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LENS GUIDE

DO YOU NEED IT?
HOW TO CHOOSE IT
HOW TO USE IT
HOW TO LOOK AFTER IT
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WHAT ARE INTERCHANGEABLE LENSES?

Most cameras are originally bought with just the one lens—the so-called standard or normal lens. This is the lens that is intended to have the angle of view and to provide the perspective* that is normally associated with the human eye. Thus, the picture taken with this lens will usually present the scene more or less as the eye sees it.

There are, however, other lenses. Some take a much wider view of the scene in front of the camera and are known as wide-angle or short-focus lenses. Others take a narrower view—like the telescope—and some of these can “see” into the very far distance. These are the long-focus or telephoto lenses.

It is therefore possible to adapt a single camera to take a very wide view in a confined space, such as in small rooms or narrow streets, or to take a very long view so as to present distant objects on an enlarged scale, such as architectural detail, ships off the coast, etc.

There are intermediate possibilities. The moderately long-focus lens, for example, is useful where a large image is required but it is inadvisable or impracticable to approach the subject too closely. The wide-angle lens can be used to present broad panoramas.

The modern 35 mm. camera, particularly the single-lens-

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*Perspective. The perspective of a group of objects is their relative grouping and sizes as they appear to the eye or camera viewing them. *Photographic Optics*, by Arthur Cox.
Confronted with a particular scene, the fixed-lens camera (left) can present only one picture from a given viewpoint.

The camera with interchangeable front elements (right) is a little more versatile. Its lens can be converted to present a slightly wider aspect or to take a narrower angle of view to pick out interesting parts of the scene. Its long-focus attachments are sometimes limited to providing about double the normal focal length or less but can go as high as four times.
The camera with full interchangeable-lens facilities is extremely versatile, particularly if it is a single-lens reflex. It can use a range of three or four short-focus lenses and long-focus lenses giving images up to about 20 times as large as those of the standard lens.

Additionally, such cameras can use many attachments such as extension tubes or bellows for close-range work or microscope adaptors to enable them to provide much-magnified images of very small subjects.
reflex* type, is well suited to the attachment of various lenses and this facility has done much to extend the range of photographic subjects available to the ordinary amateur. There are additional lenses for other types of camera, too, but these are comparatively few in number. The general principles remain the same but this book is written primarily with the 35 mm. user in mind.

The camera with only one lens is an incomplete instrument. It is like a man with defective eyesight. There are complete worlds beyond its vision. It can rarely deal satisfactorily with the picturesque scenes in the narrow streets of the quaint little villages still to be found in many parts of the world.

It often finds modern buildings too tall to be brought into the field of view.

It is not at its best with head and shoulder portraits or even with shots of children, where the close approach it calls for can be distracting.

Despite the possibility of subsequent enlargement of the image in printing, it can rarely present high-quality reproductions of distant objects or of small objects such as birds and the smaller animals.

The popularity of colour slides even rules out the practicability of subsequent enlargement of the image. The ambitious colour photographer soon discovers the limitations of the camera with only one lens. To him, the ability to change his lens to take in more or less of the scene in front of him is invaluable.

Nevertheless, we must temper our enthusiasm. It is so easy to squander money on lenses we shall rarely, if ever, use after the first flush of excitement has died. And it is so easy to forget that some lenses, particularly the really big ones, are rather difficult to use.

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SINGLE LENS REFLEX. The camera lens itself also forms the finder image. A mirror inside the camera body reflects the image on the screen while you view it. When you shoot, the mirror flies out of the way and the lens records the scene directly on the film. *Successful 35 mm. Photography*, by Andrew Matheson.
It is the purpose of this book, in part at least, to make known the disadvantages, as well as the advantages, of extra lenses. As the advantages are so readily apparent and are not infrequently overstated, we may seem in the early stages to use a disproportionate amount of space stating the disadvantages. But that is better than allowing the reader to believe that the fish-eye lens, for example, will give a normal picture over its extremely wide angle; or that the really long focus lens can present a pin-sharp image of a distant object when held in the hand.

Some readers, in fact, must be disillusioned from the start, because not all cameras can be fitted with additional lenses. These are the owners of fixed-lens cameras and we shall deal with them first.
WILL YOUR CAMERA TAKE OTHER LENSES?

It is not uncommon for a photographic dealer to be asked to supply telephoto lenses or wide-angle lenses for fixed-lens cameras. This is impossible. You cannot have full interchangeable lens facilities unless the lens on your camera is readily detachable. Wide-angle and telephoto (often more correctly called long-focus) lenses are complete lenses in themselves and are designed to replace the so-called normal or standard lens. But the normal lens on the fixed-lens camera cannot be removed. That is the first principle of lens interchangeability.

The only way in which the performance of the fixed lens can be altered is by attaching other lenses to it. In this way a limited wide-angle or long-focus effect can be obtained. This is a compromise solution and too much should not be expected of the results.

All inexpensive cameras are fixed-lens types but there are also many of these cameras in the more expensive category. Whatever their price, however, they are designed to be used with the one lens only. No guarantee of performance can attach to any attempt to extend their range.

There is, however, a group of cameras in which the front part of the lens can be removed and replaced by another part which gives either wide-angle or long-focus facilities. This is a more satisfactory arrangement than the attachment of extra elements but the quality of the results is not likely to be as high as that obtainable by replacing the whole lens with a specially designed lens of the focal
length* required. The extent to which the focal length of the lens can be altered by this method is also limited to about four times the standard focal length.

The real interchangeable-lens camera is the camera from which the lens can be easily and quickly removed. The lens can then be replaced by one of shorter focus (wide angle) or longer focus, as the occasion demands.

In theory, the degree of interchangeability with this type of camera is unlimited. Wide-angle lenses are in fact available which photograph over an angle of 180 degrees. The range of long-focus lenses is limited only by practical considerations of size and bulk and the fall-off in light strength as it covers the increasing distance to the back of the camera.

**Limits on lens changing**

In practice, there are other limitations. The interchangeable-lens camera comes in two forms—the reflex and the non-reflex.

The single-lens reflex now so popular in the 35 mm. range uses its lens both for viewing and focusing and for taking the picture. The scene in front of the lens is reflected by a mirror inside the camera on to a viewing screen on top of the camera. The image on this screen is viewed through a magnifying lens or lenses via a pentaprism or mirror arrangement which presents the image right way up and right way round.

Thus, in theory at least, any lens can be used on this type of camera. In practice, lenses made for one camera will rarely fit any other camera, except by means of an adaptor, because there has been no attempt by camera manufacturers to standardize lens mounting methods. Even when a lens can be fitted by means of an adaptor.

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**FOCAL LENGTH.** The distance from the centre of the lens to either the object or the image when the rays on the other side of the lens are parallel is the focal length of the lens. *Camera Techniques*, by H. J. Walls.
it is possible that such refinements as automatic diaphragm control may not work satisfactorily and, unless the adaptor is accurately and carefully made, the lens may not be able to focus distant scenes. This can also arise when trying to fit a lens from a non-reflex camera to a reflex. The body of the non-reflex camera is usually shallower than the reflex, and its lenses are in correspondingly longer barrels.

The non-reflex camera is more limited than the reflex in its use of interchangeable lenses. It does not view the scene through its taking lens, so it needs a separate viewfinding arrangement for each lens. It can have interchangeable viewfinders, indicator lines or changing fields in its viewfinder, or it might have a "zoom" or turret-type "universal" finder. Focusing, too, may need special attention. This type of camera often has a rangefinder coupled to its lens but the rangefinder rarely couples with lenses of longer than 135 mm. focal length on the 35 mm. camera (less than three times normal). So focusing with longer lenses has to be estimated or a reflex housing has to be fitted to turn the camera into a reflex.

The shutter plays its part

Both reflex and non-reflex cameras vary in their shutter arrangements and this, too, affects the degree of lens interchangeability.

AUTOMATIC DIAPHRAGM. You set the aperture you require and ... from then on everything is automatic unless you have to change the aperture. You press the shutter release and the iris closes to the pre-set aperture to take the picture and immediately opens up again to focus the next. How to Choose the Camera You Need, by W. D. Emanuel and Leonard Gaunt.

VIEWFINDERS, or just finders, really have a dual function. They must tell us towards what point the axis of the lens is directed and how much of the scene in front of the camera is included in the picture. Camera Techniques, by H. J. Walls.

SHUTTER. This is a precision mechanism which accurately regulates the time during which the light may pass through the lens on to the film. In other words, it controls the exposure time. The Retina Way, by O. R. Croy.
The light-path to the viewfinder image (top) is a complex one in the reflex camera. It passes through the taking lens to a mirror in the camera body. Thence, it is reflected upwards to a prism or mirror arrangement which presents the image at the eyepiece right way up and right way round.

In the non-reflex camera, viewfinder and taking lens are separate optical systems. Consequently, their viewpoints are slightly separated and, at close range, this can provide an inaccurate view of the subject.

The viewfinder built into the camera gives the angle of view of the standard lens. When other lenses are used, another viewfinder must be fitted or the original viewfinder must be capable of adaptation to the changed angle of view of the lens.

The body of the reflex camera has to accommodate a mirror. It is consequently deeper than that of the non-reflex (middle). This is why lenses of non-reflex cameras cannot be used on reflex cameras except for close-ups. The extension between lens and film would be too great for more distant photography.

Focusing by reflex screen and by rangefinder (bottom) are basically different. The reflex screen image is blurred when the lens is not focused properly and sharp when it is. The rangefinder image shows a displacement of one kind or another when the lens is not focused properly and a single, clear image when it is.
Most 35 mm. single-lens reflexes have focal-plane shutters. This is a shutter, usually consisting of a pair of moving blinds, situated immediately in front of the film and thus allowing lenses to be changed regardless of whether the camera is loaded or not.

The other common shutter type is the diaphragm shutter—also known variously as leaf shutter, blade shutter and between-lens shutter. This is a circular arrangement of thin metal leaves opening from the centre outwards and one of its names derives from the fact that it is usually contained within the lens. This type of shutter raises problems of its own and three methods of overcoming them have been devised.

One is to permit a limited range of interchangeability by providing the lens with interchangeable front elements.

The second method is to make the whole lens detachable by fitting the camera with a protective blind which can be moved in front of the film while lenses are changed. This method has been used both in 35 mm. and larger cameras. The drawback, of course, is that each lens has to have its own shutter and is, therefore, unnecessarily expensive.

The third method is to place the shutter entirely behind the lens. This is not an easy structural solution and it also calls for a larger shutter, which is apt to become less efficient with increasing size.

So much for the types of camera that can take a variety of lenses. It is now time to consider the lenses themselves in more detail.
WHAT LENSES DO

The *Focal Encyclopedia of Photography* defines a lens as an “optical device for forming an image of an object”. It goes on to say a great deal more and the article is well worth reading if you want a fuller description than we need give now. For the moment we are concerned only with the fact that the lens forms an image of the scene in front of it and the size of that image and the amount of the scene that it covers depends, other things being equal, on the construction of the lens.

**What is focal length?**

Every lens has a particular focal length. The normal or standard lens generally has a focal length roughly equivalent to the diagonal of the image area it is intended to cover. Thus, the standard lens for a 35 mm. camera has a focal length of about 50 mm. or 2 in.

The focal length of a lens is the distance between a certain point within the lens and the image formed behind the lens of a distant (near infinity*) subject. In the camera, it is the distance between the lens and the film when the lens is set to its infinity focusing mark.

All camera lenses bend the light rays entering them so as to bring them to a focus in the required plane. It is the

---

*INFINITY. A position on the focusing scale of a camera lens... The lens set to this position... receives a sharp image of very distant objects. *Focal Encyclopedia of Photography.*
extent of this bending which governs the focal length of the lens and thus its angle of view. The standard 50 mm. lens for a 35 mm. camera has an angle of view of about 46 degrees.

Wide-angle lenses

Lenses that bend the light rays more acutely have a shorter focal length and a wider angle of view. The most popular wide-angle lens for the 35 mm. camera used to be the 35 mm. but this lens now often tends to be regarded as almost a standard type, with the 28 mm. and 24 mm. as reasonably wide angle.

Most of these lenses now have to be of inverted telephoto design, meaning that their back focus is longer than their focal length, in order to allow the mirror movement of the reflex camera. Also, the wider the angle, the more complicated the construction and the higher the price for a lens capable of providing good quality images. Inexpensive, very wide angle lenses are rarely a good buy because they are likely to provide distorted images with poor definition and illumination at the edges.

With some older cameras and some specialist lenses, the reflex mirror may have to be locked up so as not to foul the back of the lens. Naturally, reflex viewing and focusing facilities are then lost.

A separate viewfinder has to be used and the lens must be focused by guess and scale. This rarely poses problems, however, because such short focus lenses give immense depth of field* in normal shooting and quite major focusing inaccuracies can pass unnoticed.

The ultimate in wide-angle lenses is the fish-eye—so-called because of the monstrously bulbous appearance of its front

*Depth of Field. While anything at the exact focused distance will be reproduced sharpest on the film, the definition deteriorates only gradually in front of and behind this distance. Over a certain range of focusing distances—the depth of field—this unsharpness is still too small to be noticeable. Leica and Leicaflex Way, by Andrew Matheson.
When a normal lens is focused on a very distant subject (top), the distance between the optical centre of the lens and the film is the focal length of the lens. With lenses of standard focal length, this distance is also roughly equal to the diagonal of the image area.

Not all lenses follow this principle. The wide-angle lens, for example, may call for a very short separation between the film and the rear element of the lens (middle).

In the reflex camera (bottom), this separation could be so small as to preclude the use of a swinging mirror. Many wide-angle lenses are therefore made with this separation (the back focus) greater than the focal length of the lens, so that the mirror can still be used. This is the retrofocus or inverted telephoto construction.
element. There are two main types, the one taking in 180 degrees all round and so giving a circular image on the film, the other placing the image frame inside the circular image patch and so taking in 180 degrees on the diagonal dimension only. Neither can provide an undistorted image in the sense that straight lines off the lens axis become curved and distances between points around the perimeter are compressed. These lenses are used for effect or in very confined spaces where no other lens could obtain the picture required. In the latter case the picture needs careful interpretation.

**Long-focus lenses**

At the other end of the scale there are lenses which bend the light less than the normal lens. They have a narrower angle of view and a longer focal length. This, of course, means that a greater distance is required between the lens and the film (the back focus). Long-focus lenses for 35 mm. cameras are therefore generally mounted at the end of long barrels to provide the necessary extension from the camera body. That tends to make long-focus lenses rather bulky.

A reduction in the physical length of the long-focus lens can be achieved by constructing it in such a way that the back focus is *less* than the focal length (the opposite principle to the retrofocus lens); a lens so made is called a telephoto lens. There is a tendency to call all long-focus lenses telephoto lenses but the true telephoto is of this special construction—not that there is any essential difference in its handling or performance.

The telephoto construction frequently simplifies the problem of producing a long-focus lens that can satisfactorily be hand held. Long-focus lenses for 35 mm. cameras have focal lengths ranging from about 80 mm. to 1,000 mm. but it is rarely possible to use a lens of greater than about 135 mm. focal length without a tripod, unless just getting the picture is of more importance than its quality.
The image formed by a lens varies in size directly with the focal length of the lens. Thus a 200 mm. lens forms an image of a given object four times greater than that formed by a 50 mm. lens used from the same viewpoint. Naturally, since the image is projected on to the same film area, the long-focus lens takes in less of the scene in front of the camera than the short-focus lens.

In other words, the shorter focus lens takes in more of the scene but on a reduced scale. The longer-focus lens takes in less of the scene but on an increased scale.

One other thing should be evident. Equipped with the normal lens, you can reproduce exactly the effect of the longer-focus lens simply by enlarging a portion of the image, but you cannot produce the effect of the wide-angle lens—except on a two-dimensional subject (see page 28).

**What do f-numbers mean?**

There is another characteristic besides focal length that is generally used to describe a lens. This is the maximum aperture.* The aperture of a lens is defined by the opening in an iris-type diaphragm located within the lens. This diaphragm can be opened or closed to allow more or less light to pass through the lens. Its opening and closing are infinitely variable but it has various fixed openings described by a series of f-numbers.

These numbers run in the series 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, 45, etc. The smaller the number, the larger the aperture and thus the more light the lens transmits in a given time. On lenses for 35 mm. cameras, the minimum aperture (greatest number) rarely exceeds f 22 and is more often f 16. The maximum aperture may not be on the standard scale. It may be f 1.9 or 1.5, for example. On long-focus lenses, it may be f 3.5, f 5, f 6.3.

The maximum aperture of standard lenses is quite

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* **APERTURE.** The hole which lets the light through the lens ... the size of this hole expressed as a fraction of the focal length. *How Photography Works*, by H. J. Walls.
frequently \( f \) 2.8 or \( f \) 2 and \( f \) 1.4 is by no means uncommon. These represent fairly large apertures but, naturally, the larger the aperture, the larger the front glass.

The size of the front glass limits the maximum aperture. This is because the \( f \)-number is an expression of the focal length of the lens divided by the diameter of the light beam entering the lens and passing through the aperture. Thus, a 50 mm. \( f \) 1.4 lens would need a front glass with a diameter of at least 36 mm. or 1\frac{1}{2} \text{ in.} \) That is practicable. But a 400 mm. \( f \) 1.4 lens would need a front glass nearly 12 in. across. That is not practicable. So the longer the focal length of the lens, the smaller the maximum aperture is likely to be.

**What affects depth of field?**

We mentioned on page 16 that wide-angle lenses give immense depth of field. This is a subject that is often misunderstood.

Depth of field is the term used to describe the distance between the nearest point to the camera and the furthest point from it at which the lens, at any particular aperture and distance setting, will produce an acceptably sharp image. Those words “acceptably sharp” govern the whole concept. Before depth of field can be calculated, there has to be an arbitrary ruling about what is and what is not acceptably sharp.

No completely satisfactorily ruling can be made unless all final prints are made at exactly the same degree of enlargement and are viewed from exactly the same distance or, what amounts to the same thing, final prints are viewed from a distance proportionate to the degree of enlargement.

In practice, this never happens, so it must be understood at the outset that all depth of field calculations are in the nature of a compromise unless they relate to one particular application of one particular lens. They are useful to supply a comparison between the depth provided by one lens and another of different focal length. As indications of the actual
Depth of field depends, in practice, on focal length, aperture and shooting distance. The 50 mm. lens (left), for example, may provide adequate sharpness from about 3 ft. 3 in. to 4 ft. 9 in. when focused on 4 ft. at an aperture of f4. At f11, the depth of field might stretch from 3 ft. to 6 ft. at the same focused distance.

As the shooting distance increases to 10 ft. the 50 mm. lens might cover from 7 ft. 6 in. to 15 ft. at f4 and 5 ft. 6 in. to the far distance at f11.

The 135 mm. lens (right) gives very little depth even at f11 when focused on 5 ft. Even at 10 ft. the depth of field may not be more than about 2 ft. overall.
depth of field in practice of any particular lens, they must be viewed with reservations.

However, in practice, the extent of the depth of field varies with:

1. Focal length.
2. Aperture.

Other things being equal, the greater the focal length, the less the depth of field; the larger the aperture, the less the depth of field; the closer the camera to the subject, the less the depth of field.

Thus, at a given aperture and shooting distance, the wide-angle lens gives greater depth of field than the normal or longer-focus lens. In fact, as most general photography is carried out at medium apertures and distances of 15 ft. or more, the wide-angle lens produces an image which, even at considerable degrees of enlargement, is indistinguishably sharp in all planes. This is not always an advantage as we shall see when we consider the use of the various lenses.
DO YOU NEED ANOTHER LENS?

When you buy your camera, it is usually fitted with a standard lens. If you are like most other camera users, you will soon begin to think that you ought to have another lens—and you will probably think first of the long-focus.

The long-focus lens has a fascination all its own. It is the fascination of being able to take “close-ups” from a distance, of being able to produce clear pictures of something the eye cannot see so clearly.

Many photographers are reluctant to go really close to their subject—to make themselves and their camera conspicuous. They like to photograph people but are a little apprehensive of the reactions of possibly unwilling subjects. The long-focus lens overcomes this problem and, of course, the really long lens enables the timid photographer to shoot from almost out of sight of his subject.

Others have more genuine uses for long-focus lenses. These are the specialists—photographers of various sporting activities, of birds and other wild life, of inaccessible architectural detail, etc. But even these uses are limited. Many bird photographers, in fact, work from hides relatively close to their subject and use lenses of only moderately long focal length. Sports photographers use long-focus lenses only when really necessary.

How long is practicable?

The average photographer (and the average amateur in particular) should think very carefully before buying an
exceptionally long-focus lens—and that generally means anything over about 135 mm. in focal length. Let us consider what the use of a lens of very long focal length entails.

First, it is safe to say that no lens of more than 135 mm. can easily be hand-held. There are one or two with which, after considerable practice, it might be possible to produce acceptably sharp results. To guarantee first-class results, it is necessary to use a really efficient tripod and a cable release. With really long lenses (say 600 mm. upwards) even that may not be enough. Ground tremors, wind, etc. can be quite enough to set up vibrations in the camera held by a single mounting.

Here, of course, we are talking of perfection or, at least, of results comparable with those given by the standard lens. If you use the long-focus lens for vital shots that just could not be obtained any other way, then perhaps some imperfection is acceptable.

Camera shake* isn’t all you have to watch. The very long-focus lens yields very little depth of field, even at comparatively long range. If you use it at relatively close range simply to avoid a close approach to the subject, the depth of field may be so shallow as to make the picture required virtually impossible.

Long-shot perspective

The distant viewpoint is not always an advantage either. Viewpoint controls perspective. Pictures taken from a distant viewpoint are nearly always easily recognizable, whether taken with a long-focus lens or presented as enlargements from part of a negative. The background looms large. There appears to be little or no separation

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*Camera shake. Blur is often caused, not by movement of the subject, but by movement of the camera at the time of exposure... Easily recognizable characteristics of camera shake... are an equal degree of blurring of all parts of the picture, and frequently the appearance of two slightly displaced and somewhat unsharp images. Focal Encyclopedia of Photography.
The relatively close viewpoint (top) shows objects nearer to the camera larger than those farther away, because the nearer object subtends a much greater angle at the lens. This is what the eye expects to see and it therefore interprets the difference in size as a separation in space.

The more remote viewpoint (bottom) does not show this size difference because the angle of view need not change much to take in nearer and farther objects when both are at a great distance from the camera. Consequently, in long-range shots, the impression of distance between objects is almost lost.

This tendency is more apparent in shots made with long-focus lenses, which give the impression of having been taken from a close viewpoint. The effect is exactly the same, however, if part of a long-range shot taken with a normal lens is enlarged.
between objects which are, in reality, at various distances from the camera. Perhaps the best-known examples are head-on shots of rowing eights, where the crew appear to be uncomfortably cramped in a very short boat; or shots down the length of a cricket pitch which show the bowler almost stepping on the batsman's toes.

This is all a matter of relative sizes. We expect distant objects to be on a smaller scale than nearer objects and that is how the normal viewpoint shows them. When the distant viewpoint presents relatively near and far objects on almost the same scale, we find it difficult to accept that there is in fact any separation between them.

We can often use this perspective effect to advantage. A close approach to the main subject enables it to loom large and to completely overshadow its background. This can frequently add considerable impact to the picture. Similarly, a low viewpoint dramatises the leap of a high-jumping athlete or show-jumping horse. With the long-focus lens used at a distance, the low viewpoint is impossible and the leap becomes much less impressive.

**The air is not clear**

It is interesting to consider the possibilities of using really long-focus lenses to shoot at extremely long range—sometimes even beyond the range of human vision. This is, indeed, possible but, to the dangers of camera shake, shallow depth of field and flattened perspective already mentioned, we now have to add what we might call atmospheric interference.

With every photograph we take, there is atmosphere between the camera and the subject. Light rays reflected from the subject have to pierce that atmosphere to reach the lens. At short range, dust and moisture in the atmosphere offer little impedance to those rays. At longer range and in unsuitable weather conditions, they might have a noticeable effect, ruining definition and flattening contrast.

The effects of light mist might be eradicated by using
an orange or red filter* on black-and-white film but very long focus lenses have relatively small maximum apertures and the addition of the filter may mean that unsuitably slow shutter speeds have to be used.

**Long-range focusing**

The accurate focusing of long-focus lenses on non-reflex cameras is not easy. Lenses of greater focal length than 135 mm. do not usually couple with the rangefinder* of 35 mm. cameras. You have to estimate the distance of your principal subject and set your lens as close to that distance as possible on the focusing scale. But, as we have already mentioned, these long lenses yield very shallow depth of field and it is easy to miss the plane of focus by quite a distance. In fact, the really long-focus lens can only be used satisfactorily on a reflex camera or on a non-reflex with a reflex housing. Even with the reflex, very long lenses may not couple with the automatic iris control. This can be somewhat confusing if you are used to lenses with this facility.

All these points should be considered very carefully when you find yourself thinking about long-focus lenses but, of course, very few of them apply to the moderately long-focus lens of up to, say, 135-150 mm. Nevertheless, many long lenses have been unjustifiably maligned because their purchasers did not understand that they need special care in handling.

Only if you are prepared to take that extra care is it

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**FILTERS** are coloured discs of glass or gelatine which usually fit in front of the camera lens and selectively absorb light of certain colours before it reaches the film. *How to Choose and Use your 35 mm. Camera*, by Leonard Gaunt.

**RANGEFINDERS** depend on viewing the subject from two slightly different viewpoints and bringing the images to coincide when the rangefinder is set to the correct distance. The latter can then be read off correctly on a scale . . . The measurement of the distance with the rangefinder and the setting of the focusing scale to this distance may remain separate operations or they may be linked together. *Camera Techniques*, by H. J. Walls.
worth considering the purchase of a very long focus lens. Remember always that the effect of a long-focus lens can be duplicated exactly simply by enlarging the relative portion of a picture taken with a lens of shorter focus. If both shots are taken from the same viewpoint, perspective will be the same and the apertures can be adjusted to give the same depth of field. Naturally, the greater the degree of enlargement, the more prominent the grain structure will become on the print from the shorter focus lens but in other respects the prints will be identical. And you always have to offset against this grain trouble the probability that the carelessly used long-focus lens will not produce a sharp picture at all.

Do you prefer the wide angle?

But perhaps you are one of the minority who think first of a wide-angle lens. Many think that this is, in fact, a much more sensible approach to the choice of a second lens. You can, as we have already mentioned, obtain a moderate long-focus effect simply by enlarging part of the image given by a standard lens—but you cannot emulate the wide-angle effect with a standard lens.

It might be said that you can obtain a wide-angle effect by taking up a more distant viewpoint, but the argument is fallacious. You then have an entirely different picture, with different perspective and depth of field. Such an argument could apply only to a two-dimensional subject. Even then, you get your result only by changing your viewpoint and the great advantage of the wide-angle is its ability to cover a wide field from a close viewpoint.

The wide-angle lens gives you something extra and it has a variety of uses. It has obvious advantages in taking

GRAIN. When you look at the image on a film through a magnifying glass—or if you make a big enlargement of it—you no longer see uniform tones, but an irregular pattern of black dots of various shapes and sizes... This irregular image structure is known as grain. How to Choose and Use Film and Filter, by L. A. Mannheim.
pictures of interiors where you want to include as much as possible of the room in the picture. It can obviate the need for tilting the camera when photographing high buildings—a very common requirement in today's crowded cities and it is absolutely essential if you want to take general views in narrow village or city streets.

In those same narrow streets, the photographing of people and events is often made difficult by the necessity for a close viewpoint. Otherwise, somebody or something is likely to come between the camera and the subject. The standard lens may not take in enough of the subject from that close viewpoint, but the wide-angle lens can take in quite large subjects from close range.

The wide angle lens also has the advantage of providing considerable depth of field at comparatively large apertures. Other things being equal, the 28 mm. lens, for example, will give about the same depth of field at $f4$ as the 55 mm. lens at $f8$.

In addition, many wide-angle lenses will focus as close as 6 in. and even less. This can prove very useful indeed for obtaining large images of small objects or for copying documents without special close-up devices.

The close viewpoint is also useful for producing special "distorted perspective" effects. Quite small objects can be made to dwarf the background when the camera can approach them closely.

What are its weak spots?

Naturally, the wide-angle lens is not without its disadvantages. Paradoxically, some of these are the very features we have already described as advantages. It is not always desirable for instance, to produce all-over sharpness in the picture. With the wide-angle lens, however, only subjects quite close to the camera can be differentially focused* so as to subdue the background.

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DIFFERENTIAL FOCUSING. This sounds very complex but it is only another way of saying "focusing on the subject alone"—allowing the background to be unsharp, so as to give a three-dimensional effect to the picture. Photography with the Eye-Level Reflex, by H. S. Newcombe.
The ability to approach the subject closely can lead to trouble. It can tempt you to move in close on the wrong kind of subject and obtain a particularly unpleasant form of perspective distortion. Even when using the wide-angle legitimately on interior scenes, you have to be careful to keep recognisable shapes away from the edges of the picture area, where the very oblique viewpoint may cause them to become distorted in a manner that will look unnatural on the final print.

Similarly, any object very close to the camera can dwarf a similar-sized object only a little farther away. That can lead either to a mistaken impression as to relative sizes or as to distance between the objects, because if we know the objects are the same size, a considerable disparity in their image sizes suggests that they are widely separated.

A further, more serious, disadvantage, is that as the focal length becomes shorter so it becomes more difficult for the lens to distribute the light evenly over the image area. The corners of the picture, particularly in colour work, may show distinct signs of under-exposure. The well-designed lens minimises this effect but it reaches the ultimate in most "fish-eye" lenses, which give an angle of view of 180 degrees but provide only a circular image in the middle of the film. No light reaches the corners of the film at all. Moreover, only a tiny portion in the middle of the field remains undistorted. Away from the centre, straight lines show considerable curvature and definition* tends to fall off.

Finally, the wide-angle lens is not as suitable as it might seem to be for producing panoramic views of distant scenes. It produces distant scenery on such a reduced scale that all sense of proportion is lost. Hills almost disappear and even high mountains are dwarfed by comparison with foreground objects. Fine detail in the distance becomes so small that the film cannot resolve it.

DEFINITION. The quality of the image which is produced by a lens. A major problem in optics is to obtain a satisfactory method of measuring definition. Photographic Optics, by Arthur Cox.
Very long focus lenses usually have relatively small maximum apertures. This is simply because the physical size of the aperture denoted by the same f-number increases with increasing focal length. The f/2 50 mm. lens needs a front glass at least 25 mm. (about 1 in.) across. A front glass of 1 in. diameter on a 300-mm. lens could provide a maximum aperture no greater than f/12. An f/2 300 mm. lens would need a front glass at least 6 in. across.

The acute angle at which a wide-angle lens projects its image onto the film can cause distortion of three-dimensional objects near the edges of the image area. This does not occur, however, with two-dimensional objects at right-angles to the lens axis. The set-up here represents film cans, the three on top presenting a tubular aspect to the camera, and those below presenting a flat, circular surface. The circles are not distorted, but the tubular shapes at the edges of the picture area are reproduced as rather fatter than the one in the middle.
Choosing your focal length

You will have decided by now whether you really need an additional lens. You had probably decided already, anyway. It remains only to make the choice. What is it to be—wide-angle or long-focus?

If your main interest is buildings, interiors, street scenes, people in crowded places, etc. your choice should undoubtedly be the wide-angle. In fact, if the only use you can think of for the long-focus lens is to take "candid" shots of people, you should ponder on how long such an interest is likely to last and whether you could not find more uses for the lens that really does something your standard lens cannot do.

Which wide angle?

Suppose you decide that the wide-angle is the lens for you. What focal length should you choose? The safest recommendation is that you should choose the lens of about half the focal length of the standard lens if you want a significant wide-angle effect. With the 35 mm. camera, this points to the 28 mm. The practical alternatives are 35 mm. and 24 mm.

The 35 mm. is a good choice for general work, is likely to be less expensive and will probably be less prone to distortion and vignetting* troubles. The 28 mm. gives just that little bit extra.

The 24 mm. lens is more difficult to use—and not easy to manufacture. The lower-priced versions might be prone to vignetting* and poor definition at the edges of the picture area. A good 24 mm. lens could be very expensive, and you may find comparatively little use for it after the first enthusiastic search for suitable subjects.

*VIGNETTING. Underexposure of image corners produced deliberately by shading or unintentionally by faulty equipment, such as unsuitable lens hood or badly-designed lens. Commonsense Photography, by Leonard Gaunt.
We have noted that the shorter the focal length of the lens, the greater the depth of field provided. This becomes evident on the focusing screen and can make very wide angle lenses rather difficult to focus because the image does not snap into and out of focus so abruptly.

Anything shorter than 24 mm. is really specialist—if not, indeed, a "gimmicky" lens. Only the most recent, very expensive designs can provide an undistorted image and some vignetting is almost inevitable.

The 28 mm. has the edge but if you need a fast lens and can make do with a moderately wide angle, the 35 mm. might be more easily obtainable with a large maximum aperture.

**Which long focus?**

If you decide on a long-focus lens, the choice of focal length is more difficult. We need not reiterate the care needed with the really long lenses. These, too, are specialist lenses and you should preferably put out of your mind any thought of a longer focal length than about 200 mm. unless you definitely have in mind a reasonable amount of work that necessitates shooting from really long range and you are prepared to work from a tripod most, if not all, of the time.

If there could be an ideal focal length in this field it would be the 135 mm. This gives an image a little over 2\(^{1/2}\) times the size of that from the average standard lens on the 35 mm. camera. It is not the ideal lens for portraiture but it can be used quite successfully. It will give a head and shoulders portrait from less than 10 ft. It gives a useful size image for most other moderate long-focus work and is comparatively inexpensive while giving sufficient quality to be able to stand quite considerable degrees of enlargement.

If, however, your interest is almost entirely in the portraiture field, the ideal lens is in the range 85–105 mm. The 90 mm. lens has long been recognised as almost the standard for portraiture but in recent years the 105 mm. has become very popular.
**Mirror lenses**

A special type of lens intended to bring hand holding capability to the very long focus region is the mirror lens. It follows the reflecting telescope principle of using mirrors to fold the light path so that the overall length of the lens can be considerably reduced. The bulk, however, is correspondingly increased and, while some of the shorter focal lengths (300 or 500 mm.) can be hand held at a push, there are 1000 mm. types of truly enormous size. Prices vary from rather expensive to astronomically high.

A considerable disadvantage of the mirror lens construction is that it precludes the use of a variable aperture, and light transmission usually has to be controlled by the use of filters. This raises the problem of where to set the fixed aperture and manufacturers remain undecided between about $f4$ and $f11$. Very wide apertures are impracticable, because they provide virtually no depth of field at even medium shooting distances.

**The choice is personal**

The ultimate choice of focal length, whether wide-angle or long-focus, is yours. You must consider carefully the kind of work you intend to do. Remember that image size is directly proportionate to the focal length. Doubling the focal length doubles the size of the image you obtain on the film of any given object shot from a given distance.

Avoid the extremes unless you are sure you really need them and are prepared to accept the need for special precautions in their use.
WHAT ABOUT CONVERTERS AND ZOOMS?

So far we have talked mainly about actual camera lenses designed to be used in the orthodox manner. There are, however, other possibilities. Before we go on to consider how you should choose the particular lens to buy, we must look at converter lenses, monoculars and zoom lenses. If you are not sure that the amount of work you expect to do justifies the expense of a complete additional lens, a converter or a monocular might be a better buy.

There are many lens attachments known by various names based on adaptations of the description "tele-extender". These are attachments which fit between the lens and the body of a reflex camera and have the effect of increasing the focal length of the camera lens.

What are converter lenses?

Tele-extenders come under the heading of "converter lenses". They cannot be used on the camera alone. They are, in essence, negative (diverging) lenses*. Parallel rays of light (as from a distant object) diverge after they pass through such a lens and cannot therefore be brought to a focus behind the lens. Naturally, rays that are already diverging when they enter the front of the lens (coming from

*NEGATIVE LENS. All negative lens shapes are thinner in the centre than at the edges... Negative lens elements diverge light and cannot be used alone for making photographs. Basic Photography, by Michael J. Langford.
a nearer object) continue to diverge when they leave the rear surface of the negative lens. If, however, the rays are made to converge by a positive lens before they reach the negative lens, they will emerge from the negative lens with rather less convergence and so be brought to a focus at a greater distance behind the lens than would have been the case if only the first, converging, lens were used.

That is how the tele-extender works. The camera lens emits converging light rays aimed, when the lens is focused on infinity, at a plane one focal length behind the lens. The negative extender lens intercepts these rays, lessens their convergence and brings them to a focus at a greater distance behind the prime lens. At the same time, the lessening of the convergence spreads the image so that less of it falls on the now more distant film. Thus a larger image is obtained—usually two or three times larger according to the construction of the tele-extender.

Thus, if you have a 50 mm. standard lens and would like to have a lens of rather longer focus for occasional portraiture or similar work, you can buy a 2X tele-extender and have the equivalent of a 100 mm. lens as well. This is considerably cheaper than buying a complete 100 mm. lens.

Naturally, the lower cost is reflected in the result. The best of the tele-extenders work surprisingly well but they cannot give better results than the prime lens. In fact, they magnify disproportionately any faults that may exist in the lens with which they are used. Additionally, the extra glass components and the increased length of the light path inevitably mean some loss of illumination on the film. This works out at about two f-stops for each doubling of focal length. Thus, your f2 50 mm. lens used with a

**Exposure Meter.** I am a sort of miniature electricity works... I measure the light which the various objects reflect, and indicate the correct exposure which will produce a clear image of these things on the film. *All-in-One Camera Book*, by W. D. Emanuel.
The tele-extender type of converter fits behind any prime lens and provides an increase in focal length of, usually, either two or three times. Thus, from the same viewpoint, a larger image can be obtained on the film (bottom).

The tele-extender is a negative lens. It intercepts the converging rays from the camera lens before they reach their plane of focus (the film) and lessens their convergence so that they come to a focus farther back (top).

This new plane of focus is, of course, the plane in which the film now lies, because it has been moved farther back from the lens by the depth of the converter. The effect is to narrow the angle of view accepted by the image area and thus to present a larger image on the film.

A side-effect is that, as the light from the camera lens has, in effect, been spread over a greater area, the strength of the light falling on the film has been reduced. Extra exposure is therefore necessary, usually amounting to four times as much for each doubling of focal length.
2X tele-extender becomes an f/4 100 mm. Put another way, if your exposure meter* indicates an exposure of 1/125 sec. at f/8, you have to give 1/125 sec. at f/4 when you add the tele-extender.

Some tele-extenders also have a tendency to produce flare and thus reduce contrast to a greater or lesser degree. This, as might be expected tends to be more noticeable in the lower-priced models. Nevertheless, considering its price in relation to a complete long-focus lens the tele-extender can be good value for money for those who only occasionally need the extra focal length. When used, for example, with a 135 mm. lens, the 2X tele-extender gives you the impressive focal length of 270 mm., which is long enough for virtually any requirement of the average photographer.

Moreover, the tele-extender does not make your "combination" lens as long as some equivalent focal length complete lenses, so it does not introduce any additional danger of camera shake and may even tend to be less unwieldy than the ordinary lens. It has the further advantage that it has no effect on the focusing scale of the lens with which it is used. You can thus have a 270 mm. lens that focuses much closer than a normal lens of that focal length.

**How does the monocular work?**

Another comparatively inexpensive way of obtaining long-lens facilities is to use a monocular. This is simply an extension of the make-shift method of shooting through a telescope or half a binocular. You can do this with any camera by focusing the telescope or binocular and shooting through the eyepiece with the camera lens set to infinity.

There are, however, one or two monoculars which are, in effect, half a binocular specially designed for photographic use. These are versatile instruments. They are supplied with a method of fixing to the camera lens. The combined focal length is then the focal length of the camera lens multiplied by the magnifying power of the monocular.
The monocular is a versatile instrument. It can be fitted to the front of the standard camera lens to provide an increase in focal length equal to the magnification of the monocular multiplied by the focal length of the camera lens. This usually provides a focal length of about 350–400 mm. The monocular is usually fitted to the lens via an intermediate ring screwing into the front of the lens mount.

Alternatively, the monocular can be fitted directly to the camera via an extension tube or tubes, using no camera lens. One now-discontinued model provided focal lengths of 400, 600, 800 and 1,000 mm.

There was also a zoom unit for this monocular. It replaced the tubes and allowed infinite variation of focal length between about 350 and 1,250 mm.

Supplementary, or close-up, lenses can be used on the monocular to provide considerably magnified images on the film.
This is generally about 6–8 times and will thus convert a 50 mm. lens into a 300–400 mm. lens. The price of the monocular is generally much lower than that of a normal photographic lens of comparable focal length.

Again, you have to sacrifice something for the lower price. First, the maximum aperture is limited. This you might expect. As we mentioned on page 20, the maximum aperture can be roughly calculated from the diameter of the front glass of the monocular. This might, perhaps, be 30 mm. It is not likely to be more than 40 mm. We know that the $f$-number is the focal length of the lens divided by the diameter of the beam of light striking the front glass of the lens and actually getting through the aperture. This beam obviously cannot be greater than the diameter of the front glass itself. Thus, a 300 mm. lens with a front glass of 30 mm. diameter cannot have a maximum aperture greater than $f$ 10. In fact, light losses in the system are likely to reduce this to nearer $f$ 16.

Additionally, the monocular is not easy to handle. Camera shake is an ever present problem and, at long shooting distances, it takes only the slightest shake to produce the most disastrous blur on the film.

Nevertheless, provided its drawbacks are recognized and it is used with ordinary common sense, the monocular can give good results for its comparatively low cost.

Both tele-extender and monocular are designed for use with reflex cameras. They cannot be used satisfactorily on a camera without a focusing screen although it is, of course, possible to focus the monocular visually and then shoot through the eyepiece with the camera lens set at infinity. You have to guess the field of view, however.

Similarly, the tele-extender could theoretically be used with non-reflexes because it does not affect the focusing scale of the prime lens. Again, however, you would have to guess the field covered or use an additional viewfinder. There is, in fact, a Japanese version that couples with the rangefinder of the old screw-mount Leicas but it has to be specially ordered and is expensive.
What about fixed-lens converters?

For the sake of completeness in this field of attachments, we must mention the facilities available for altering the focal length of fixed-lens cameras. A few attachments are available to fit over the front of such lenses to convert them to either wide-angle or long-focus use. These attachments have to make very big compromises. As with any other type of attachment, they cannot improve the performance of the prime lens. They take quite a lot away from it. In exchange for a usually slight increase or decrease in the size of the image, they give, according to quality, a slight to noticeable softening of definition, a reduction in maximum aperture and a loss of covering power, i.e. loss of definition and/or illumination at the corners of the image. Naturally, they also make additional viewfinders necessary.

These attachments should not be confused, however, with the interchangeable front components we have already mentioned. These are considerably more expensive sets of lenses designed around a common rear component. This rear component is so constructed that it can be fitted with various interchangeable front components to give a limited range of different focal lengths.

The principle is entirely different from that of the attachment lens, which is not designed as part of any particular lens system but is intended for use with any lens of approximately the standard focal length of the 35 mm. camera. The interchangeable front component is designed to be fitted only to one particular construction of rear component. Thus, the best of such lenses can give incomparably superior results to those of the attachable-lens system, although possibly still inferior to those of individually designed complete lenses of comparable quality.

What is a zoom lens?

So far in this chapter we have dealt mainly with comparatively inexpensive methods of obtaining the long-focus effect.
There is one rather more expensive method—the zoom lens. This is a lens containing movable elements which enable its focal length to be changed at will—within certain limits.

The zoom lens was first developed for movie work, where the speed with which lenses can be changed is rather more important than it is with the still camera. The early models were extremely expensive and by no means as good performers as individual lenses of comparable focal length.

The zoom lens is a complicated construction. The greatest problem is to design it in such a manner that it will remain focused on its preset distance throughout the zooming movement although that is not really necessary for still photography. It is this problem that limits the range of the zoom. At present few zoom lenses for 35 mm. cameras exceed a zoom ratio of 3 : 1, i.e. the greatest focal length to which they can be set is rarely much more than three times the shortest. They may provide focal lengths between 35 and 100 mm. for example, or between 100 and 300 mm. They are infinitely adjustable between these limits, so that you can set them to provide any image size within the limits of the range.

This facility is, of course, particularly useful for colour work. If you need to frame your subject just a little more tightly or to give it a bit more “air” and cannot easily change your shooting position to do so, the zoom lens provides an easy answer. You simply focus your subject and then adjust your focal length to give the required image size in the viewfinder—from which it is self-evident that this is yet another type of lens suitable only for the reflex camera.

For monochrome work the value of the zoom lens is rather less. It is rarely necessary to frame your picture quite so accurately because you will almost certainly carry out a certain amount of trimming when enlarging. It is, indeed, often useful to have just a little more “air” around it to give more scope for possible tilts or rearranged trims in the final print.

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The zoom lens (left) provides the equivalent of several lenses of differing focal lengths (right). The separate lenses, however, provide a range of focal lengths proceeding in steps—one focal length for each lens. The zoom lens provides infinite variation of focal length between its stated limits, so allowing precise framing of the picture without moving the camera or changing the lens.

Most zoom lenses for 35 mm. still have a rather limited zoom range. The longest focal length available is rarely more than 2½ times the shortest (giving a so-called zoom ratio of 1 : 2½). The most common range is about 100/200 mm. but a few lenses with shorter minimum focal lengths are available for certain cameras and others with greater zoom ratios.
Also, against the advantage of being able to change focal lengths rapidly, you have to set the considerable cost of the zoom lens and the not inconsiderable disadvantage of carrying extra bulk for possibly 90 per cent of your camera work. Moreover, although they have improved vastly in recent years, only the best of the zoom lenses can claim equality of performance with the average, good quality single focal length lens.

A comparatively recent development is the so-called macro-zoom lens with the ability to focus extremely close so as to produce images at about half natural size. This facility is usually provided by a switch-over mechanism which rearranges the lens components to provide the macro facility. The value of such a lens to the still photographer is a little difficult to appreciate.

We have now discussed all the methods available by which you can influence the size of the image you obtain from a given viewpoint. It is time to consider, in the light of the qualifications so far made, what factors should influence you in boiling your choice down to one particular lens.
HOW TO CHOOSE YOUR LENS

For cameras without reflex viewing facilities, the choice of alternative lenses is limited. It is limited, first, as all lens interchangeability is, by the number of lenses made with the particular screw thread or bayonet design of the camera in question.

It is further limited by focusing problems. Even at long range, the long-focus lens gives limited depth of field and scale focusing alone is not sufficiently accurate. Few lenses of greater focal length than 135 mm. are made to couple with the rangefinders of non-reflex 35 mm. cameras. For longer lenses, the camera has to be fitted with a reflex housing to convert it to a reflex camera.

Will it fit your camera?

The first limitation is absolute. There are very few non-reflex cameras with similar methods of attaching the lens. Most can accept only the lenses provided by the camera manufacturer. A notable exception is the older screw-thread Leica. This camera had many imitators, including the older Canons, the Russian Fed, and the British Reid. In addition, the British Periflex used the same thread and a few lens manufacturers made lenses specially for these cameras.

Thus, even now, there are many lenses that can be interchanged at will between any surviving models of these cameras with the exception that Periflex lenses do not
couple with the rangefinder. The Periflex was an early, unorthodox design of reflex camera.

In the reflex field, there are still many different mounting systems but independent lens manufacturers have made greater efforts to overcome the problem. The first 35 mm. reflex was the old Kine Exakta and there have been innumerable lenses made to fit its successors. Similarly, the Praktica, the Asahi Pentax, the screw-thread Edixa models and many recent cameras use a 42 mm. thread that is rapidly becoming standard. Lenses made for one can be attached to the others, although not always retaining the full facilities of automatic operation. These cameras have all sold in large numbers, so independent lens manufacturers have also turned out very many lenses to fit them. Bayonet attachments, however, are mostly unique to the one make of camera.

Additionally, in recent years there has been a trend towards the lens in a standard barrel designed to take a variety of mounting arrangements to suit it to various cameras. These are known by such names as T-mounts, Interflex mounts, etc. One manufacturer can thus supply the same lens with mounts suitable for 20 different cameras.

**What about quality?**

Where such a range of lenses is available, it is essential to ensure first that the prospective purchase will, in fact, couple accurately with the camera’s rangefinder in the case of non-reflexes or with any system of automatic aperture control in the case of non-reflexes. With the longer focal length lenses, this latter question may not arise; many very long lenses have no automatic facilities.

Check that, when fitted to the camera, the lens will focus very distant subjects. When the lens is set at its infinity focus setting it is one focal length distant from the film in the back of the camera (or, if it is a retrofocus or telephoto lens, a specified longer or shorter distance). Thus it will not fit accurately on two different cameras unless they have exactly the same depth from lens flange to
couple with the rangefinder. The Periflex was an early, unorthodox design of reflex camera.

In the reflex field, there are still many different mounting systems but independent lens manufacturers have made greater efforts to overcome the problem. The first 35 mm. reflex was the old Kine Exakta and there have been innumerable lenses made to fit its successors. Similarly, the Praktica, the Asahi Pentax, the screw-thread Edixa models and many recent cameras use a 42 mm. thread that is rapidly becoming standard. Lenses made for one can be attached to the others, although not always retaining the full facilities of automatic operation. These cameras have all sold in large numbers, so independent lens manufacturers have also turned out very many lenses to fit them. Bayonet attachments, however, are mostly unique to the one make of camera.

Additionally, in recent years there has been a trend towards the lens in a standard barrel designed to take a variety of mounting arrangements to suit it to various cameras. These are known by such names as T-mounts, Interflex mounts, etc. One manufacturer can thus supply the same lens with mounts suitable for 20 different cameras.

What about quality?

Where such a range of lenses is available, it is essential to ensure first that the prospective purchase will, in fact, couple accurately with the camera’s rangefinder in the case of non-reflexes or with any system of automatic aperture control in the case of non-reflexes. With the longer focal length lenses, this latter question may not arise; many very long lenses have no automatic facilities.

Check that, when fitted to the camera, the lens will focus very distant subjects. When the lens is set at its infinity focus setting it is one focal length distant from the film in the back of the camera (or, if it is a retrofocus or telephoto lens, a specified longer or shorter distance). Thus it will not fit accurately on two different cameras unless they have exactly the same depth from lens flange to
Many factors can affect quality, i.e. sharpness, tonal range, brilliance, etc.

No matter how good the camera lens, wrong exposure can affect both sharpness and tonal range. Subject or camera movement can cause varying degrees of blur.

Wrong processing has a similar effect to faulty exposure. It can lead to excess or lack of contrast and overdevelopment can destroy fine detail and increase grain size.

A shaky enlarger is as bad as an unsteady camera and the quality of the final print can only be as good as the enlarger lens will allow.
film plane. It may work with close-to-medium-range subjects but be unable to focus anything at long range.

If these conditions can be satisfied, the choice of the lens becomes a question of price and quality. The two usually go together. It is reasonable to assume, for example, that the rather expensive, genuine Leitz lenses are the best for the Leica cameras and it may well be that they would offer an improvement over the not so expensive lenses fitted to its imitators.

Nevertheless, it cannot be taken for granted that the most expensive lens is always the best. As in so many other fields you pay something for the name. The manufacturers of really high-quality goods can, and generally do, charge higher prices for the reliability that purchasers expect.

It is this reliability that is the most important factor in the choice of a lens. The expensive lens from a well-known manufacturer can confidently be expected to reach a certain standard of quality. Such manufacturers have rigid inspection procedures which are designed to ensure that lenses which do not reach their standards are rejected by their inspectors and are not offered for sale.

Those manufacturers who sell their lenses at significantly lower prices cannot afford such quality control. Their standards will generally be a little lower—the lower the price, the lower the standards. They may well allow a lens to be put on the market that the better-quality manufacturer would reject.

*Are cheaper lenses any good?*

This is not to say that one lens design may not be as good as another. It is quite possible to obtain a comparatively inexpensive “unknown” lens that performs as well as a lens by a well-known manufacturer. The chances are, however, that you will be comparing one exceptionally good product of the “unknown” and one of the only just acceptable products of the better-known manufacturer.

This is why it is rarely possible to state categorically that any particular make of lens is better than another. Most
modern lenses are of first-class design—even the least expensive—but the original design has to be translated into a carefully ground, polished, coated* and assembled complex of glass and metal. The slightest inaccuracy anywhere along the line can impair or even completely ruin the performance of the lens. The manufacturer who charges more can afford to pay greater attention to the prevention of such inaccuracies—and the manufacturer with a good reputation cannot afford not to take these extra precautions.

Thus, there is much to be said for the general principle of paying as much as you can afford for your lens but the less expensive lens need not be rejected out of hand as necessarily markedly inferior. You just have to take greater care in buying the less expensive product.

This is especially true for those camera users who do not really need the startling quality of which the most expensive lenses are actually capable. Those, for example, who rarely require enlargements of more than 4–5 times magnification or who project their transparencies on to a medium-sized screen which is viewed from several feet, can get all the quality they require from quite modestly priced lenses.

Those who use only moderate quality enlarging lenses and projectors are similarly placed because no matter how sharp an image the camera lens produces, the final print or projected picture can only be as sharp as the enlarger or projector lens will allow. Extreme care in shooting and processing are also necessary to obtain the true quality of the first-class lens. Even the best lens will give inferior results, for example, if the camera is shaken during the exposure.

Many people are confident that they never experience

*COATED. That means that all glass-to-air surfaces are given a coating of an extremely thin metallic film that has the property of almost completely eliminating reflections on the glass surfaces. On an uncoated lens, reflections result in an appreciable loss of light. The Contaflex Way, by H. Freytag.
camera shake, even at slow shutter speeds, yet there is little
doubt that this is the greatest enemy of true sharpness and
that very few camera users indeed can hold a camera *perfectly*
steady at shutter speeds slower than 1/125 sec. The shake
may not be noticeable in normal circumstances but it is
usually quite sufficient to take the edge off true quality
when the enlargement reaches 6–8 times and greater.

**What do resolution tests show?**

This is one of the reasons for not regarding lens resolution
tests as the ultimate test of lens performance. These tests
are never made under actual shooting conditions. They
are not made on normal photographic emulsions. They are
often not even made with ordinary cameras. To say that a
lens has a resolving power* of 112 lines per mm. is meaning-
less in itself. The average film cannot resolve more than
80 lines per mm. under ideal conditions—and practical
conditions never are ideal. Moreover, a lens can be made to
provide higher resolution figures at some sacrifice of its
contrast rendition (acutance). This is pointless if the
theoretically greater resolving power is unusable in practice.

The practical lens has to be designed to provide a reason-
able compromise between contrast (separation of tones)
and resolution (separation of fine lines or detail). It will be
of little practical value if it has superb resolving power but
gives results so lacking in contrast that acceptable prints
cannot be made. In such conditions, the lens with lower
theoretical resolving power but more “bite” will give
better-looking prints—and the additional contrast will even
make the prints *look* sharper.

This is not to say, of course, that the resolution test is
of no value whatever. It gives useful information on one
aspect of the lens’ performance. It is of no value in compar-

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RESOLVING POWER. The power of a lens to produce images of closely
spaced lines or points in such a fashion that the individual identities
of the images may be recognised. This resolving power of a photo-
graphic lens is usually specified in lines/mm. *Photographic Optics*, by
Arthur Cox.
ADVANTAGES OF FAST LENS

The fast lens is of particular value on the reflex camera because of the brighter screen image it gives, making viewing and focusing easier.

In actual photography, the fast lens allows reasonably fast shutter speeds to be used even in dim light. Its large aperture makes differential focusing easier, so that even close backgrounds can be thrown out of focus. It obviates the need for fast film where the light is poor or very high shutter speeds are required for fast-moving subjects.
ing different lenses, however, unless the conditions of the test are very rigidly controlled and are absolutely identical for each lens. This entails extremely accurate calculation of exposure, identical contrast in test targets, perfect focusing (and therefore perfect construction of the camera body with which the lens is tested), clinical control of processing time, temperature, agitation* and even washing and drying. Many tests depart quite considerably from these ideals.

The common-sense approach

So how do you choose a lens for quality? The truth is that unless you go for the expensive lens with a well-known name, you simply have to take a chance. Most medium-priced lenses are of quite acceptable quality and some of them are very good. If a lens is offered at a price far below that of all others, the chances are that it is not very good and you run the risk of wasting your money. In other words you must apply ordinary common sense.

You can, of course, study the specification. In some cases, there may be a reason for the lower price. The long-focus lens may be of orthodox, rather than telephoto construction. That need not affect its performance in any way (indeed, it might even be better for the simpler design) but it will be rather more bulky.

Similarly, the cheaper lens may have a smaller maximum aperture. The 135 mm. f 3.5 or f 4 lens, for example, may be cheaper than the f 2.8 lens. If the slower lens is adequate for your purposes—and it is for most—there is no point in paying more for a design that might conceivably have been “stretched” a little to give the extra speed. In these circumstances, the cheaper lens can often be the better buy.

In any event never pay the considerable additional cost

Agitation. You need to stir up the developer in the tank, while the film is in it. This stirring or agitation brings fresh chemicals in contact with the film surface and distributes the by-products of development through the whole of the solution. Do Your Own Film Processing, by L. A. Mannheim.
The lens of the single-lens-reflex needs to be fully open for viewing and focusing. Usually, it then needs to be stopped down to the taking aperture before shooting.

The simplest method is to stop down in the normal way, but that slows down operations while the camera is taken away from the eye or the click stops counted.

Some lenses use the pre-set method (top). These may have two aperture rings. One is in the usual form and is set to the shooting aperture when the exposure is determined, but the diaphragm remains open. The other ring is usually much looser and has no click stops. It is turned as far as it will go just before shooting, causing the diaphragm to close to the pre-set aperture (2). Then the shutter can be released (3).

Lenses with fully automatic aperture control use just the one control ring (bottom), which is set in the usual way (1). It does not, however, operate the diaphragm. This remains open until the shutter release is depressed (2). Then it closes to the required aperture just before the shutter opens and re-opens fully immediately after the exposure is made.
of a greater than average maximum aperture unless you 
really expect to be working frequently in very low light 
conditions. The lens with a large maximum aperture is 
always difficult and expensive to make. The effort is fre-
quently misplaced, in that, overall, the lens is inferior to 
one of more modest specification. There is a great tendency 
these days to produce 35 mm. standard lenses with maxi-
mum apertures of $f$ 1.8, $f$ 1.4 and even greater. Only too 
often the purpose of this extra light-transmitting ability is to 
give a brighter image on the reflex viewing screen.

Another part of the specification that adds to the price 
is the automatic aperture control mechanism. Not all 
lenses have this facility and it gets rarer as the focal length 
increases. Some may be of the pre-set type, where you set 
the aperture on one ring and then stop down after focusing 
by turning a free-wheeling ring to its limit—or one ring may 
be movable against a spring to serve both purposes. Some 
may be ordinary manually-operated types. If you can do 
without the automatic facility, you may obtain an excellent 
 lens at below average price.

Don’t attach too much importance to other specification 
figures, such as resolution and number of elements. Resolu-
tion we have already dealt with. It is of little value compar-
ing one manufacturer’s claims with another when you know 
nothing of the basis of the test. The number of elements in 
a lens can become a similar fetish.

There are those who consider that a lens can be little 
use unless it has at least five elements—i.e. individual 
 pieces of glass. These are usually the “equipment worship-
pers”. To them, the specification is the performance. To 
the more realistic, a lens is as good as the results it produces. 
It is true enough that the single-glass lens cannot produce 
 first-class results. It would be a bold man who would take 
the argument much further. In recent years, with the in-
creasing use of newer forms of optical glass, there has been 
a move towards fewer elements in high-quality lenses.

Once you have bought your lens, there is little point in 
putting it through all sorts of complicated tests. Use it in
the ordinary way on the camera. If it does not give the results you expected, look for the fault in yourself or in the camera first before doubting the lens.

If the lens appears not to produce sharp results anywhere in the picture area, there are various mechanical defects which could be the cause. There is also the far more likely cause of camera shake, especially if the lens is a long-focus one. Try it on a tripod or other rigid support, using a cable release, before condemning it. At least try it at maximum shutter speed.

If there are sharp areas in your picture but they appear to be in front of or behind the plane on which you focused, the defect could be in the rangefinder linkage or in the position of mirror or focusing screen—or, if neither are available, it could be an inaccurate focusing scale. Nevertheless, it would be as well to make sure that your focusing is not at fault. This could easily happen with a wide-angle lens, owing to the extreme depth of field in the comparatively small screen image. It could happen with the long-focus lens for the opposite reason. Focusing is very critical and if you miss the plane of sharp focus only fractionally, it is liable to show up very obviously in the enlarged result.

If you can satisfy yourself that the fault is not yours, take the lens back and demand a replacement. If the fault is not bad enough to justify an exchange (and that must depend on the price of the lens and the circumstances of its purchase) it will almost certainly repay you to take both lens and camera to a lens specialist. This applies particularly, of course, to any lens you buy on the used market.

The new lens, despite its more-or-less precision nature, is mass-produced. Very few are tailored to the particular camera on which they are to be used. The used lens can have suffered all sorts of knocks and misuse. The lens specialist can very often effect an enormous improvement in the performance of even a brand new lens by very simple re-adjustments. You lose nothing by taking the lens along and asking for a report and an estimate.
HANDLING
THE LONG-FOCUS LENS

Basically, there is very little difference between handling a standard lens and handling a lens of longer or shorter focal length. There are, however, the odd few differences that are worth bearing in mind.

How to hold it

The long-focus lens is longer in the barrel and heavier than the standard lens. This generally makes it inadvisable to hold the camera in the orthodox manner with one hand at each side of the camera body. This gives an unbalanced grip which has to fight against the tendency for the lens to pull downwards and so encourage camera shake.

A much more balanced grip is obtained by holding the lens barrel with the left hand, while the right hand retains the orthodox grip on the camera. The left hand operates the aperture control, the right hand the shutter speed setting and release.

A little more care than usual should be taken to ensure that the camera is held as steadily as possible. This really means a relaxed rather than a rigid grip. If you grip the camera really tightly, you are quite likely to transmit muscle tremor to the camera and the longer you maintain the tight grip the greater the danger of shake.

Whenever possible, support your body against a tree, a wall, a lamp-post or anything else that may be available. If you cannot lean on anything, see if you can at least rest your
The long-focus lens can be bulky and difficult to hold steady. Wherever possible a tripod should be used (top). A solid pan-and-tilt head with a positive locking action is preferable. With very long lenses, there should be a tripod bush in the lens mount. This must always be used in preference to the bush on the camera.

If a tripod is not available seek some other support for the long lens (bottom). A handy tree branch, a wall, the back of a chair, etc., can all be pressed into service.

When the lens has to be hand-held (middle), balance the body carefully with feet slightly apart and elbows close to the body. Support the lens under the barrel with the left hand and hold the camera with the right.
elbows on something. If a low viewpoint is acceptable, try the semi-kneeling stance with the left knee forward to support the left elbow.

If you are trying to hand-hold a really long lens, you could do with some support for the end of the lens barrel. At a push this could even be a friend’s shoulder.

As we have already implied, you can obtain acceptable results, with care, by hand-holding almost any lens, especially if you can improvise some additional support. But with most lenses of greater focal length than about 135 mm., it is virtually impossible to obtain absolutely shake-free results.

If you want really good resolution of small distant detail, you must use a tripod.

We cannot leave it at that, however. Some of the tripods offered to amateurs today are so insubstantial as to positively invite camera shake. Often, they are surmounted by tiny ball-and-socket heads that are strained to their limits when supporting even a moderately heavy camera and standard lens.

For serious use, the tripod must be absolutely rigid, with no “whippiness” in the legs or any tendency to wave about in the breeze. If a ball-and-socket head is used it must be of reasonable proportions with easily operated positive locks that will hold the camera reliably in any position. A pan-and-tilt head with a sizable platform is usually better. Here again, however, the locking arrangements must be reliable and the pan-and-tilt movements must be smooth and steady.

If the lens is of any appreciable weight, it should be mounted directly on the tripod, so that the camera is an attachment of the lens rather than the other way round. Many really long-focus lenses are fitted with tripod sockets for this purpose. Few tripods could hold, for example, a camera and 800 mm. lens if the usual camera mounting were used. If they could hold such a combination without the lens dragging the whole assembly downwards, the strain on the threads or bayonet mountings of lens and
camera would be sufficient to introduce a danger of damage or distortion.

Finally, as the tripod is intended to prevent movement or vibration of the camera, it would be foolish to operate the shutter release with such a relatively clumsy instrument as the finger. A cable release is imperative. The flexibility of such a release prevents vibrations of the body or hand being transmitted to the camera. For that reason, the cable release should never be held tautly stretched. It must be allowed to fall limply so that movement of the hand will not transmit any movement to the camera. Thus, a reasonably long cable release, say 10 in. or more, is preferable.

*Take care with focusing*

Other things being equal, the longer the focal length of the lens, the less depth of field it gives. Thus, the long-focus lens usually appears to be much easier to focus on a reflex screen than does the standard or wide-angle lens. The image passes rapidly from unsharp to sharp and back to unsharp again; it seems to “pop” into focus with extreme certainty.

It has the drawback, however, for those who prefer rangefinder cameras that few lenses of greater focal length than 135 mm. can couple with the rangefinder. Even the split-image or microprism rangefinder spots of reflex cameras cannot work at apertures smaller than about f 4 and some very long focus lenses have maximum apertures smaller than that. Spectacle wearers often have trouble with both split-image and microgrid* rangefinders, mainly owing to difficulty in bringing the eye close to the eyepiece and in centering the eye behind the eyepiece. This difficulty

*Microgrid*. The grid is composed of many tiny optical pyramids. When the image is not in focus, the pyramids “fracture the image” into tiny jagged pieces which seem to shimmer. At the point of exact focus, the image snaps into sharpness and the shimmering stops. *Asahi Pentax Way*, by Herbert Keppler.
does not arise with the coincident-image rangefinder in the non-reflex camera.

The ease of focusing long lenses naturally depends primarily on the focusing system of the camera. Undoubtedly, the fully focusing screen is the best arrangement. Those cameras that have only a viewing screen with rangefinder centre and small ground glass collar are at a considerable disadvantage. The full screen enables you to observe the sharpness of any part of the image without having to bring it into the middle of the screen.

Nevertheless, the precision with which the image appears to jump into and out of focus on such a screen must be regarded with caution. It indicates, in fact, the shallowness of the depth of field. It should serve as a warning, too, that you only have to miss the plane of focus by a fraction to make the error very obvious indeed when the picture is finally enlarged.

Naturally, you always focus at the maximum aperture to obtain the greatest brilliance and the least depth of field in the screen image, but you have to be extremely careful to ensure that you focus with absolute accuracy, especially if you are going to shoot at a larger aperture.

... and with shooting

Once you have composed and focused your picture with the long-focus lens, you might think that the shooting is a pure routine operation that has no dependence on the focal length of the lens. This is not so. You still have to keep that arch-enemy—camera shake—in mind. One thing you can do about that is to use the fastest possible shutter speed. It stands to reason that the less time you allow the shutter to remain open, the better chance you have of minimising the blur caused by movement of the camera.

Do not delude yourself, however. Most people, if they take sufficient care, can guarantee virtually shake-free results with a standard lens and a shutter speed of 1/125 sec. —but it is still possible to suffer camera shake even at 1/1000 sec. With the long-focus lens you need only the
tiniest of shakes to give really noticeable blur in your final print or projected slide.

You may have heard it said that the long-focus lens does not magnify camera shake. According to this rather head-in-the-clouds argument, if the camera is held just as unsteadily, the effect of the shake will be exactly the same on same-size images no matter what focal length is used. That may well be so, but to provide a same-size image from a 50 mm. lens as from a 400 mm. lens, you will have to enlarge the standard-lens image eight times more than that from the long-focus lens. That may mean something like a 50-times enlargement from the standard lens to provide a whole-plate print. You would be prepared to expect some imperfection there. But your long lens shot would only be enlarged about 6 times and you would expect that to give a near perfect result.

The net result is that you have to be extra careful with the long lens. Its bulk tends to encourage camera shake and you have to guard against that. The effect of the camera shake is magnified in proportion to the focal length—on the film—so you need an extra steady hold to counteract that.

Thus, you must take every precaution possible—and a fast shutter speed is one of the most sensible. Unfortunately, the faster the shutter speed you use, the larger the aperture you will need. That can raise complications because the shallow depth of field given by the long-focus lens may make a small aperture necessary. In any event, many long-focus lenses—and particularly such compromise arrangements as monoculars and tele-extender combinations—have relatively small apertures.

This leads naturally to the question of film speed.* The

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**FILM SPEED.** There have been many methods of indicating film speed in the past but only two are now widely used... The ASA system is arithmetic which means that a film with a speed of 100 ASA is twice as fast as one of 50 ASA. The DIN system is logarithmic. A doubling of film speed is indicated by an increase of 3 in the DIN figure. 35 mm. Photo Technique, by H. S. Newcombe.
faster the film, the higher the shutter speed and/or the smaller the aperture you can use in given conditions. So perhaps you should always use fast film with long-focus lenses.

There would be some sense in that but for the ever-present disadvantage of the faster film—that it tends to make the grain more noticeable. It is also of inherently rather lower contrast than that of slower film. This is marginal and would be relatively unimportant but for the fact that the long-distance shot tends also to lack contrast. One of the reasons for this is the greater thickness of atmosphere you are shooting through, which causes some scattering of light on its way to the lens. Shadows tend to be lightened and highlights degraded. The atmosphere, in fact, acts rather like a diffusing screen.

Will a filter help?

Of course, the diffusion becomes particularly noticeable in misty conditions, when there is more “diffusing material”—in the shape of water droplets and solid particles—in the atmosphere. There is one way out of this dilemma. Light is scattered more or less in accordance with its wavelength. The shorter wavelengths are scattered more than the longer. Thus, the tendency of blue light (short wavelength) to diffuse the image can be counteracted by reducing the amount of blue light allowed to reach the film. This you can do with a filter. Yellow, orange and red filters cut out the blue light to a lesser or greater degree in that order, and will thus show a tendency to haze-cutting and increase of contrast.

The snag is probably obvious to you already. What is the advantage of using a faster film to permit increased shutter speed or smaller aperture if you then use a filter to cut out some of the image-producing light and thus make a slower shutter speed or greater aperture necessary? What, indeed!

It is all a matter of compromise. Fortunately, emulsions are constantly being improved and some of today’s fast
emulsions compare very favourably in grain size and contrast with much slower emulsions used only a few years ago.

In general, with very long-focus lenses, you would do well to use a relatively fast film—say 320 to 400 ASA or, in colour, 160 to 200 ASA—and the fastest shutter speed the conditions will allow. That way, you increase your chances of getting satisfactory results from shots you really should not, but probably will, hand hold.

**How to “stop” moving objects**

The focusing and shooting of moving objects with long-focus lenses can be rather difficult. While you are focusing, they are apt to move out of range. While you are attempting to follow them with your camera you are likely to introduce the wrong kind of camera movement or even lose them behind some previously unseen obstacle.

The distant object seems to move surprisingly fast when you train your long-focus lens on it and, naturally, if it occupies a large part of the image area and is rendered with some clarity it has to move only fractionally to make the blur noticeable. That rather defeats the object of using the long-focus lens to produce a large, clear image.

Frequently, therefore, it is advisable to use a prefocusing technique. This involves focusing on a spot you know the subject is going to pass and releasing the shutter fractionally before it reaches that spot. That, however, may not solve the movement problem. The subject may be moving too fast for the available shutter speed. In that case you use a combination of prefocusing and panning,* picking up the subject in the viewfinder before it reaches your preselected

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**PANNING.** With motor cars, motor cycles, etc., the movement is frequently so fast that even the fastest shutter speed would not stop it. Then the solution is to pan the camera. This entails holding the camera rock steady in the taking position but swinging the body from the hips in the direction of movement so as to keep the subject in the same relative position in the viewfinder. The shutter must be released **during** the swing or pan and the panning movement continued afterwards. *Ultra Miniature Camera Technique*, by T. L. Green.
spot and keeping it in the same relative position while you swing or pan the camera to follow its course. When it reaches the prefocused spot, you release the shutter but you do not stop panning. You continue in a “follow-through” motion to avoid the temptation to stop just before you shoot. The panning method is best effected by swinging the whole upper part of the body in a single movement, pivoting at the hips. There should be no independent movement of head or arms.

The panning technique allows relatively slow shutter speeds to be used with moving objects. In theory, of course with perfect technique, any speed could be used. In practice, speeds of 1/60 and 1/125 sec. can be used safely even with fast-moving objects. The advantage is that the slower shutter speed may make all the difference between obtaining an adequately exposed shot and risking under-exposure. Nevertheless, the fastest practicable shutter speed should always be used with any moving object and with most long-focus lens shots, regardless of subject.

Is zoom technique different?

Zoom lenses for 35 mm. cameras have come on to the market in increasing numbers in recent years and the quality of the image they give is now better than it was in the early days of this type of lens design.

Most zoom lenses offer a range of medium to long focal lengths but there are also some models in the standard to portrait range or thereabouts.

The zoom lens, is, of course, bulkier than the standard lens and it is usually advisable to use the long-focus grip described on page 56. There is, however, a further control to manipulate. In addition to aperture and focusing rings the zoom lens has a control which allows the focal length of the lens and thus the angle of view to be infinitely varied within the range available.

Thus, having focused your subject, you can operate your zoom control to give you the exact framing you require
Focusing the moving object can sometimes be difficult. A useful technique is to focus on an object, such as a tree, that the moving object has to pass.

Blur caused by movement too fast for the available or practicable shutter speed can be minimised by shooting from dead ahead or from a diagonal viewpoint. It can also be made to appear less if the shooting distance is increased, although it will increase again, of course, with enlargement of the image.

A special method of photographing movement which proceeds in a direct line at more or less constant speed is to swing (or pan) the camera so as to keep the subject in the same relative position in the viewfinder. The subject is then rendered sharply but the background is blurred, giving an acceptable impression of speed.
without having to change your viewpoint. That is the essence of the true zoom. Once you have focused your subject, it remains in focus throughout any movement of the zoom control. Some earlier lenses did not do this. You had to refocus with every change of focal length. Such lenses would be more accurately described as variable focal length lenses.

Focusing the zoom lens follows the same procedure as with any other lens. You should preferably focus with the lens set to give the greatest brilliance of screen image and the least depth of field. With the zoom, that means full aperture and maximum focal length. Then, after focusing, you shorten the focal length to give the required framing.

In practice, you will frame the shot first to make sure you can include all you require from your chosen viewpoint and you may well be able to focus accurately enough at that setting. But to focus critically you should zoom in on your subject to obtain the best possible conditions for really accurate focusing.

A danger of the zoom lens is that it may tempt you to stand off from your subject when you really should move in on it. The close viewpoint nearly always has more impact, intimacy, involvement with the subject—call it what you will. You should only use the “long end” of the zoom when a close approach is impossible or impracticable.

The zoom movement has no effect on perspective. We have already explained that it is the viewpoint that controls perspective. If you shoot two frames at the same subject with the zoom control in two different positions, you can enlarge the results differentially to give exactly the same picture. Your long shot won’t give the effect you would get if you moved in closer on your subject.

**When is the zoom most useful?**

Sometimes, however, the long shot provides the better picture. You would not want to move in too close, for example, for a head and shoulders portrait. It would be
Moveable elements in the zoom lens control the size of the image. For critical focusing, always use the "long end" of the zoom, i.e. the setting at which it provides the largest image. Then move the zoom control to provide the required framing.

Note that the use of the zoom control to alter focal length has no effect on perspective. The effect is exactly the same as when different lenses are used from the same viewpoint. The perspective of the long-focus shot is identical to that of an enlarged portion of a shot with the lens set to a shorter focal length.
better to stand off and use the zoom to lessen the risk of distortion.

The zoom range of 35 mm. lenses is generally limited to about 3 or 3½ to 1, so the value of such a lens for black-and-white work is not great—considering its price. It is a different story with colour, however. Most colour transparencies taken with ordinary lenses could be greatly improved by the kind of trimming that is done in making enlarged black-and-white prints. “Trimming in the camera” however, by choosing the exact shooting distance can be a tedious and sometimes even impossible task. The zoom allows you to make minute adjustments to your framing without moving a step.

The zoom lens can be used for close-ups just as any other lens can. It behaves exactly as other lenses when used with extension tubes, bellows or supplementary lenses. Additionally, however, it enables you to vary your reproduction ratio (image size in relation to subject size) without changing your viewpoint or you can obtain a given image size from a variety of shooting distances.

There are some “gimmicky” uses, too. You can obtain some extraordinary effects by changing focal length smoothly (quickly or slowly) while the shutter is open at a slow shutter speed. If your camera permits multiple exposures, you can put different sized images of the same subject on the same film—superimposed, side by side or otherwise arranged. A combination of zoom movement and static or flash exposure can create interesting impressions of subject movement.

**Do the f-numbers change?**

No conversion of f-numbers is necessary with the zoom lens despite the changes in focal length. They remain accurate throughout the range. On some models this was effected by compensating changes in the physical size of the diaphragm aperture as the focal length changed. Most zoom lenses now made, however, consist basically of an
afocal supplementary lens system in front of a fairly ortho-
dox camera lens.

"Afocal" in this context means that although the focal
length is changed no alteration of the lens-to-film separa-
tion is required. The "camera lens" contains the iris
diaphragm and remains at a fixed distance from the film.
So the light leaving the lens does not have to travel any
increased distance to the film when the focal length is
increased. The same size aperture can therefore carry the
same f-number for different focal lengths.

The principle is not unlike that of using a monocular or
telescope in front of the camera lens. In these cases, however,
the f-numbers are affected to the extent that the larger
apertures are unusable, because the front glass of the
telecope or monocular is not large enough to collect the
amount of light required. The smaller apertures, perhaps
from f11 downwards, remain reasonably accurate.
HANDLING CONVERTERS

We shall deal under this heading with the three alternative methods of obtaining long-focus facilities (and wide-angle facilities for the fixed lens) that we have already described:

1. The tele-extender
2. The fixed-lens converter
3. The monocular

The monocular is not strictly a converter in the sense that the other two are, as it can be used without a camera lens, but it is convenient to consider it separately from the normal type of long-focus lens.

How do you use the tele-extender?

The tele-extender type of converter lens does not present any great problems in handling. Naturally, it adds length to any lens to which it is fitted and therefore makes it advisable to use the long-focus grip already described.

It reduces the illumination of the screen, in that the maximum aperture is reduced by two stops for each doubling of focal length. The correspondingly reduced depth of field, aperture for aperture, occasioned by the increased focal length, however, offsets any difficulty that might be anticipated in screen focusing. Rangefinder focusing (on the reflex screen) may become difficult or impossible owing to the reduction of maximum aperture.
It is impossible to be precise about the extent of the depth of field when using a tele-extender but, in general, it moves in sympathy with the change in effective \( f \)-number. If, for example, you focus on a plane 6 ft. away with a 135 mm. lens and then add a tele-extender, you remain focused on that 6 ft. plane and, aperture for aperture, your depth of field does not materially alter. But, without altering the aperture size, you have, by restricting the angle of view, reduced the diameter of the beam of light entering the lens and passing through the aperture. This, naturally, affects the \( f \)-number (see page 20). With a 2X converter, for example, the \( f/8 \) of your 135 mm. lens becomes \( f/16 \) with the 270 mm. combination—and you get more or less the depth of field you would expect from that combination of aperture and focal length. This applies with any type of lens, whether of normal, telephoto or retrofocus construction.

The results obtained from tele-extenders vary from model to model and, as with all lenses, there will even be some of the same model that are better than others. Generally speaking, however, some of the less expensive models introduce a certain amount of flare* (or, perhaps, exaggerate the tendency of the camera lens to produce flare) which can considerably reduce contrast in the image. This does not necessarily greatly impair definition but it does make black-and-white negatives more difficult to print and somewhat reduces the sparkle of colour transparencies.

The more expensive tele-extender may cost twice as much as the more numerous, popular variety, but it is far less liable to introduce this fault and can give good results.

The great advantage of the tele-extender is, of course, that it gives you an extra lens for very little extra bulk. If you have a fast standard lens (\( f/2 \) or greater), the reduction in maximum aperture with the tele-extender attached is of

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*Flare. The distribution of extraneous light on the plate or film which is due to light that has been reflected at two air-glass surfaces in the lens, when this light produces a more or less even illumination. *Photographic Optics*, by Arthur Cox.
little importance. The doubling of focal length, on the other hand, can be extremely useful for a variety of pictures where the standard lens cannot provide sufficiently tight framing. If you want a "big head" portrait, for example, the standard lens alone may tempt you to approach the subject so closely that you obtain a distorted image. When you attach the tele-extender you can stand off rather more and reduce or eliminate this risk, while still obtaining the same size image.

The tele-extender can be useful for close-up work, too. The standard lens on extension tubes or bellows may, again, produce perspective distortion by its very close approach, which may also cause lighting difficulties. Here, too, with the tele-extender attached, the subject-to-camera distance can be increased without decreasing image size.

Is the fixed-lens converter any good?

The fixed lens camera is not really intended to provide long-focus or wide-angle facilities. Nevertheless, there are a few converter systems available to attach to the front of such lenses. None of these can be said to be very efficient. If they effect any considerable alteration of the angle of view of the camera lens, they usually introduce marked vignetting, i.e. a cutting-off of light from the corners of the image area. This can sometimes be partially cured by using separate attachable "f-stops" to eliminate the rays reaching the outer edges of the lens from the image-forming light. Vignetting is usually caused by some of these rays being cut off during their passage through the lens mount.

The cure for vignetting is, however, rather drastic. The working aperture of the fixed-lens plus attachment is already less than that of the camera lens alone. The further stopping down may reduce the aperture to impractical proportions. The greater the alteration the converter tries to make to the focal length of the camera lens, the worse the vignetting trouble is likely to be.

Those converters that are more modest in their efforts may not give rise to this sort of problem but their effect
on the quality of the image is usually just as noticeable. In most cases it is likely that extra enlargement of the image from the camera lens alone would be preferable. That is not always convenient with colour, of course, and it does not apply to the wide-angle converter. Nevertheless, it would be advisable to see some results from one of these converters before laying out money to buy one. Some of them are far from inexpensive.

When used on non-reflex cameras, these converters have to be used in conjunction with a viewfinder to match the field of view.

Why use a monocular?

As a relatively inexpensive extra-long-focus lens, the monocular has its advantages. It is generally used by affixing it to the front of the standard camera lens via a special device screwing into the filter thread. Focusing is effected on the monocular—the camera lens being set to infinity. The aperture control of the camera is usually rendered almost ineffective, the effective aperture of the combination rarely exceeding \( f\frac{8}{11} \), as explained on page 40.

The monocular is not heavy but it is rather cumbersome when fitted to the camera and is not easy to hold steady. The focusing control is usually at the front, making a change in grip necessary after focusing the image, unless the left elbow can be rested on some firm support while shooting. Naturally, the usual long-focus grip is necessary, the right-hand gripping the camera and the left supporting the monocular.

Provided the problem of a steady hold can be overcome, the best monoculars can give remarkably good results, but their strength probably lies in their versatility rather than in their value as long-focus lenses alone.

Some monoculars can be used, for example, with special close-up lenses to give considerably magnified images on the film—true macrophotography—and can also be attached to a microscope for photomicrographic work.
Finally, the photographic monocular can be used by itself in the ordinary way at sports events and for any long distance viewing. As it is generally of better optical quality than the average non-photographic product, it gives an exceptionally bright, sharp image.

It is this versatility then, that is the strength of the monocular. As a long-focus lens only, it should not be the choice for anybody contemplating a great deal of long-focus work. To get good results when used at really long range, it needs firm, two-point support that the ordinary tripod cannot give. Even then, its quality cannot be expected to approach that of the orthodox long-focus lens.

As we have previously indicated, the average photographer rarely needs a lens of greater focal length than about 135 mm. Those who frequently need longer lenses are specialists and would be better advised to pay for the better quality and easier handling of the true photographic lens.
HANDLING
THE WIDE-ANGLE LENS

The wide-angle lens is not usually very bulky and it calls for no special technique in holding. It must, of course, be held just as steadily as any other lens. The result of slight camera shake might not be so evident on a small print as it would be on a print from a long-focus shot from the same viewpoint but it would soon become apparent on enlargement.

Is focusing easier?

It is often said to be easier to focus the wide-angle lens. In fact, the great depth of field it gives, especially over the range of 10–15 ft. or so to far distance often makes it difficult, even at full aperture (and very large aperture wide-angle lenses are uncommon) to ascertain the exact plane of sharp focus on a reflex screen. The non-reflex, coupled rangefinder camera actually has the advantage in this respect.

Nevertheless, with such shots there is rarely any particular plane or shallow zone that is required to be sharper than the rest of the picture and, at normal degrees of enlargement, slight inaccuracy in focusing will probably pass undetected. Once you start to use the wide-angle lens close up however (and some of them focus down to a few inches), depth of field becomes markedly shallower and precise focusing is vital. But then, of course, it is also easier.

The tricky field is that between, say, about 10 to 30 ft. or so. The appearance of the screen image may change
very little between these limits and, unless you are very
careful you could finish up with an enlarged print that is
far from sharp.

It is within this range, in fact, that you would often be
well advised to use a system of zone focusing. This is the
system whereby you make use of the depth of field scale
on the lens to set a compromise distance and aperture that
will give you acceptably sharp results within a certain
range of distances from the camera.

This method is invaluable for rapid shooting in crowds,
at sporting events, at the scene of newsworthy incidents,
etc. You simply note the range you can cover and make
sure that you are within that range of shooting distances
before you release the shutter. If you try to refocus for every
shot you may waste valuable time and miss a vital picture.

How common is vignetting?

The value in use of the wide-angle lens is sometimes
offset by its tendency to introduce various types of distor-
tion and other troubles.

One common trouble in the less well made lens in this
category is vignetting. This is caused by some of the rays
which strike the extreme edges of the front element of the
lens being impeded by the lens mount and failing to reach
the corners of the image area.

Vignetting is more often encountered in the extreme
wide-angle lenses and, indeed, is inevitable in most “fish-eye”
lenses. But it should not be present in lenses of 28 mm. or
greater focal length. Where it is present to a slight degree
it is relatively unimportant in black-and-white work but
can be troublesome in colour.

What is wide-angle distortion?

Distortion with the wide-angle lens takes two forms. The
first is perspective distortion, which is not really attributable
to the lens itself but to the fact that it permits shooting
from close range.
When shooting rapidly at a variety of distances, zone focusing is sometimes preferable to re-focusing every shot. The standard lens, for example, can be set to 10 ft. and f 8 to provide adequate sharpness over a zone from about 7 ft. to 15 ft. At 25 ft. and f 8, it will reproduce sharply any object at more than about 15 ft. from the camera.

The wide-angle lens is particularly useful in such circumstances. The depth of field of a 28 mm. lens set to 10 ft. and f 8 stretches from 6 ft. to the farthest distance.
With any lens, a relatively small object close to the camera can be made to dwarf a considerably larger object farther away. With the extremely close viewpoint that the wide-angle lens often permits, this characteristic can frequently be put to interesting uses.

It is possible, for example, to take profile portraits against widely sweeping backgrounds which appear virtually in miniature. The background can even be rendered quite sharply with the use of a suitably small stop.

If you go even closer, single blooms in flower beds or displays can be taken without the aid of special close-up equipment and can be made to dominate the rest of the arrangement. But here you have to be careful of perspective distortion. Go too close and your bloom may be distorted in shape, the petals nearer the camera being rendered noticeably larger than those farther away—even where the difference is only an inch or two.

In table top or model photography, the steep perspective of the wide-angle lens can be used to create an impression of much greater distance or depth than is actually present in the miniature set up. This can be used to good effect but it also has to be guarded against where such steep perspective would be inappropriate to the picture.

Interiors of rooms, offices, warehouses, etc. can be made to look much more capacious than they really are. Exteriors of tall buildings, flagpoles, trees, etc., taken shooting upwards from close to the base, can provide dramatic lines. The family saloon, shot from within a couple of feet of the bonnet, can become a powerful limousine.

This is getting close to the “gimmicky” use of the wide-angle lens and it must not be overdone, but it occasionally has its uses. A close, high viewpoint of the human figure can give an enormous head and eyes perched on a tiny body. A more distant viewpoint of a child can isolate it in a vast area of countryside or playground. The characteristic cigar can be made to dominate the well-known face behind it.

These distortions of the human face and figure constitute
a disadvantage of the wide-angle lens if it is not used intelligently. We mentioned just now that a profile portrait could be taken. It is rarely advisable to take advantage of the close-focusing ability of the wide-angle lens to take a full-face portrait. The close viewpoint will then make the nose disproportionately large and the ears exceptionally small. The really close viewpoint will even make some faces look much thinner than they actually are by failing to “see” the sides of the face and ears at all.

On the other hand, young children and babies can be taken from extremely close range without noticeable distortion. Their noses are relatively small and their faces rounder. There is less “depth” to their features to be exaggerated.

This type of distortion can be equally disconcerting in interior shots. Objects too close to the camera and receding from it will look much longer than they are. The foreground in such shots needs to be carefully chosen. You need something to provide depth in the picture but it should preferably be something with little depth of its own, such as a chair back, part of a lamp standard, perhaps, or even just the edge of a door.

It is in the interior, too, that the second type of wide-angle distortion may become apparent. This is in some ways rather like perspective distortion but it is actually caused by the acute “projection angle” of the wide-angle lens, which is necessarily rather close to the film. Thus, the image is projected from the back of the lens at such close range that it has to “branch out” very sharply to reach the edges of the image area. This causes the normally virtually circular shape of the image-forming light rays to be pulled out into ellipses and so to broaden any shapes at the extreme edges of the image area.

This is less likely to occur with two-dimensional objects, because the extreme projection angle is cancelled out by the similar viewing angle. A circle at the edge of the field and perpendicular to the lens axis will be “seen” by the lens as an ellipse. But that ellipse projected at the same
acute angle returns to its circular shape on the film. Thus, the close viewpoint is no bar to copying.

The three-dimensional object, such as a tubular or spherical structure, however, cuts across the angle of view so that only part of it is seen by the lens. But, when projected on to the film, this part is stretched out to the same extent as the greater expanse of the two-dimensional object. Thus, the sphere becomes elliptical and the tube at the edge of the picture looks thicker than a similar tube nearer the centre (see page 31). The human figure on the end of a group is similarly affected and may be made to look singularly obese. The remedy, of course, is to keep such recognizable shapes away from the edges of the image area as far as is possible and to ask people at the ends of groups to turn slightly inward to face the camera.

Choose your viewpoint

The wide-angle lens has tremendous advantages but it has to be used with a great deal of care. The shorter the focal length and the closer the camera-to-subject distance, the more care the photographer has to take.

Choice of viewpoint is much more important than with other lenses. The exceptionally wide view the lens can give you is of no value if you allow distractingly distorted, or even irrelevant objects to creep into the foreground or edges of your picture.

When using a wide-angle lens for the first time you are apt to be rather taken aback when you realise the all-embracing nature of its view. You may find yourself with an immense amount of bare foreground stretching almost from your feet outwards. Or you may find objects creeping into the foreground that you did not realise the lens could “see”. It is so easy to overlook these items yourself, even though they appear in the viewfinder.

You must be careful with angled viewpoints. The wide-angle lens enables you to shoot tall buildings at relatively close range but if you take the recommended corner view, including the front and one side, don’t get too close. This
The wide-angle lens may encourage a too-close approach to the subject. To take a head-and-shoulders portrait you might go as close as 2 ft. This could cause unpleasant distortion of the features which might, however, be lessened by taking the shot in profile.

This effect could be used deliberately to produce an intentional imbalance in proportion between, for example, head and body, or hand and face. It can be used to emphasize or caricature various characteristics or to exaggerate proportions.
is where perspective distortion can make the near corner loom large and the front of the building appear twice as long as it really is. That’s fine if you are after a special effect but it can be disconcerting to the viewer who knows the building.

Similarly, high and low viewpoints exaggerate the tendency towards converging verticals. Except when you are deliberately aiming for unusual or dramatic effects, it is advisable to keep the wide-angle lens on a reasonably even keel.

You must remember, too, that the wide-angle lens tends to take a miniature view. There is always a temptation to use it to take in broad detailed scenes of rolling landscape, with farmhouses in the middle distance, perhaps, and hills or even mountains as a backdrop. Such a scene looks singularly attractive as the eye ranges over it. But the camera’s eye cannot range; it has to take it all in at one go and, as the wide-angle crams in such an enormous sweep of the scene in front of it, it miniaturises those farmhouses almost to pinpoints, flattens the hills and reduces the mountains to mere bumps on a very distant horizon.

The wide-angle lens is put to much better use on views more restricted in depth with bold lines and sizable masses. It is at its best in cramped conditions where it can secure shots for you that could be obtained with no other lens.
WORKING AT CLOSE RANGE

Surprisingly, perhaps, the long-focus lens can be very useful for close-range work. It does not usually focus very closely as normally fitted to the camera but it can be used with extension tubes* or extension bellows*.

These are devices designed to increase the distance between the film and the lens. That is how any lens focuses closer. Any lens can, in fact, focus down to a distance equivalent to a fraction more than its focal length but, to focus down even to its focal length plus one-third, it has to be moved away from the film by a distance equivalent to about four times its focal length. That is quite a distance, even for a short-focus lens, so ordinary camera lenses do not focus that close as normally fitted.

How are tubes and bellows used?

The extra extension can be provided either by rigid tubes or by extendable bellows on a rigid framework.

The rigid tubes are suitable for use on non-reflex cameras

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EXTENSION TUBES. Metal tubes threaded or with bayonet mounts at each end to provide attachment to lens or another tube and camera. Used to obtain the additional separation between lens and film required for close-up photography. Commonsense Photography, by Leonard Gaunt.

EXTENSION BELLOWS. Device used to provide the additional separation between lens and film required for close-up photography. Consists of extendible bellows with mounting plates at front and rear to fit the lens and camera body respectively. Rigidity and adjustment of length is provided by a rod or rods attached to the rear plate and passing through holes in the front fitted with a lock. Commonsense Photography, by Leonard Gaunt.
or reflexes. They can be supplied in various accurately-measured sizes which enable the distance at which the lens will focus to be calculated. The bellows can be satisfactorily used only on reflex cameras. They allow infinite variation of focused distance within the limits prescribed by the length of the bellows.

This extra extension can be provided for any lens and, naturally, the shorter the focal length of the lens, the greater the relative extension provided by any given tube or bellows, the closer it allows the lens to focus and the larger the image it gives on the film.

On the other hand, for a given size of image on the film, although the shorter focus lens needs less bellows extension it also gives less distance between lens and image, which can be inconvenient. The long-focus lens gives a greater working distance for the same size image.

This can have two advantages. In photographing flowers at close range, for example, the very close viewpoint has the same effect as that we have already mentioned for the wide-angle lens. It will frequently introduce perspective distortion, making the petals nearer to the camera look much larger than those farther away, even when the separation between the two is very small. The longer focus lens can give the same size image, provided the bellows is long enough, and at the same time minimise this type of distortion by working at longer range.

The other advantage of the longer focus lens in close-up work is that it can frequently make the lighting of the subject easier. When the subject is, perhaps, within two or three inches of the lens, there is very little room to direct light on to the front of it. Even where daylight is used, the camera may be so close as to cast its shadow over the subject. The greater shooting distance of the longer focus lens may allow flexible lighting arrangements.

**Why give more exposure?**

When you use extension tubes or bellows you extend the path the light has to travel to the film after passing through
Any lens can be provided with additional extension by means of tubes or bellows fitted between lens and camera. This added extension enables the lens to focus closer.

The long-focus lens is particularly useful for such work. It allows a greater shooting distance, which can facilitate the positioning of lights. It can also reduce the distortion caused by a very close viewpoint.

Exposure for close-ups has to be carefully calculated. The increased lens-to-film distance means that the light transmitted by the lens has to travel a greater distance which, in turn, means that it will spread over a greater area. If the lens-to-film distance is doubled, for example, the light will cover a four times greater area. In such circumstances, the light falling on the film would be reduced to one-quarter the strength it would be without the additional extension. The lens diaphragm has to be opened up to compensate or the exposure time must be lengthened.
the lens. The farther it travels, the greater the area it covers and the weaker the light becomes over a given area. This also happens, of course, whenever you focus a lens on a near object but the increase in lens-film separation with the normal focusing movement of the lens is not very great and can usually be disregarded.

The exposure adjustment necessary with increased extension is quite easy to calculate. It can be expressed by a factor which provides a multiplier for the normal exposure. This factor is given by the formula: \( EF = \left(\frac{f + e}{f}\right)^2 \), where \( EF = \) exposure factor, \( f = \) focal length of lens and \( e = \) additional extension.

Thus, where a 50 mm. lens is used with a 50 mm. extension tube or bellows extension, the formula gives \( \left(\frac{100}{50}\right)^2 = 4 \). This indicates that you would need to give four times the exposure recommended by a straight meter reading of the subject.

This is, in fact, the level of exposure required for 1:1 reproduction, i.e. an image on the film that is the same size as the subject. To obtain 1:1 reproduction you always need additional extension equal to the focal length of the lens.

**Supplementary lenses are cheaper**

You can also take close-ups by attaching supplementary lenses* to the camera lens. The supplementary lens thus used is usually a single positive or converging lens. It is of comparatively long focal length, those most commonly used being of about 1,000, 666.6 and 333.3 mm.

The principle is simple. Such a lens will accept rays of light from points one focal length in front of them and transmit them as parallel rays behind the lens. This is...
The ordinary camera lens may not focus closer than 2 or 3 ft. This is too distant for adequate-size reproduction of small subjects. The use of a positive supplementary lens permits closer focusing and provides a larger image.

When the supplementary lens is placed at a distance \((X)\) from the subject equal to its focal length, parallel rays of light are projected from the back of the lens. Thus, if the supplementary lens is placed in front of a camera with its lens set to the infinity focusing position, those parallel rays of light will be accepted by the camera lens as coming from infinity and will be brought to a focus on the film in the back of the camera.

The focal length of the camera lens has no effect on the distance at which the supplementary lens will focus. This is always the focal length of the supplementary (measured from the supplementary lens itself) when the camera lens is set to infinity. The only difference with the lens of greater focal length is that it produces a larger image.
simply the reverse of the ordinary lens focused on an infinitely distant object. It accepts parallel rays and transmits them to converge to a focus one focal length behind the lens. It also explains why no lens can focus at its own focal length or closer. Rays from an object that close to the lens will be transmitted as parallel rays and will not come to a focus on the film.

When the supplementary lens is used in this way, however, the camera lens accepts these parallel rays as if they were coming from “infinity” and brings them to a focus on the film. So the combination of camera lens and supplementary lens is made to focus on a plane much closer than is normally possible with the camera lens alone. At that range, the angle of view of the lens is also widened and the focal length of the camera lens is effectively decreased. This, of course, would necessitate less lens-to-film separation if the new combination were required to focus on more distant objects. But the lens-to-film separation has not been altered and the combination is unable to focus at any greater distance than the focal length of the supplementary lens. It can, however, focus a little closer by using the focusing travel of the camera lens to give additional extension.

Close-up lenses have disadvantages and advantages. Their main advantages compared with bellows and tubes are that they need no careful setting up (although a tripod is nearly always necessary with the stronger supplementaries owing to the extremely limited depth of field), they add no bulk to the camera, they call for no exposure correction—and they are a lot cheaper.

Their main disadvantage is that they interpose another piece of glass between the highly-corrected camera lens and the subject. This will nearly always have some deleterious effect on resolution and definition but, even with quite simple supplementary lenses the effect is minimal for the average use.

Another possible disadvantage is that the supplementary lens used for close-up work has no effect on the aperture of
the camera lens, whereas additional bellows extension affects the aperture size/lens-to-film distance ratio and therefore the effective aperture and depth of field. In some circumstances this could be considered an advantage of supplementary lenses because they do not cause the excessive fall-off in illumination of the focusing screen occasioned by long bellow extensions.

Supplementary lenses can be used on either reflex or non-reflex cameras, because, if the focal length of the supplementary is known, its focusing distance when used with a camera lens is always calculable.

The focal length of the supplementary is rarely quoted directly. These lenses are usually identified by their strength in dioptres, the most common being those we have already quoted (page 86), which are of 1, 2 and 3 dioptre strength respectively. The focal length is simply one metre (1000 mm.) divided by the dioptre strength.

The focused distance of the supplementary lens remains the same, no matter what lens it is used on. Thus, a 2-dioptre supplementary will focus at 500 mm., or about 19¾ in., whether it is used on the 50 mm. standard lens or a 135 mm. telephoto, provided of course the camera lens is set to its infinity focusing mark. The difference is that the narrower angle of view of the telephoto lens causes it to take in less of the scene and to render it on a larger scale. The longer focus lens thus gives you a greater working distance for the same size image or a larger image from a given working distance. The wide-angle lens gives you greater magnification at a given lens-to-film separation.
LOOKING AFTER YOUR LENS

Optical glass is comparatively soft and can be scratched quite easily. The coating that is applied to virtually all modern camera lenses is extremely tough, but it is microscopically thin. It can also be attacked by some solvents.

Nevertheless, a camera lens is intended to be used—not kept in a glass case. If you want long life and continued good performance from your lenses, you must look after them—but you don’t have to make a fetish of it. The human eye is incomparably softer and more prone to damage than the finest optical glass and it cannot be replaced so easily. Yet there are many who pay far more attention to the welfare of their lenses than to that of their own eyes.

Should you use a lens case?

The camera lens can withstand a great deal of handling and even ham-fisted treatment, short of bouncing it off concrete floors. Sometimes, even with the most rapid-change mounts, it has to be treated with rather less care than its delicacy deserves but it is, after all, the picture that counts. There is little point in carrying interchangeable lenses with you if, when it comes to changing, you have to extract the required lens from layers of protective material before you can use it.

The lens case for example, is ideal for storing the lens when it is not in use. Then, the lens should have caps on both ends and be placed in a polythene bag inside the case.
It should be stored in a room not subject to violent changes in temperature or to excess of humidity. It should not be stored in the darkroom if chemicals are kept there unless it is thoroughly sealed against possible chemical fumes, airborne chemical dust, etc.

When the lens is taken out of storage to be used, the case should be left behind. If you are carrying an additional lens, the chances are that you will be carrying other equipment as well. So you should have a case, commonly known as a gadget bag. This need not be an elaborate affair. It should preferably be on the small side so that you are not encouraged to carry too much equipment with you. It should have separate well-padded compartments, so that when changing your lens, you can simply drop the lens you do not need into the bag.

You should literally be able to drop the lens into the bag, although naturally you will place it in if you are not pushed for time. Even if you are in a hurry, though, don’t fumble with the actual changing of the lens. Practise this operation often, moving deliberately and carefully. Screw threads and bayonet attachments are usually very robust but they don’t take kindly to misalignment and the use of brute force.

It is always advisable to leave the lens cap on until the lens is on the camera. However careful you are, this is the moment when the errant finger so often finds its way on to the front glass, leaving a mark that is singularly difficult to remove and which, if not removed in a reasonable time, might attack the coating and, indeed, the glass itself.

Whether you should keep the lens cap on between shots or spells of shooting is debatable—especially with non-reflex models, where it is so easy to forget to remove it before pressing the shutter release.

**Keeping the weather out**

In bad weather, or by the sea, or even in very dusty conditions, it is advisable to protect the lens as much as
possible. Some use a UV filter* in such circumstances. That is reasonable if the filter is a good one and is kept in perfect condition. If it is not a very good one and/or if it encourages you to be careless so that you are constantly cleaning the filter, it could have quite an adverse effect on the quality of your results.

It is not only the glass that needs protection against dust, sand, moisture and so on. The focusing and aperture rings and the screw threads or bayonet attachments are traps for such adverse elements. Sand, in particular, has a bad habit of getting into the focusing movement, especially on the less well made lens. In such conditions it is a good idea to keep all your accessories in polythene bags inside the gadget bag.

You will not of course put your camera down on the beach without covering it in some way. You will be fully aware of the dangers of flying sand but you must also remember that the lens will not take kindly to rapid changes in temperature. If it gets extremely hot lying in the sun and is then taken into a much cooler place indoors, it could possibly suffer sufficient expansion and too-rapid contraction to cause some misalignment.

Similarly, although there is no need to handle the camera with kid gloves, you will do your best to protect the lens from violent knocks or buffetings. That too can damage the carefully balanced arrangement of the components in a way that may not become noticeable until much later.

When should you clean it?

Routine maintenance of a lens should be kept to the absolute minimum. The mount can obviously be wiped with a soft, clean, fluffless cloth. Bayonet catches or threads can

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*UV FILTER. The ultra-violet filter absorbs only ultra-violet radiation and possibly the extreme violet. The filter itself is virtually colourless and is used mainly to cut out ultra-violet rays which — though not visible to the eye — affect the film. Mostly it is used in colour photography. *Filter Practice,* by Hans Clauss and Heinz Meusel.
To remove dust from the front surface of a lens, use lens cleaning tissue in preference to a brush, which is difficult to keep clean. Fold a fresh tissue as shown and tear the end to form an irregular sweeping edge. Brush the dust towards the centre of the lens and flick it off with the camera inverted so that the lens faces downwards.

Use lens tissue in the same way to remove finger marks but moisten it slightly with a proprietary lens cleaning fluid. Then carefully blot off any excess fluid with a fresh tissue.

Do not apply undue pressure to the tissue. It should sweep the lens with its own weight only and should not be reinforced by finger pressure.
be brushed out periodically, keeping an eye out for any loose hairs on the brush. Never, on any account, put oil or grease on any part of the lens. The grease used for the moving parts of lenses is a special optical grease, with a good deal of "body". It is not in the least like machine oil or petroleum jelly, which will almost certainly find their way to parts of the lens in which they have no right to be. If some stiffness develops in aperture or focusing rings, etc., leave them strictly alone and take the lens to an expert as soon as possible. It is probable that there is some dust or other foreign matter present that will entail a thorough cleaning and regreasing.

Dust on the lens surface is best blown off from a little distance with not too heavy breath. If that doesn't dislodge it use a clean, high-quality lens tissue in preference to a brush, which can pick up a lot of dust and dirt in a short time and could do more harm to the lens than good.

In most towns and cities it is virtually impossible to keep a lens spotless. Don't try it. If you are constantly removing every single speck of dust from your lens as soon as it appears, it probably won't take you long to ruin the lens completely. Even a couple of dozen tiny specks of dust on your lens are not likely to have any detectable effect on its performance.

**How to clean it**

When you *have* to clean the lens, use a lens tissue folded and torn to form a kind of brush edge. Sweep inwards from the edges and flick the offending specks from the centre with the lens held upside down or as near to as convenient.

Never use any kind of lens cleaning fluid except to remove stubborn marks that a water-moistened lens tissue will not shift. If you should get a finger mark that you can't shift, use a good quality proprietary lens cleaning fluid or an organic solvent such as methylated spirit, denatured alcohol,
acetone-ether mixture, etc. Use it sparingly and make sure no solvent is left on the lens.

If you should be so unfortunate as to get salt spray on your lens, wash it off immediately with clean water—distilled if possible. That doesn’t mean moisten a rag and scrub the lens. It would be better to flood the front of the lens with water than that. But turn the lens upside down immediately and blot off the excess water with a soft, clean rag. Then, very gently, without pressure, swab all over the lens surface to dry it thoroughly. With a well-made lens, there should be no danger of the water penetrating the mount. If there is any sign of such penetration, take the lens to a specialist immediately and have it thoroughly cleaned.

These are counsels of perfection of course and there are few of us who have not used a handkerchief to clean a lens before now. If it is a soft, many-times-washed handkerchief and you use it under its own weight only, i.e. without pressing it directly on to the glass with the fingers, the lens will probably come to no harm. Small grease marks can usually be removed in this way, especially if the handkerchief is lightly moistened. This is really emergency treatment. The regular, vigorous polishing of a lens by such methods is close to sacrilege.

If dust finds its way on to the inner surfaces of any of lens components, leave it alone. A few specks will do no harm whatsoever. If there is a noticeable amount of dust all over the component, however, or signs of pitting or erosion of any glass surface, take the lens to an expert repairer immediately.

Like human ailments, lens troubles, if caught early enough can usually be cured at little expense. Coatings can be removed and fresh ones applied. Lens surfaces can be repolished to remove minor marks. Sometimes, they can even be regrounded to remove more deep-seated scratches. This can be expensive but repolishing and recoating is generally a comparatively inexpensive process.
Probably the best advice that can be given about cleaning lenses is, in the majority of cases, "Don’t". If handled and stored properly, lenses need cleaning very rarely indeed. They will inevitably attract a little dust but it is fatally easy to do more damage by constantly removing tiny, unimportant marks, than those marks themselves could ever do, either to the lens or its performance.