffraction and aberrations at the edges of the picture. Such diffraction and aberrations usually are not visible even though the pictures are greatly enlarged. Supplementary lenses vary widely in quality but Zeiss lenses can be used without fear except for the most critical work to be tremendously enlarged.

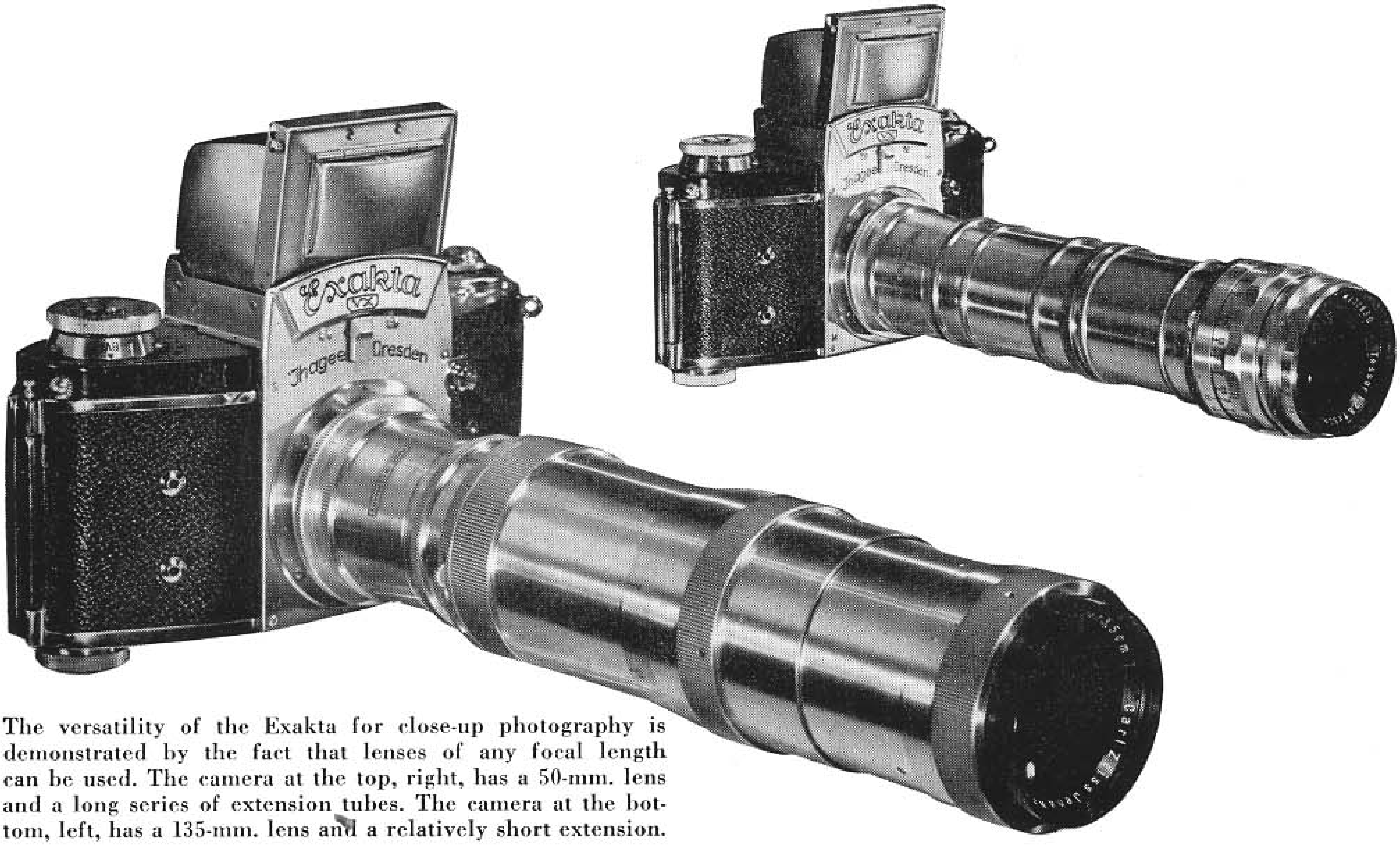
The technique of hyperclose-up photography is no more complicated than ordinary indoor picture taking. There are two variables, however, that influence the way you go about it. One of these is the natural size of the subject and how much of it you want in the picture. The second is how much you want to magnify the subject image.

Some hyperclose-up photographers calculate before they set up their equipment what they want to get in the picture. Others do not know what they want until they see it in the viewfinder. Hyperclose-up technique depends entirely upon your approach.

Photographers who work by visual means solely undeniably simplify matters a lot. They set up their equipment and subject. Then, starting with the smallest extension, they keep on adding tubes or extending the bellows until they see in the viewfinder the image composed and magnified as they want it. There is nothing wrong with this method. It is accurate enough. However, it is time consuming, especially if you use extension tubes.

The other method usually takes less time, although the preliminaries may seem occasionally to take longer than the visual method. Calculation is especially time saving when the subject is tiny and the magnification great. It is based on a ratio of the actual size of the subject to the size of its image on film. In other words you aim for a definite object-to-image ratio.

If the subject is 1 inch long in real life, but measures only 1/10 of an inch on the negative, the image has been reduced 10 times. The relationship of object to image size is 1:0.1. Conversely, if the subject



The versatility of the Exakta for close-up photography is demonstrated by the fact that lenses of any focal length can be used. The camera at the top, right, has a 50-mm. lens and a long series of extension tubes. The camera at the bottom, left, has a 135-mm. lens and a relatively short extension.

measures 1/10 of an inch in real life and is magnified to measure 1 inch on the negative, it has been magnified 10 times. The relationship of object to image is 1:10. For the sake of consistency, the subject part of the ratio is always considered to be 1. If this is done, then in reading any ratio you can always tell which part of it refers to the subject size.

The hyperclose-up photographer finds one optical fact handy to know. A 1:1 relationship (the object and image size are identical) cannot exist unless both the distance between the film and lens and the distance between subject and lens are double the normal focal length of the lens. A 50-mm. lens cannot provide a 1:1 relationship, in other words, unless it is extended an additional 50 mm. and brought to 100 mm. of the subject. The total distance from film to subject, therefore, would be 200 mm., or four times the normal focal length of the lens.

A 150-mm. lens, following the same rule, cannot provide a 1:1 relationship unless the lens is 300 mm. from the film and 300 mm. from the subject, or a total of 600 mm. from subject to film. It is apparent, therefore, why longer lenses cannot be used for high magnifications in hyperclose-up work. A 400-mm. lens would require 400 mm. of extension for just a 1:1 relationship. A higher magnification would require a much greater extension, which would introduce the problems of acquiring considerable equipment and increasing exposure time considerably.

It is desirable to use the least amount of equipment feasible for hyperclose-ups. The more equipment used the more complicated picture taking becomes. Therefore, use the shortest lens and extension practicable to get the results you want.

If you intend to work scientifically, you will first want to determine the amount of magnification required. Image magnification, as we have seen, is a two-step process. First the image should be magnified to fill the film frame. This, as we know, is desirable to eliminate as much of the enlarging by projection printing as possible. What we want to know, actually, is the maximum amount of magnification possible on the Exakta's film frame.

This is determined by the size of the subject and the size of the film frame (24 by 36 mm., or roughly 1 by 1½ inches). The appropriate dimension of the film (1 or 1½, depending upon whether the picture is to have a horizontal or vertical format) is divided by the longest dimension of the subject. The answer you get is the maximum magnification you can give the subject on film.

For example, supposing you want to photograph a detail ½ inch long and you want a picture with a horizontal format. Dividing 1½ by ½, you get 3, the maximum magnification you can give a subject ½ inch long on a film frame 1 by 1½ inches. More magnification is possible of course, if only a tiny portion of a subject is required or the subject itself is tiny. For instance, if only half of a ½-inch detail is required in the picture, you can magnify it 6x (1½ divided by ¼ gives 6). If the subject is only ⅛ of an inch long, you can magnify it 12x, etc.

The second step in image magnification is projection enlargement. With it, the image can be magnified usually to adequate size for inspection without a great loss in quality. A 35-mm. negative can be enlarged to 8-by-10, 11-by-14 or even 16-by-20 inch size if it is lighted, photographed, processed and enlarged well. A ½-inch detail would be magnified to about 18x its original size if it was first magnified to 3x on the negative and then blown up to 8-by-10 by projection printing. If it were blown up to 11-by-14, the magnification would be about 27x. On a 16-by-20 print, the magnification would be about 39x.

It is apparent therefore, that even a fairly large detail can be magnified to great size without much loss in quality. If the detail is minute, it can be magnified to tremendous size without loss of definition by this two-step method. All that is required is first to fill the film frame with the subject's image as much as possible so that the maximum amount of magnification is accomplished with the lens. Then definition will not suffer greatly from enlargement by projection printing.

Before we discuss how to fill the film frame, it is important to point out that it is a rectangle. It will not take a square subject and squeeze it into a rectangular shape. Hyperclose-up photographers often ask how they can fill the film frame with a subject that is not proportionate to the film frame size; for example, an object ⅛ by ⅝ of an inch.

It cannot be done. All you can do is take the largest dimension and magnify that to the limits of the film frame. Some of the frame will be wasted because of the smaller dimension, but that cannot be helped.

Calculating how a ½-inch detail can be magnified 3x can be done with a formula. It is so much easier, however, to use a table. On page 12, you will find four tables, one for each of the lenses you are likely to use for hyperclose-up work — the 50, 58, 105 and 135-mm. lenses. These tables have all the information you require for most occasions. They provide the required length of extension, distance from subject to lens, distance from lens to film, total distance from film to subject, scale of subject image to life size and required exposure increase.

Merely go down the column showing the scale of image to object (column 5) in the appropriate table and when you reach the scale you want, read across the line and get the required data. Then, all that is necessary is to set up your equipment according to the data. It's as simple as that.

Because of space and other limitations, of course, these tables list only a maximum extension of 150 mm. Although they will be sufficient for most situations, occasionally you will need a longer extension, despite the fact that the exposure increases tremendously with such extensions. For these unusual instances and so that you understand how these figures are obtained, it is desirable that you know how to use the formulas for obtaining each type of figure in the tables.

In every case, the formula looks more complicated than it is. All that is required is that you supply the specified information in the formulas and then, in all but two cases, do simple arithmetic.

Formulas for Hyperclose-up Photography

The first problem that may arise is to compute the ratio of object to image size, when both are known. This is done with the simple formula:

$$\frac{\text{object size}}{\text{image size}}$$

The answer is the ratio. For instance, if the object is 6 inches long and the image is 1 inch long, substituting in the formula we get $\frac{6}{1}$ or a ratio of 1:0.17.

You will, of course, want to know what the ratio of reduction or magnification is; in other words, how much a lens reduces or a lens and extension magnify the image of a subject. The formula for figuring the reduction is:

$$\frac{\text{subject-to-lens distance} - \text{lens focal length}}{\text{lens focal length}}$$

This works out easily, too. Supposing your object is 700 mm. from your lens. The focal length of the lens is 50 mm. Substituting, you get $\frac{700 - 50}{50}$ which is 13 or, given a ratio form, 1:0.08. The subject's image is one-thirteenth life size.

You may prefer, however, to figure this ratio in terms of magnification, as it is given in column 5 of the tables on page 12. This can be done with the formula:

$$\frac{\text{lens focal length}}{\text{lens-to-film distance} - \text{lens focal length}}$$

Using a 50-mm. lens and 60-mm. extension, the ratio of magnification, by substitution, is $\frac{50}{110 - 50}$ or 1:1.2.

If you know the rate of reduction, you can, of

CLOSE-UP DATA FOR 50-MM. LENSES

Length of extension in mm.	Distance from subject to lens in mm.*	Distance from lens to film in mm.†	Total distance from film to subject in mm.‡	Scale of subject image to life size§	Required exposure increase°
0	infinity	50	infinity	variable	1.00
5	550	55	605	0.1	1.21
10	300	60	360	0.2	1.44
15	217	65	282	0.3	1.69
20	175	70	245	0.4	1.96
25	150	75	225	0.5	2.25
30	133	80	213	0.6	2.56
35	121	85	206	0.7	2.89
40	113	90	203	0.8	3.24
45	106	95	201	0.9	3.61
50	100	100	200	1.0	4.00
60	92	110	202	1.2	4.84
70	86	120	206	1.4	5.76
80	81	130	211	1.6	6.76
90	78	140	218	1.8	7.84
100	75	150	225	2.0	9.00
110	73	160	233	2.2	10.20
120	71	170	241	2.4	11.60
130	69	180	249	2.6	13.00
140	68	190	258	2.8	14.40
150	67	200	267	3.0	16.00

CLOSE-UP DATA FOR 105-MM. LENSES

Length of extension in mm.	Distance from subject to lens in mm.*	Distance from lens to film in mm.†	Total distance from film to subject in mm.‡	Scale of subject image to life size§	Required exposure increase°
0	infinity	105	infinity	variable	1.00
5	2310	110	2420	0.05	1.10
10	1208	115	1323	0.10	1.21
15	840	120	960	0.14	1.30
20	656	125	781	0.19	1.42
25	546	130	676	0.22	1.49
30	473	135	608	0.29	1.66
35	420	140	560	0.33	1.77
40	381	145	526	0.38	1.90
45	350	150	500	0.43	2.05
50	326	155	481	0.48	2.19
60	289	165	454	0.57	2.47
70	263	175	438	0.67	2.79
80	243	185	428	0.76	3.10
90	228	195	423	0.86	3.46
100	215	205	420	0.95	3.80
110	205	215	420	1.05	4.20
120	197	225	422	1.14	4.58
130	190	235	425	1.24	5.02
140	184	245	429	1.33	5.43
150	178	255	433	1.43	5.91

CLOSE-UP DATA FOR 58-MM. LENSES

Length of extension in mm.	Distance from subject to lens in mm.*	Distance from lens to film in mm.†	Total distance from film to subject in mm.‡	Scale of subject image to life size§	Required exposure increase°
0	infinity	58	infinity	variable	1.00
5	731	63	794	0.09	1.18
10	394	68	462	0.17	1.37
15	282	73	355	0.26	1.59
20	226	78	304	0.35	1.81
25	192	83	275	0.43	2.05
30	170	88	258	0.52	2.30
35	154	93	247	0.60	2.60
40	142	98	240	0.69	2.85
45	133	103	236	0.78	3.17
50	125	108	233	0.86	3.46
60	114	118	232	1.03	4.14
70	106	128	234	1.21	4.87
80	100	138	238	1.38	5.66
90	95	148	243	1.55	6.51
100	92	158	250	1.72	7.42
110	89	168	257	1.90	8.39
120	86	178	264	2.07	9.42
130	84	188	272	2.24	10.50
140	82	198	280	2.41	11.70
150	80	208	288	2.58	12.90

CLOSE-UP DATA FOR 135-MM. LENSES

Length of extension in mm.	Distance from subject to lens in mm.*	Distance from lens to film in mm.†	Total distance from film to subject in mm.‡	Scale of subject image to life size§	Required exposure increase°
0	infinity	135	infinity	variable	1.00
5	3780	140	3920	0.04	1.07
10	1958	145	2103	0.07	1.15
15	1350	150	1500	0.11	1.23
20	1046	155	1201	0.15	1.32
25	864	160	1024	0.19	1.40
30	743	165	908	0.22	1.49
35	656	170	826	0.26	1.59
40	591	175	766	0.30	1.68
45	540	180	720	0.33	1.78
50	500	185	685	0.37	1.88
60	439	195	634	0.44	2.09
70	395	205	600	0.52	2.30
80	363	215	578	0.59	2.54
90	338	225	563	0.67	2.78
100	317	235	552	0.74	3.03
110	301	245	546	0.82	3.29
120	287	255	542	0.89	3.57
130	275	265	540	0.96	3.85
140	265	275	540	1.03	4.12
150	256	285	541	1.12	4.49

These tables have been computed mathematically. You may find that the figures are not precise for your lens. Minor variations exist because all lenses differ slightly, even those of the same focal length. Therefore, use this data as a guide rather than as absolute measurement. If greater accuracy is required, the necessary data can be computed quickly with the formulas given in the text of this booklet. All lengths are given in millimeters. To convert to inches, multiply by 0.03937.

* The customary point of measurement of the lens is the center, usually considered to be iris diaphragm plane.

† This distance is the sum of the extension and the focal length of the lens. It is measured from the center of the lens (diaphragm) to the film plane in the camera.

‡ The sum of columns two and three.

§ The ratio of the size of the subject's image on film to the actual size of the subject.

° This column shows by how much the basic exposure time, computed for the lens without additional extension, must be multiplied to compensate for the extension used.

course, determine the distance from the subject to the lens by substituting in the formula backwards; that is, by making an equation out of it. Using the information given before, D (distance from the subject to the lens) can be calculated as follows: $\frac{D - 50}{50} = \frac{13}{1}$ or $D - 50 = 650$, $D = 700$. You have to know a bit of elementary algebra, but it is easy.

If you know the ratio of magnification, you also can calculate the distance from the film to the lens by substitution. If you know either distance, the other can easily be calculated.

If you want to know how far to put the object from the lens for the required magnification, use the formula:

$$\frac{\text{lens-to-film distance} \times \text{lens focal length}}{\text{lens-to-film distance} - \text{lens focal length}}$$

Assume that you want to find the distance to place a subject from the lens when using a 50-mm. lens and 100-mm. extension. The total distance between lens and film is 150 mm. (100 + 50), of course. Substituting in the formula, $\frac{150 \times 50}{150 - 50} = \frac{7500}{100}$ or 75 mm.

You may want to know, on the other hand, what extension to use to get a specific object-image size ratio. The formula is:

$$\frac{\text{subject-to-lens distance} \times \text{lens focal length}}{\text{subject-to-lens distance} - \text{lens focal length}}$$

Assuming that you need to know what extension you must use to get a magnification of 1:0.2 with a 250-mm. lens, you calculate that the distance between subject and lens is 12,750 mm. Substituting, $\frac{12750 \times 250}{12750 - 250}$ gives 255. Accordingly, the distance from the film to lens must be 255 mm. You are using a 250-mm. lens, so deduct the 250 from the 255. The remainder, 5 mm., is the length of the extension you need.

It sometimes happens that a photographer knows the object-image size ratio and the distance from subject to lens, but not the length of the lens and extension to use. The formula for the lens to use is:

$$\frac{\text{subject-to-lens distance} \times \text{ratio of image size to life size}}{1 + \text{ratio of image size to life size}}$$

The formula for the needed extension would be:

$$\text{subject-to-lens distance} \times \text{ratio of image size to life size} - \text{lens focal length}$$

Let's take an example. Say, a half-life size picture must be taken of an object 540 mm. (approximately 1½ feet) from the lens. We must determine the length of the lens and additional extension required.

We get the length of the lens required substituting in the formula: $\frac{540 \times 0.5}{1 + 0.5}$ or a 180-mm. lens. We get the length of the extension the same way: $540 \times 0.5 - 180$, or 90-mm.

Formulas for Exposure Increase

When the lens is extended, less light reaches the film. Telephotos and other long focal length lenses are designed to compensate for this without an increase in exposure. Ordinary lenses are not, so you must calculate the amount of compensation. The exposure increase varies with the length of the extension used. A short extension requires very little exposure increase, a long one considerable. For example, a 5-mm. extension on a 50-mm. lens requires 1.21x more exposure than when no extension is used; a 150-mm. extension on the same lens requires 16 times more exposure than when no extension is used.

The amount of exposure increase required for specified extensions is given in the tables for the four lenses on page 12. If you are using either Novoflex model, the amount of exposure increase for a 50-mm. lens and the special 105-mm. Steinheil lens can be read off scales on either side of the carriage. In other cases, you will have to calculate the proper exposure increase.

The normal exposure should first be determined with an exposure meter containing a photoelectric cell. (If the subject is too small to permit you to take a reading from it conveniently and with accuracy, substitute a card the approximate color of the subject and take your reading from the card.) Then the exposure increase can be calculated with these formulas:

$$(\text{ratio of magnification} + 1)^2$$

or

$$\frac{\text{lens-to-film distance}^2}{\text{lens focal length}^2}$$

The easiest way to compute the final exposure is to multiply the exposure increase directly with the exposure time normally required without an extension (as, for instance, $2.25 \times \frac{1}{2}$ second $= \frac{2.25}{2} = \frac{9}{8} = 1\frac{1}{8}$ seconds) and use the nearest speed setting on the camera. Where precise accuracy is sought and the nearest speed setting is inadequate, slight adjustments can be made by opening the lens diaphragm slightly to admit more light.

You may prefer to think about exposure in terms of the f/stop (aperture) of your lens. Whenever the lens is extended by a bellows or tubes, the aperture scale engraved on the lens no longer indicates the true aperture or diameter of the lens opening being used.

The true aperture can be determined with this formula:

$$\frac{\text{f/stop at which the lens is set} \times \text{lens-to-film distance}}{\text{lens focal length}}$$

Using a 50-mm. lens and 50-mm. extension, supposing you closed the lens down until the aperture scale indicated it was at f/8. To get the true aperture, substitute in the formula to get $\frac{8 \times 100}{50}$ or f/16. Then, when you calculate the exposure time, you use the true aperture instead of the one indicated on the lens.

The lens aperture is of great significance, by the way, other than in exposure. The definition of a lens varies from aperture to aperture. Therefore, a lens should be used, whenever possible, at apertures at which it is sharpest. These usually are between f/6.3 and f/11.

Depth of Field

Aperture also affects depth of field, often wrongly called depth of focus. Depth of field is the range of (apparent) sharpness in the picture (the distance between the nearest and farthest point apparently in focus). In hyperclose-up photography, it has an important purpose—to tell you how much of your subject will appear sharp in the picture if photographed at a specific distance with a specific lens closed down to a specific aperture. To understand depth of field, you must go into the optics of photography a bit more.

As we know, technically speaking, the conventional lens can give a critically sharp picture of only one plane, the plane or spot focused upon (called the plane of focus). This means that everything outside the plane of focus (that is, before and beyond it) actually is unsharp, but may not appear so to the eye because the unsharpness is too minor to notice.

When the lens is focused on a predetermined distance, the light rays from other distances are not all brought to a focus exactly in the focal (film) plane. Some are focused in the plane, some ahead and some behind it. If the lens were able to bring objects at varying distances to a sharp focus in one plane, then they would be sharply defined all over the film. Since this is contrary to optical principles, each ray that is brought to focus in front or behind the focal plane records not as a point of light but as a small circle, called the circle of confusion. Literally, it is used as a measurement of the acceptable degree of unsharpness.

The circle of confusion is not an inherent quality of a lens. It is a measurement, just like Centigrade and Fahrenheit degrees are measurements of temperature. The circle of confusion, however, measures something much more complicated than temperature. It measures the diameter of a light ray's image on film.

The subject's image will be composed of many sharp points from the plane focused upon, plus many overlapping circles of confusion from objects near or farther away from the plane focused upon. These may blur the image and destroy definition.

Fortunately, however, a tiny circle looks like a point to the eye if its diameter is 1/100 of an inch or less. Therefore, this size is the largest permissible circle of confusion where a sharp image is desired. When the diameter of the circle of confusion is 1/100 of an inch or smaller and the point is viewed at a distance of 10 inches, the image appears sharp.

However, if a negative with an image containing circles of confusion of 1/100 of an inch is enlarged to twice its size, the relative diameter of the circles of confusion is doubled also to 1/50 of an inch and the picture loses sharpness proportionately.

For this reason, 35-mm. camera negatives, which are always given considerable enlargement require a tiny circle of confusion. When enlarged 10 times, for example, a negative with 1/1000 of an inch circle of confusion will appear as if it has a circle of confusion of 1/100 of an inch in the enlargement.

The circle of confusion is affected by two factors — the depth of field and the size of the enlargement. It varies directly with both factors. In other words, when you increase the depth of field and the enlargement, you increase the circle of confusion. Since both of these factors are determined by the photographer, the decision on the size of the circle of confusion also rests with him.

The proper circle of confusion for a 35-mm. negative varies, naturally, with the size of the enlargement to be made and the ultimate purpose of the picture. For ordinary purposes, a circle of confusion of 1/1000 of an inch is desirable.

Depth of field varies with the focal length of the lens, the distance upon which it is focused, the aperture being used and the diameter of the circle of confusion. A separate depth-of-field table must be computed for each focal length, each aperture and for the specific circle of confusion you want.

Depth-of-field tables can be computed in three steps. The first is to determine the diameter of the lens opening being used. The formula for it is very simple:

$$\frac{\text{lens focal length}}{\text{f/stop of lens}}$$

For example, the diameter of the opening of a 50-mm. lens at f/8 is $\frac{50}{8}$ or 6.25 mm.

The next two steps calculate the nearest and farthest points of the subject that will appear to be in focus;

this information will give you the range of (apparent) sharpness, or depth of field.

The formula for the nearest point is:

$$\frac{\text{diameter of lens opening} \times \text{subject-to-lens distance} \times \text{lens focal length}}{(\text{diameter of lens opening} \times \text{lens focal length}) + \text{diameter of circle of confusion } (\text{subject-to-lens distance} - \text{lens focal length})}$$

The formula for the farthest point is:

$$\frac{\text{diameter of lens opening} \times \text{subject-to-lens distance} \times \text{lens focal length}}{(\text{diameter of lens opening} \times \text{lens focal length}) - \text{diameter of circle of confusion } (\text{subject-to-lens distance} - \text{lens focal length})}$$

Short focal length lenses always have more depth of field than long lenses. Nevertheless, long lenses sometimes are used to gain more depth of field than short lenses will provide in hyperclose-up photography. This sounds ambiguous but actually is not. The reason is simple. When a lens is focused on a near point, depth of field is extremely narrow, much narrower than when it is focused on a far point. This is of great significance in hyperclose-up photography, which is done largely at very close distances.

Since short lenses must be used very close to the subject in hyperclose-up photography, they provide very little depth of field. A long lens, on the other hand, must be used much farther away and will provide a wider range of apparent sharpness. Consequently, it may be preferable to a shorter lens.

Depth of field always is greater when the lens is stopped down, then when it is opened up. Therefore, it is preferable to use smaller apertures in hyperclose-up photography. There is so little depth of field when the lens is wide open that it is rarely used at full aperture in hyperclose-up work.

You must take these facts into consideration when altering the aperture of the lens, especially if your subject is wide or thick. To make sure you will get a sharp image of the entire subject, calculate the depth of field for the set-up before taking the picture.

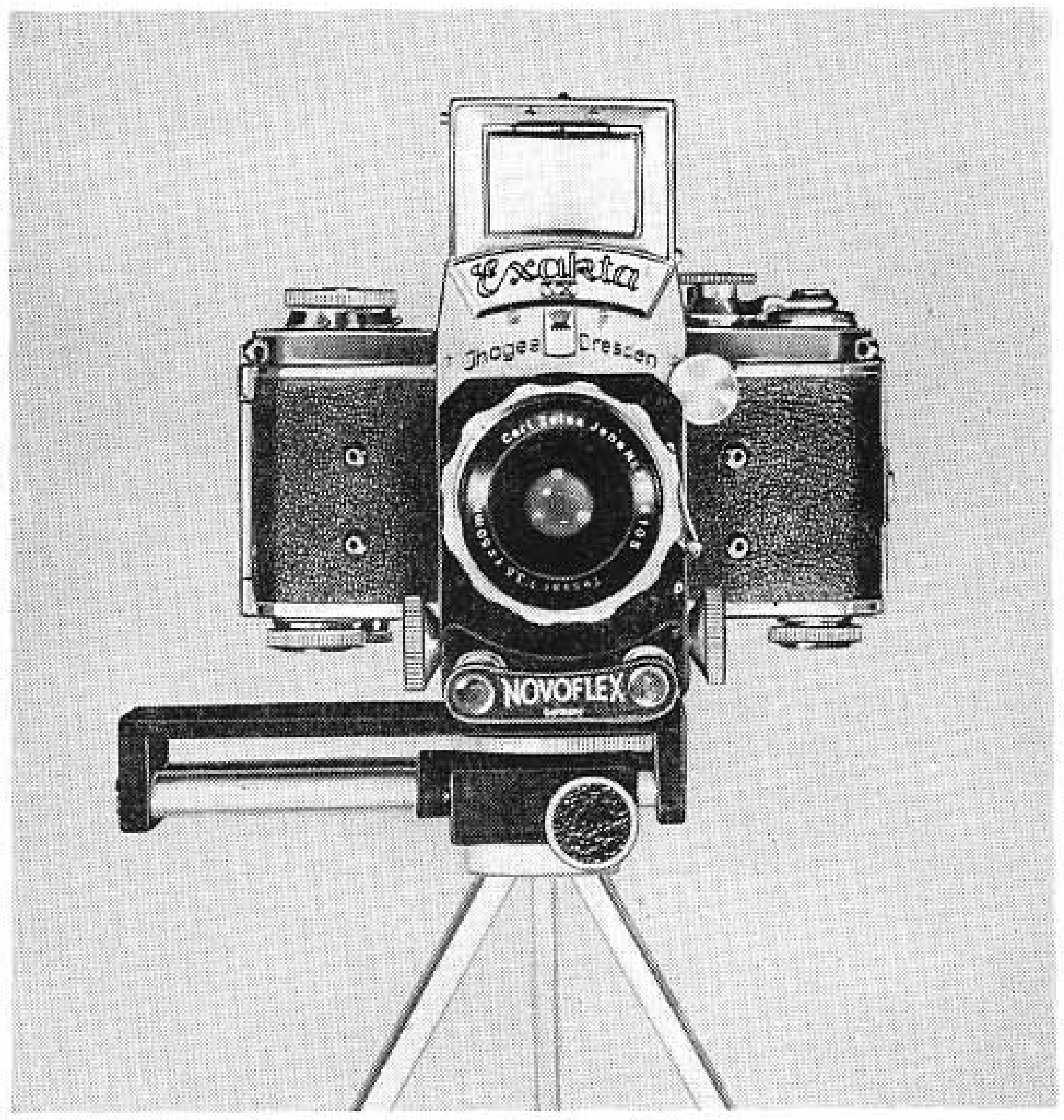
Hyperclose-up Stereography

One additional formula should be given. It is invaluable to anyone planning to do close-up stereography. Third-dimensional hyperclose-ups are striking. They are marvelous for visual education.

Stereography with the Exakta is limited to subjects that do not move, because two separate exposures are required. Most hyperclose-up subjects are ideal for stereography because they are inert.

In stereography with the Exakta, the problem simply is to take one exposure of a subject, then move the camera over approximately 62 mm. and take a second exposure on the identical plane as the first. The 62-mm. distance roughly corresponds to the distance between the pupils of a human's eyes.

To take hyperclose-up stereos with your Exakta, attach the Novoflex unit CASTEL to a tripod and then mount your Exakta on top of CASTEL. In ordinary stereography, as we have said, the camera must be moved about 62 mm. for the second exposure. In hyperclose-up stereography, less distance is required between the two camera positions. If you retain the normal 62-mm. separation between camera positions for hyperclose-up stereos, the subject's image will not appear on the second exposure because it will be out of range of the lens.



The Novoflex unit, CASTEL, can be used to take close-up, as well as ordinary, stereo pictures. The tripod rack permits the camera to be moved a maximum of 62 mm.

In addition, hyperclose-up stereography introduces a visual problem. You can look with comfort at an object three feet away, but not at one three inches from your eyes. To see the object comfortably, you must move it back. Depending upon its size, you may move it back from 2 to 6 feet. For the sake of illustration, let's assume you move it back 3 feet, a distance 12 times as great as 3 inches. If you move the camera back 3 feet from the subject, its image size is only 1/12 that at 3 inches. In close-up stereo, therefore, the problem is to preserve the larger image size and include the viewing comfort of (2 to 6 feet) distance from eye to subject.

This can be done by reducing the distance between the two camera positions. The actual distance between positions can be computed by means of a formula provided by Herbert C. McKay, the well-known stereographer and Director of the International Association of Stereographers. The formula is based on the relationship of the distance between subject and lens (called real distance), the distance at which the image is seen (that is, the viewing distance you want to achieve, called the apparent distance), the normal separation between camera positions (62 mm.) and the required camera separation (the unknown dimension you want to find).

The real distance is easy enough to determine after you have set up camera and subject and extended the lens so you get the magnification you want. Then, you find the subject-to-lens distance by table, formula or actual measurement. The apparent distance is either determined by arbitrary choice or by experimentation. In many cases, you will probably want your stereo to look as if it were taken at a distance of 3 feet, so 3 would be the apparent distance.

The normal separation we know, so the rest is substitution in the following formula:

$$\frac{\text{normal eye separation}}{\text{apparent distance}} = \frac{\text{required camera separation}}{\text{subject-to-lens distance}}$$

In using any of the formulas given here, it is essential that you reduce all measurements to the same system, either metric or linear. Usually, hyperclose-up photographers prefer to use millimeters so that the answer need not be converted (lenses and extensions are in millimeters).

Regardless of the equipment you use, the set-up for hyperclose-up photography is essentially the same. The camera should be mounted on a tripod for stability. The lens must be removed and the tubes or bellows inserted. The subject, for convenience, should be on a table or level board about waist or chest high.

Lighting need not be a problem in hyperclose-up photography if you observe the rules you have learned in other types of indoor photography. Floodlamps or spots can be used, but regular or electronic flash lamps are more convenient (built-in electronic contacts are provided only on Exakta models V and VX).

Avoid burning up the subject with lights of a great intensity. The trick is to balance your lighting so you get maximum exposure speed, yet do not degrade the image. Side lighting is preferable to flat lighting because it gives texture and roundness to the subject. Spots are often handier to use than floods because more of the available light can be aimed better at small areas. Flash, of course, is ideal, especially electronic flash.

No matter whether the lights are near your lens or not, *always* use a lens shade. This practice will improve the definition in your picture because a shade excludes light reflections that degrade the image.

Finally, a word about film. Hyperclose-up photography is a constant effort to record detail as well as possible. Give yourself the advantage and use black-and-white film of the finest grain available (and processed in fine-grain developer). If exposure speed is no object, use slow but extremely fine-grain films such as Eastman Microfile, Ansco Minipan and DuPont Microcopy. If you require a faster film, use Eastman Panatomic-X (temporarily unavailable, but replaceable with Eastman Plus-X if developed according to instructions of manufacturer) and Ansco Finopan. Use fast films like Eastman Super-XX or Ansco Ultra-Speed Pan only when speed is essential, because these two films do not have the fine grain of the slower films.

Color hyperclose-up photography offers much less variation in film than black-and-white. Both Eastman and Ansco make color film for exposure with tungsten lights (flood or 3200° Kelvin lamps). Color films are very slow and the color balance is seriously altered if exposures are long. Therefore, it is important that you use the shortest possible exposures. Make certain, too, that if you use any lights other than those for which the film is balanced (Kodachrome Type A is balanced for floodlamps and Ansco Tungsten is balanced for 3200° Kelvin lamps) that you use the recommended filter to compensate.

Until you gain enough experience to be able to hit the right exposure without failure, it may be advisable for you to take several exposures of the same picture. This procedure will assure a well-exposed negative or transparency. Give the first of the three black-and-white pictures the exposure you have calculated, the second double the exposure, the third half the exposure. With color, give the second a half-stop more and the third a half-stop less.

Exclusive factory representative for sales and service in the U. S. A.

EXAKTA CAMERA COMPANY • 46 WEST 29th STREET • NEW YORK 1, N. Y.

Price: 25 Cents

Printed in U.S.A. 952-30M-P89-50