ONE'TWO — A look at very fast lenses

by Geoffrey Crawley

When Canon produced their f/0·95 lens at photokina in 1963, it seemed possible that we were in for a run of competitive wide-aperture lenses for 35mm cameras. In fact the only advance on 0·95 has been the f/0·7 special applications Planar fitted with a mid-lens blade shutter developed by Carl Zeiss (Oberkochen) and shown at photokina in 1966. However, such special phenomena apart, it seems that the present stage of development is to regard the f/1·2 aperture as the maximum necessary to make available for the modern 35mm camera.

This aperture commends itself in a number of ways. First: the size and weight of one of these lenses are just about as much as can be mounted on a 35mm camera without appearing, or actually being, very clumsy. Second: with modern films and processing techniques, there is very little in the way of poor-light photography which cannot be satisfactorily handled at this aperture. Third: at any aperture wider than f/1·2, the increasingly shallow depth of focus at the film plane makes demands on the precision of camera engineering which could not easily be met by normal production methods and also, for the same reason, maintenance of film flatness is more important. Fourth: the difficulties of manufacturing, grinding and polishing the component glasses as well as their mounting and accurate centring becomes so much greater that the price to the consumer becomes prohibitive. Even at f/1·2, the cost is quite high enough to deter any but those who have a real use for such high speed or, sad to say, who wish to show off to their friends. With the appearance of the new f/1·2 lens for Minolta there are four lenses of this aperture on the British market: These, in alphabetical order of manufacturer are:

55mm f/1·2 Canon Lens FL
50mm* f/1·2 Leitz Noctilux
58mm f/1·2 MC Rokkor-PG
55mm f/1·2 Nikkor-S Auto

*Standard lenses for rangefinder cameras are, by convention, rated as of 50mm focal length, but are in fact 52mm.

Some general details of the specification of these lenses are given in the accompanying table.

It is interesting to see that one of the most famous names in photographic optics, Carl Zeiss, has nothing available in the f/1·2 field. As already mentioned, Zeiss make a special purpose f/0·7 lens, but the Contarex system offers f/1·4 as its widest aperture and the exposure meter coupling system has no provision for a lens of higher speed than this.

General Points

Although the primary concern was the relative optical performance of these lenses, some general points as to handling necessarily emerged during testing.

The Noctilux, being designed for a rangefinder camera, does not require to be of retrofocus design. In passing, it may be noted that this advantage is even more marked with wide-angle lenses for CRF cameras, since retrofocus lenses for 35mm SLRs are usually larger and heavier than their standard lenses, whereas for rangefinder models they can frequently be smaller and lighter. For these reasons it was not surprising that the Noctilux should prove the easiest to handle of the four lenses. The next to it in convenience was the Canon. Although the Rokkor had a much more smooth and even focusing movement, the Canon scored on its smaller size and weight. The Nikkor had a stiff and somewhat uneven focusing movement and the leverage exerted by the very broad diameter focusing ring made it somewhat difficult to hold the camera really steady when focusing. With the focusing inertia eased, this fault would have lessened.

As regards focusing screen illumination, the Nikon F used with the 'F' normal screen had the highest. The Rokkor with the Minolta SRT 101 gave the next brightest screen image, followed by the Canon, used on the FT, which gave a noticeably duller image. The Nikon apparent screen size is some four-fifths of the Minolta and therefore concentrates the light more.

When changing over to a wide-aperture standard lens, many users will expect to notice a considerable increase in focusing screen brightness, as compared with that obtained with, say, an f/2 lens. This does not occur in practice however, or at least not to the expected degree, because the optical system in the viewfinder of an SLR has its own focal length and aperture and, therefore, its own entrance pupil diameter. In theory, as soon as the exit pupil of the lens on the camera exceeds in diameter the entrance pupil of the viewfinder ocular system, no further increase in screen brightness can be expected. Readers of the writer's analyses of TTL systems, e.g. in the BJ Annual 1970, will remember that the exit pupil of an objective appears to decrease rapidly in diameter as the distance from which it is viewed behind the focusing screen increases. This is very easily seen by looking through binoculars and then slowly distancing them from the eyes. However, although in theory, no increase in brightness should be apparent beyond the point described, in practice, there will be an increase in stray light in the viewfinder system with the wider aperture lens and this will make some contribution to brightening the image seen in the viewfinder.

For example, internal reflections are rather high in the Nikon F standard pentaprism viewfinder, and therefore the image does appear noticeably brighter with the f/1·2 lens; although, since some of the internal reflecting surfaces actually become visible, these distract the eye somewhat from the actual screen image. The SRT 101 viewfinder gives better screen isolation, although internal surfaces are certainly visible, including an inverted reflected image at the bottom, which is visible if the eye is raised a little above the centre of the ocular. There is, however, much less stray light than with the Nikon.

The Canon FT comes between the Minolta and the Nikon as regards internal reflections and stray light in the viewfinder system, and, like the Minolta, has an inverted reflected image visible below the viewfinder frame. The Leica has, of course, a direct vision viewfinder and therefore the use of the wide-aperture Noctilux does not improve the existing excellent viewing brightness.

Although the flare effect referred to can brighten the focusing screen of an SLR, if it is too marked, then the acuity of focusing is decreased. The reason is the simple one that flare degrades the contrast of detail on a focusing screen just as it will when an exposure is made on the film. This effect was most noticeable on the Nikon, as might be expected with the smaller brighter screen, but it did not make it difficult to focus. The Minolta and Canon differed very little in this respect, although the better brightness of the former gave it an advantage. With the rangefinder Leica, naturally, focusing acuity depends on the basic optical properties of the rangefinder system.

Finally, with lenses having an automatic iris diaphragm control, the wider the diameter of the glass elements, the greater are the problems of making an entirely reliable auto-iris movement at the smallest apertures, although they will not often be used with lenses of this type.

This point was carefully tested in the lenses examined, both photographically and mechanically. The samples tested behaved consistently and accurately down to the smallest aperture, f/16. The Noctilux, not having an automatic diaphragm, was not open to this fault. One point was noticed about the Rokkor, which was that, if the aperture ring was pre-set to f/5·6 or a lower aperture and the step-down button pressed to take a TTL reading, the f/1·2 Rokkor tested did not return to full aperture after the exposure had been made but opened only to f/2. It continued to return to this

...ups	Extension from Camera Set Infinity	Overall Diameter	Front Glass Diameter	Rear Glass Diameter	Back Extension	Weight	Aperture Scale	Closest Focused Distance	Auto or Manual	Filter Size
...on Lens FL ...m f/1·2 ...lasses in ...oups)	55mm	68mm	44·5mm	34·5mm	37·5mm	450gm	f/1·2, f/4 then click whole stops to f/16	0·6m	Auto/ Manual and stop-down button	57mm screw-in (special)
...kor-S Auto ...m f/1·2 ...glasses in ...oups)	50mm	73·5mm	46mm	36mm	38·7mm	415gm	f/1·2, f/1·4 then click whole stops to f/16	0·6m	Auto (stop-down button)	52mm clip-on (special)
...ctilux ...2)mm f/1·2 ...glasses in ...oups)	53·5mm	60·5mm	44mm	23·5mm	28mm	450gm	f/1·2, f/1·4 then click half stops to f/16	1m	Manual (non SLR)	52mm clip-on (special)
...kkor-PG ...mm f/1·2 ...glasses in ...oups)	53·5mm	69mm	49mm	34·5mm	36mm	460gm	f/1·2, f/2 then click half stops to f/16	0·6m	Auto (stop-down button)	55mm screw-in (special)

...erture after exposures until the aperture ring was turned ... f/1·2. In connection with the point made above about ...creases in camera lens aperture not necessarily improving ...e screen brightness, it was interesting to note that the fact ...at the Rokkor was not opening up above f/2 was impossible ...detect through the viewfinder.

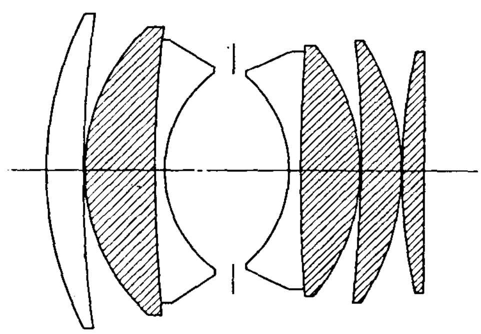
One remote possibility of error with the Canon FT occurred. ...th the shutter open on the B setting and the button locked ...wn using the Time lock lever coaxial with the button, when ...sting collimation, the lens was re-inserted before the Time ...ck lever was released. The iris trip-pin in the rear of the ...s mount was inserted to the right—as one looks into the ...amera—of the trip lever. Consequently the iris diaphragm ...uld not shut down to the pre-set aperture when exposures ...ere made, until the lens was extracted and re-inserted. The ...her camera of the four having a Time setting is the Nikon ... where it is a separate setting on the shutter speed dial; ...t the iris actuating mechanism placement does not permit ... similar error to be made.

...egister

...ne of the earlier points made about the problems imposed by ...ide-aperture lenses was the greater precision necessary in ...e engineering of the camera. With a rangefinder camera, it ...s vital that a lens be focused on virtual infinity when the ...ocusing ring is turned to the infinity stop and that the range-...nder coupling cam should, at this point, give perfect image ...oincidence. This condition must obtain with all lenses irres-...ective of focal length and aperture. With a single-lens-reflex ...amera, the vital essential is that what appears in focus on ...e focusing screen is actually in focus in the film plane. ...hus the condition differs from that obtaining in a range-...nder camera in that the correlation between subject distance ...ocused and settings on the lens distance scale on the focus-...g ring do not need to coincide exactly.

Neglecting the special case of a subject at virtual infinity ...r the moment; with an SLR, so long as the subject plane ...cused in the viewfinder is also sharply rendered on the ...m, the user will probably completely ignore any inaccuracies ...n the distance scale on the focusing ring. With a range-...nder camera, the user must rely on the rangefinder setting ...ccurately predicting the optimum focused subject plane ...roughout the travel from infinity to the closest focused ...stance. Therefore, with a rangefinder camera, focusing ...fficiency depends on engineering precision in both lens ...nd camera mechanics; whilst, with an SLR, efficiency will ...epend mainly on the precision of alignment between reflex ...irror/focusing screen and the film plane. Thus there may, ...ithin reason, be a wider tolerance in the mounting and ...egistration of a wide-aperture lens for an SLR—with the ...ajor exception already briefly referred to. This exception ...oncerns subjects at and near to virtual infinity. 'Virtual in-...nity' is the distance beyond which all planes are, for all practical purposes, equally in focus: a distance dependent on the focal-length and aperture of the lens. With a single-lens-reflex 35mm camera there is the question of 'virtual focusing infinity'. As the focus setting of the lens approaches its photographic virtual infinity so the efficiency of focusing with an SLR decreases and the point at which determination of focus setting on the focusing screen, aided by microprism and/or cross wedge rangefinders, becomes uncertain occurs before the photographic virtual infinity is reached. There is therefore a tendency for the SLR user to turn the focusing ring against the infinity stop with an SLR when he knows that the subject is at virtual infinity. A more experienced photo-

Optical section of the 55mm f/1.2 Canon FL. (The shaded glasses are of new high-refractive-index glass.)



grapher will set the lens just short of infinity, if the exposure is to be made with the lens a little stopped down, since depth-of-field will then ensure that sharpness extends up to infinity and also permit sharpness to extend a little into the middle distance. At a wide aperture, however, there is a temptation to use the infinity stop. It can be seen that, although on many occasions the importance of accurate lens registration is less with the SLR, it is still significant near and at the infinity setting. This does not mean that the SLR manufacturer can be sloppier with the mounting of his lenses, but merely that a wider manufacturing tolerance is acceptable.

The registration of the f/1·2 lenses examined here was investigated photographically and with a collimator. It was first established that a very precise correlation between film plane and reflex-mirror/focusing screen existed on the three SLRs. When the respective f/1·2 lenses were fitted, it was found that the widest tolerance at the infinity setting occurred with the Rokkor which had a small focusing travel remaining after the true infinity setting was reached. The Nikkor showed the next widest tolerance, and also had a slight travel after the true infinity point. The Canon was, for all photographic purposes, spot-on and the Noctilux absolutely accurately set. Subject distances in front of visual focusing infinity on all three SLRs naturally gave complete accuracy since, as stated, the film-plane and reflex-mirror/focusing screen relationship was precisely maintained.

The practical result was that, with the lens brought back to

the infinity stop, the Rokkor did not show its best performance at full aperture on subjects at virtual infinity, in company with the Nikkor with which the fall-away was not quite as great. The Canon and Noctilux gave their optimum.

The fall-away from optimum full-aperture performance would only be noticeable with the Rokkor and Nikkor samples tested with subjects near and up to infinity when photographed at full aperture. By f/2, depth of field or depth of focus covered the error.

Finally on the mechanical side, the shallow depth of focus at f/1·2 makes film flatness a much more critical factor; although in the cameras used here, this did not seem to pose a problem.

Optical Properties

Before examining the practical performance of these lenses, a few remarks about the capabilities of wide-aperture lenses should be made. In the present state of the art, a standard lens for a 35mm camera, with a maximum aperture of f/2, can be designed to have a very minimum of residual aberrations; so that it is flare-free, distortion-free, coma-free and so well colour-corrected that fidelity is maintained with fringe-free detail down to the finest which the film permits to be recorded. If a maximum aperture of f/1·4 is required, then a little of the utmost rigour of these corrections must be sacrificed with the difference in performance becoming noticeable to the critical. An f/1·4 lens is one stop faster than an f/2 lens, but the increase of the aperture to f/1·2, which is only a ½-stop faster, decreases the rigour of correction quite markedly and in particular makes spherical aberration, fall-off in illumination towards the corners of the frame, and coma much more of a problem. In addition, the large front glass makes the lens susceptible to flare. In years gone by, indeed, stray light in the system was the limiting factor in wide-aperture lens design. The possibility of reducing stray light, derived from inter-surface reflections, by means of surface-coating led to the introduction of a number of interesting very wide-aperture designs after the last war. However, coating on its own was unable to overcome the quality degradation from the considerable stray light inevitably introduced into the system by the large number of component glasses. It is only since the introduction of the higher refractive index low-dispersion glasses of the last decade that the design of a high contrast f/1·2 lens has really become possible.

Of the four lenses examined, the Noctilux differs from the others in that it employs one aspheric surface. This enables the number of glasses to be reduced to 6 and an unusually high degree of correction of spherical aberration and coma to be achieved. In addition, non-image forming light entering the front glass is projected out of the system, resulting in exceptionally low flare.

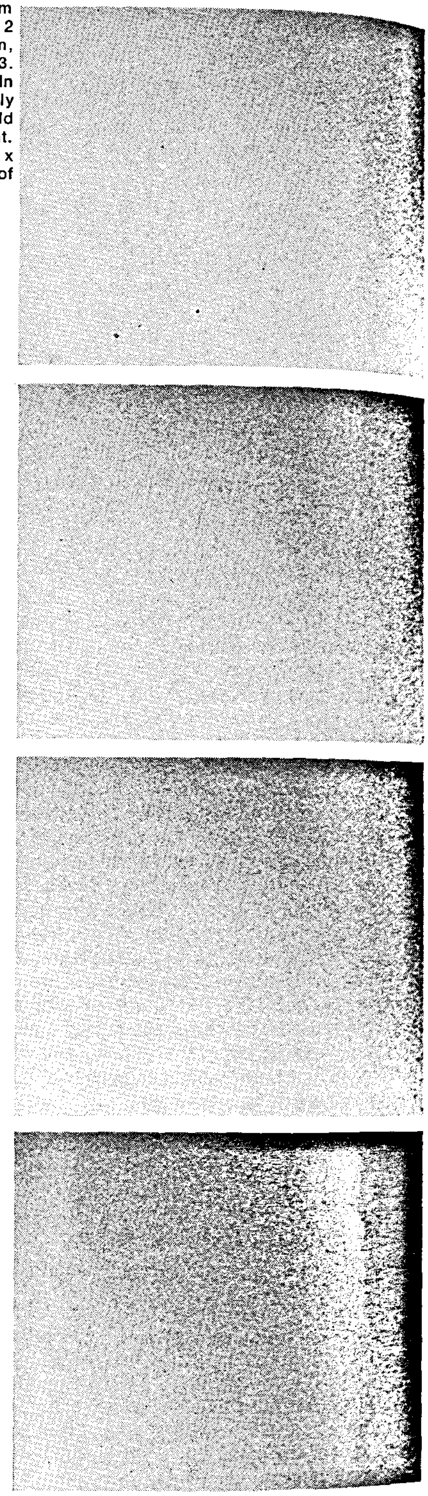
A further limiting factor with a wide-aperture lens is that its maximum correction is only obtained over a limited range of subject distances. Photographic objectives are usually corrected for infinity and normally hold their corrections well enough down to the closest focused distance; but, the greater the maximum aperture, the more quickly corrections fall off at other than the distance for which the lens is corrected. Stopping the lens down will improve results but does not reduce all types of aberration. With an f/1·4 lens the effect at the closer distances may be quite noticeable, and with an f/1·2 design the quality of results towards the near end of the focusing scale may, dependent on the type of subject, very noticeably lack any real sharpness. F/1.4 and f/1·2 lenses are thus not likely to give a critically satisfactory result when used with extension tubes or bellows unit.

As regards colour reversal work, these lenses do not provide the same gradation and separation of hues on small subject areas as the lower aperture types, even when stopped down, but their colour rendering is usually free from cold casts due to the number and thickness of the glasses.

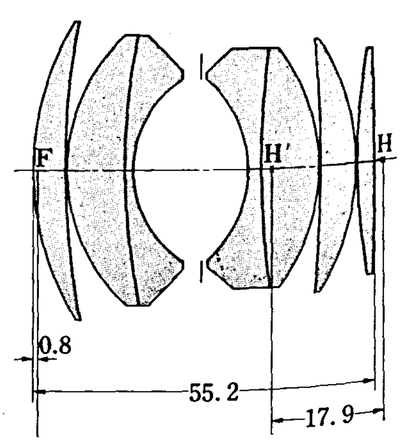
These then are some of the limiting factors on performance which a very wide-aperture design is likely to impose and we can now proceed to examine the performance of these four lenses bearing these points in mind.

Illumination Characteristics

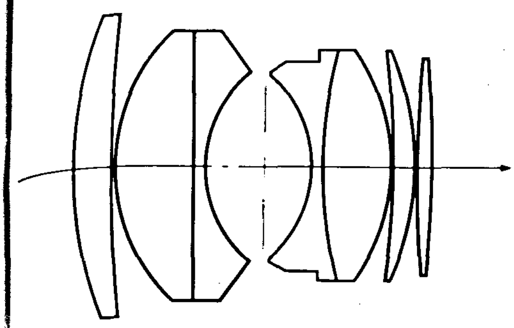
It may seem a truism but it has to be pointed out that anyone meeting the expense of a very fast lens has every right to expect that it will deliver light on the film according to its claims. It should be remembered that all lenses do vignette—



Corner vignetting on film (printed on Grade 2 paper): Top to bottom, 1. Nikkor, 2. Rokkor, 3. Canon, 4. Noctilux. In practical photography only the Noctilux fall-off would be likely to be significant. Area of negative 6mm x 4mm top right corner of frame.



Optical section and manufacturers' dimensional data for the 55mm f/1·2 Nikkor S-Auto.



Optical section of the Minolta MC Rokkor-PG 58mm f/1·2 lens.

give reduced illumination in the frame corners—but this is normally kept below the level at which it becomes photographically noticeable. Naturally minimum- or under-exposure tends to make any illumination fall-off towards the corners of the frame more apparent. Photographs were taken of an evenly-illuminated even-toned surface and the results examined. The maximum fall-off towards the corners with minimum exposure was found with the Noctilux under these conditions, and it was quite marked. The corner fall-off with the Rokkor and Canon lenses was next in order of obtrusiveness but considerably less than with the Noctilux. Finally the Nikkor showed a minimum of fall-off and for most practical purposes the effect could be neglected. The Rokkor fall-off was more gradual than that with the Canon and therefore was less noticeable, although the final value was the same.

It should be pointed out, perhaps, that, of the four lenses, the Noctilux is of the shortest focal-length and therefore has a wider field-angle to cover. Under normal conditions, and with fuller exposure, corner illumination fall-off would be unlikely to be noticeable with the three SLR lenses, although, under some conditions, the extreme corner fall-off would certainly be detected with the Noctilux.

As regards illumination elsewhere in the frame, the most critical inspection failed to reveal any photographically significant differences in speed between the four lenses. These tests were carried out with shutter speeds controlled to within a tenth of a stop and it is likely that deviation from the marked shutter speeds sometimes accounts for user findings that one or other lens is actually faster than another.

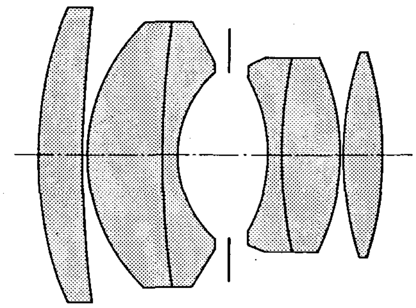
Turning to the question of flare, the Noctilux had a very markedly lower level than the other three lenses, with the Canon next, followed very closely by the Rokkor and the Nikkor. The photographic effect was that the Noctilux isolated adjacent light sources, whilst the Canon showed them with symmetrical haloes, and the other two lenses distorted the shape of the light source slightly. The Noctilux gain was a noteworthy one over the others and its quality in this respect was most noticeable in the confinement of the halo around street lamps as well as in the perfect circular nature of this halo. The other two lenses showed the drag to one side characteristic of residual coma (See the photographs on page 1154). In this respect the Canon came next, followed by the Rokkor and then the Nikkor. The gain of the Canon over the other two SLR lenses was practically significant, and Noctilux photographs could be immediately and unerringly picked out by looking at light sources or highly reflectant surfaces in the picture.

Looking at the results overall in this section of testing, it might be said that the possibility of fall-off showing in the corners with the Noctilux was more than off-set by its remarkable freedom from flare and ability to confine the halo around light sources. The writer had been quite prepared to find some difference in the speed of these lenses and it was pleasing to see that none existed. A word of warning should perhaps be added here. When flare is present in a lens, non-image-forming light falls on the surface of the film and therefore tends to lighten the shadows. This may superficially give the impression that one lens is faster than another which produces darker shadows. However, if the detail in these shadows is examined, it will usually be found that there is actually less extreme shadow detail recorded by the lens with the higher flare factor and giving lighter-tone shadows. This error was carefully excluded in the tests conducted. With the Nikkor, Rokkor and Canon lenses, the effect was hardly significant and it was absent with the Noctilux.

Sharpness, Definition, Resolution

It is now generally understood that it is the clarity of the main outlines of the subject in a photograph which gives it clarity and impact. Modern photographic objectives are designed to give clarity—good contrast that is—of very fine detail, rather than merely achieve a high but mushy resolving power. Contrast of fine detail is particularly important towards the limit of the film's resolving power, since, without it, such detail is very rapidly lost in the grain structure of the film. With most camera lenses today, it is possible to combine high resolving power with good contrast, but this becomes more difficult as the aperture increases. Since the clarity of the picture depends on its main outlines and structural information, it is particularly important that an f/1·2 lens, which, in the present state of the arts, cannot be sufficiently well-corrected at full aperture for very high resolving power, should have good contrast. If contrast is preserved then gradation will be preserved and, so long as sufficient textural detail is present, image quality should then be good.

Optical section of the Leitz 50 (52) mm f/1·2 Noctilux for Leica. This lens, by using an aspheric surface, restricts the glasses necessary to six, and the elements to four, thus automatically increasing contrast by elimination of one series of internal reflection over the seven glass, five element lenses.



In this general sense of the term the Noctilux gave the best quality, particularly with its ability to preserve gradation close to strong highlight areas at full aperture. Next in overall contrast—at the low spatial frequencies which record the main subject outlines and texture—were the Rokkor and Nikkor lenses with the Canon a little behind. However, although the Canon was below the other two in contrast of major outlines—low frequencies—it showed improved contrast of textural detail in the mid-frequency range—that of medium-fine detail. The quality rating of the three SLR lenses would probably be a matter of individual preference. It has been established that the absence of coma is a major factor in improving image quality and the Canon picture gave a 'cleaner' effect than the Rokkor or Nikkor pictures on subjects where this was of importance. The slightly higher contrast of the Rokkor combined with its good rendition of mid-frequency range textural detail gave, however, excellent quality. Contrast of fine detail—towards the high frequency range that is—was better with all three SLR lenses than with the Noctilux, but it was this lens's fine constrast and hence ability to separate the tones on which the feeling of roundness or plasticity is derived which gave its pictures the improved effect, apart from the highlight rendition already noted. Nevertheless, for scientific purposes, where maximum information is required, the Rokkor would be the better choice, followed by the Nikkor and Canon lenses.

Other Characteristics

Very wide-aperture lenses usually give some degree of barrel distortion although this has now been overcome to a large extent. Of these four, the Rokkor and Canon lenses showed least, the Nikkor gave somewhat more and the Noctilux quite markedly more. With the Rokkor and Canon lenses, buildings could be photographed without barrelling being apparent unless it was closely looked for. With the Nikkor it was sufficient to be noticeable on verticals up to about 4mm from the frame edges, and with the Noctilux it was noticeable on verticals 5-6mm in from the frame edges.

Loss of edge and corner definition due to spherical aberration was not significant with the three SLR lenses. The Noctilux field characteristics differed, presumably owing to the use of an aspheric surface: edge and corner definition was good, but there were some poor zones closer in, a little off axis.

Turning to colour rendering, the Rokkor and the Nikkor

gave (pleasingly) warmish results with the Canon cooler and the Noctilux cooler still but not quite neutral. The high contrast of the Noctilux and its low flare gave colour reversal pictures taken with it at full aperture a quite marked increase in separation and saturation of hue over the others. The Rokkor transparencies were interesting too as showing more detail, although the picture was 'softer' overall. The flare suppression with the Noctilux is particularly advantageous with photographs taken outdoors in bright light, where the stray light introduced into the optical system by the large-diameter front glass of an f1·2 lens is virtually absent even on strongly back-lit subjects.

All the results described above refer to the performance of these lenses at their full aperture.

Stopped Down

If one buys an f/1·2 or f/1·4 lens it should be because there is need of such wide aperture; therefore the most important point is to find out how the lens behaves at that wider aperture. Nevertheless, it is also material to ascertain what one is losing or gaining over the more usual f/2 or perhaps f/1·8 lens when the wide-aperture lens is stopped-down.

The answer to this question has already largely been given. Unsharpness at corners and edges caused by spherical aberration can be masked by stopping down, but curvilinear distortion cannot. The effects of some types of colour aberration are masked by stopping-down, but others are not. Stopping-down can cut out a certain amount of flare, but cannot do so altogether. It can be seen therefore that, until f/1·2 and f/1·4 lenses can be designed as well corrected at full aperture as their f/2 fellows, the results stopped-down cannot be as good.

From the practical point of view, however, there is an area in which a gain, which can prove important, may be made. The closing in of the iris diaphragm of an f/1·2 lens at f/2 is quite considerable, and, as regards definition of detail and evening up of definition across the whole frame, such stopping down can bring about a very marked improvement. Indeed, an f/1·2 lens is likely to be somewhat sharper at f/2 than an f/2 lens used wide open. In this connection it may be remembered that, in the recent review of the Pen F equipment in the Journal, it was mentioned that the Zuiko f/2·8 enlarging lens was in fact an f/2 lens design with an iris which would not open it up beyond f/2·8. This is another example of the same principle.

At f/2·8 the f/1·2 lens is still likely to be sharper than the f/2 stopped-down, but at f/4 the advantage will usually swing to the f/2 lens which, being basically the better corrected lens, now begins to show its superiority in the subtler aspects of image quality in both black-and-white and colour work. At f/5·6, the faster lens will be maintaining or perhaps just declining from its optimum, whereas the f/2 lens is now at its very best. With each stop down now, the faster lens will give lower image quality, whereas for most practical purposes the slower lens will maintain it to f/11 and then perhaps decline a little at f/16. To complete the picture, it should be mentioned that, at its full aperture, the f/1·2 lens will not be as good as the f/2 fully open.

Lenses of f/1·4 exhibit intermediate relative definition properties. At full aperture, this type of lens will give better quality than an f/1·2 lens at full aperture. If the iris of the faster lens is shaded in to give f/1·4—of the four lenses examined here only the Noctilux had a calibration at f/1·4 setting whilst the Nikkor and Canon had unmarked click stops at f/1·4—it cannot be expected to give quite the same quality as the f/1·4 lens fully open. At f/2 quality will be very similar, looked at solely from the point of view of definition coverage, but by f/2·8, the f/1·4 lens will start to go ahead, being basically the more highly corrected of the two. It will also maintain its quality on stopping down further, down to perhaps between f/8 and f/11. Both f/1·4 and f/2 lenses will give better drawing, absence of curvilinear distortions that is, as well as lower flare, throughout.

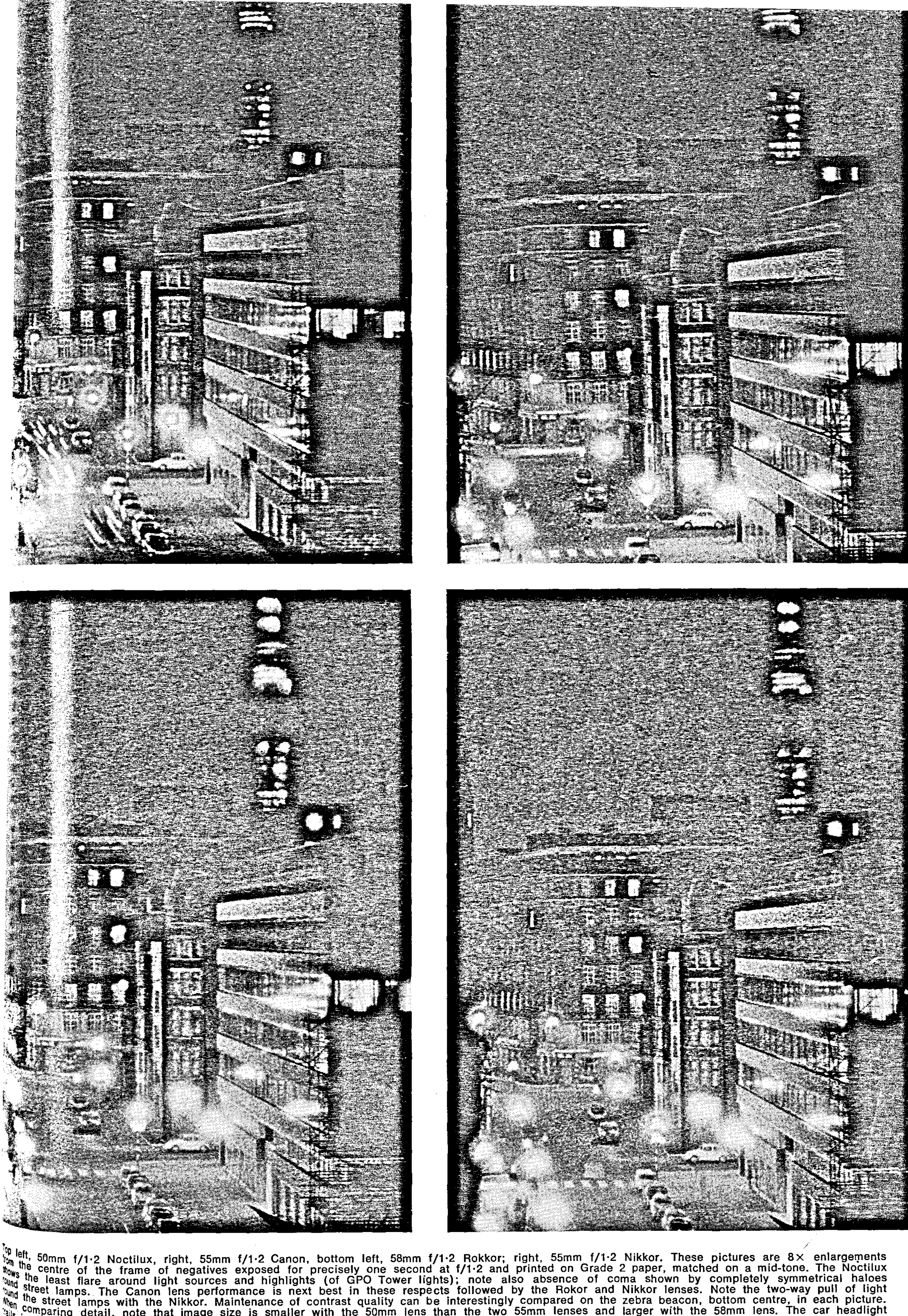
It will be noted that in this general discussion of aperture for aperture, no names have been mentioned. This is because these general remarks are true within a given manufacturer's range. In other words, although the actual performance of lenses of the same specification by different manufacturers may vary, within one manufacturer's range the comparative remarks made above apply. The one exception seems to be provided by the Noctilux, presumably owing to its unusual construction. At full-aperture, this lens gives overall image quality which can be compared with that of the 50mm f/1·4 Summilux at full aperture, although the latter does not exhibit curvilinear distortion or corner illumination fall-off. The Noctilux follows the general rule stated above in that, at f/1·4, it is not quite as good as the Summilux; but at f/2 image quality overall is not as good as with the Summilux at f/2 or the 50mm f/2 Summicron at full aperture, nor can it compare with the quality given by these two lenses aperture for aperture on further stopping down. The Noctilux is therefore a lens whose exceptional qualities are only exceptional at full aperture. The other three f/1·2 lenses discussed, however, follow the general rule stated above when compared with their slower colleagues of the same range.

Another factor must be borne in mind: although when stopped down the f/1·2 lens is capable of giving even coverage of very fine detail over the whole frame, it is of inherently lower contrast, partly due to the increased stray light present. Consequently, if optimum quality is to be obtained, exposure will have to be close to the 'minimum correct'. With over-exposure this low contrast fine detail will begin to block up, whereas, with the better detail contrast of a lens of lower maximum aperture, definition is preserved over a wider range of exposures. Also, a lens giving good contrast detail is better at preserving the structural elements of detail at the point where the resolving power of the film is interrupted by granularity and therefore gives a clearer picture and also less apparent graininess in the print. Again in poor-light work, which is usually candid, the outlines of a subject showing movement have less clarity with a low-contrast lens than when photographed with one of a higher contrast. On the other hand, a faster lens enables one to use a higher shutter speed to arrest movement.

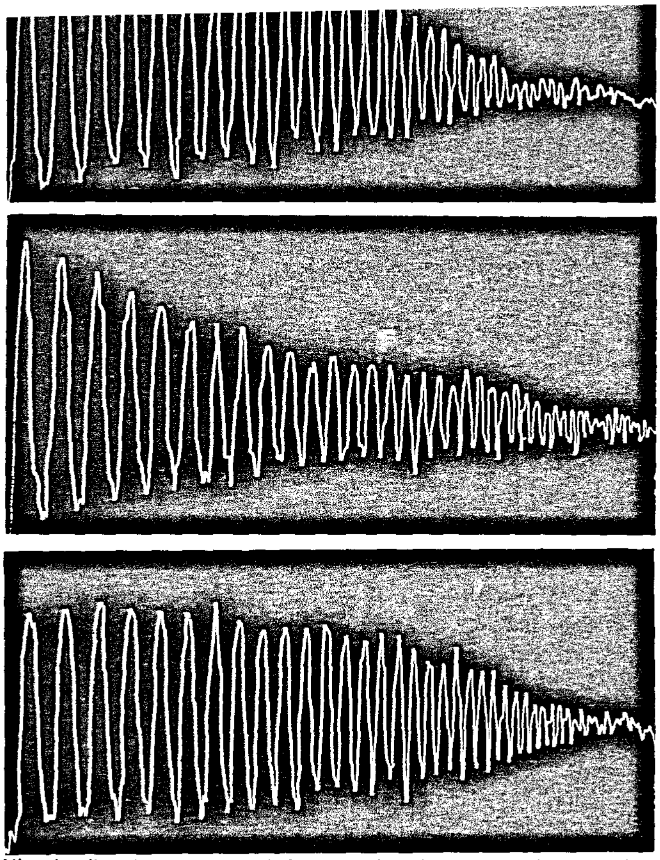
The question of the optimum contrast of frequency response, the Optical or Modulation Transfer Function of a lens, in relation to the photographic materials with which it is likely to be used becomes more important when considering the design of a lens of very wide aperture. With the design of the latest normal-aperture lenses the trade-off between contrast and resolving power can be very advantageously made. As aperture increases, however, the designer may have to decide how best to exploit the possible compromises between contrast and resolving power in the low, medium and high-frequency ranges, say, 5-15 line pairs per mm, 15-30 l.p.p. mm and 30-50 l.p.p. mm. Generally, any improvement at the high frequency end will have to be paid for by lower contrast at the low frequency end of the range. If the designer envisages his lens being mainly used for poor-light work for which ASA 400 or faster material will be employed, then, since the high frequency range is beyond the recording ability of the film, he may prefer to give highest contrast to the lower and mid-frequencies. This philosophy has the advantage that, if mid-frequencies have good contrast, then, as described in the preceding paragraph, the structural elements of detail at the point where the mutual resolving power of film and lens is interrupted by granularity, will be better preserved and may even be preserved in part beyond the actual resolving power of the film; so that when the print is viewed from a little distance these structural elements appear to coalesce and give detail where none is really continuously present. If, on the other hand, the designer envisages his lens as a general-purpose lens even at its full aperture, then he may decide to go for the more extended high-frequency range response (resolving power) which slow and medium-speed materials are capable of recording, although this may mean that actual photographic resolving power and detail clarity may be less on high speed materials than with that obtainable with a lens of the other 'philosophy'.

Of these two philosophies, the Noctilux very obviously belongs to the former type, with the three SLR lenses giving slightly different balances between the two viewpoints.

In connection with these factors, it is interesting to note that one aspect of the use of very wide-aperture lenses is the possibility of using, say, ASA 200 material instead of ASA 400 material if one is able to obtain the coverage with the lens wider open. As can be seen from the description of the relative performance around f/2 and f/2·8 of standard f/2 lenses and f/1·2 lenses, this is a practical proposition, as it is, to a lesser extent, with an f/1·4 lens. On the other hand an ASA 400 film has a longer toe to its characteristic than its



Top left, 50mm f/1·2 Noctilux, right, 55mm f/1·2 Canon, bottom left, 58mm f/1·2 Rokkor; right, 55mm f/1·2 Nikkor. These pictures are 8× enlargements from the centre of the frame of negatives exposed for precisely one second at f/1·2 and printed on Grade 2 paper, matched on a mid-tone. The Noctilux shows the least flare around light sources and highlights (of GPO Tower lights); note also absence of coma shown by completely symmetrical haloes round street lamps. The Canon lens performance is next best in these respects followed by the Rokor and Nikkor lenses. Note the two-way pull of light round the street lamps with the Nikkor. Maintenance of contrast quality can be interestingly compared on the zebra beacon, bottom centre, in each picture. When comparing detail, note that image size is smaller with the 50mm lens than the two 55mm lenses and larger with the 58mm lens. The car headlight trails in the Noctilux picture have provided a greater flare potential than in the other pictures, but contrast has been preserved on the immediately adjacent cars.



Microdensitometer traces read from bar-line (square wave) test object imaged on ASA 400 material. The trade-off between resolving power and contrast can be seen. The Rokkor, centre, and the Canon, bottom, have about the same resolving power, but the Canon has higher contrast over most of the range except, left, at the lower spatial frequencies which record subject contours and main structure. The Noctilux, top, has lower resolving power than the other two, but higher contrast in its low-frequency response. This, combined with its exceptional flare suppression (see previous page) enables it to give improved overall photographic quality.

medium-speed counterpart and hence, is effectively faster in poor-light conditions. The faster lens therefore tends to be used more to extend possibilities of faster materials than to lead to their substitution by slower ones. There is, however, room for experiment also in connection with depth of field—the shallowness of which gives very fast lenses interesting possibilities. With a wide-aperture lens one tends to think automatically of using fast film to complement its possibilities, and this may not be an always logical combination.

In the section above many of the comparative aspects of the performance of f/1·2, f/1·4 and f/2 lenses have been discussed. The interlinking of the various factors is so complex that there is room for several valid viewpoints as to the best selection of type to be made. To provide a starting point., the writer's own views are as follows. The lens which will handle the widest variety of photographic situations in black-and-white and colour and which is capable of the highest image quality remains the standard f/1·8 or f/2 standard lens for a given camera system. If a photographer has a genuine and continuing use for a wider aperture, then the selection of an f/1·4 lens is logical and, somewhat dependent on which make it is, this will not provide a very marked fall-off in quality for general work at other apertures from the f/2 lens, when it is stopped-down—as it will need to be in good light. If the photographer finds that he frequently needs the last ounce of speed and that his results at f/1·4-f/2 do not have the required detail, then the expense of an f/1·2 lens might be justified. However, it is more or less certain that, unless the whole of his work consists of reportage, he will need a standard f/2 lens as well.

In brief then, if one must have the utmost speed on numerous occasions as well as improved quality around f/2, then the f/1·2 lens is justified.

Testing Wide-Aperture Lenses

A word of warning should perhaps be given to those who may undertake the photographic testing of very fast lenses. For example, if it is required to test the lens performance at infinity, it is not sufficient, for the reasons we have seen, to turn the focusing ring back to the infinity stop and make a series of exposures. Although reflex-mirror/focusing screen and film-plane in the camera body may be correctly aligned, there may be some tolerance in the setting of the lens. It is therefore necessary first to make a series of exposures with the lens racked fully back and then with it advanced a few 'thou' at a time. After processing, the exposures at each of these settings are examined and the setting at which the best overall detail quality over the frame is obtained, noted. This setting is then adopted and a series of exposures at each aperture is then made. From these, the performance of the lens in practice under those conditions can be assessed.

Similarly, when making exposures on a test subject indoors with controlled lighting, it is not wise to trust, for full-aperture testing, with the way one's eyes happen to be feeling that day—if you are using an SLR. The same procedure should be adopted as with exposures made at full aperture and the pictures made at slightly separated focus settings either side of the visually assessed one. Again, after processing, the negatives are examined for the setting showing best overall quality and the lens tested across its range of apertures at this setting. A number of exposures at each setting is recommended, since at full-aperture performance is more sensitive to variations in film flatness. If 3 or 4 exposures are made at one setting this is normally sufficient to indicate any flatness errors. The camera should not be wound on too sharply as this may contribute to any unflatness.

It is now generally accepted that a lens is tested at the setting which gives the best overall performance across the whole frame, but in testing for himself, the photographer may find he has a choice: either the setting giving best overall quality or the one which gives the best central sharpness.

It need hardly be emphasised that, when photographing flat surfaces as test subjects, a wide-aperture lens must be very accurately straightened up to the surface if the test is to have any validity. Also it is worth noting that wide-aperture lenses should be tested on the ASA 400 materials with which they will often be used as well as the slower and medium-speed materials of higher performance and image quality—the reasons for this were given above.

The Four—Conclusions

Each of the four lenses examined forms part of the equipment available in a complete camera system and, at the outset, it is worth stating that the users of each of these systems—Canon, Leica, Minolta and Nikon—are well served. Although it is unlikely that anyone would choose a camera system on the basis of the performance of the fastest lens available for it, it is nevertheless of some technical and scientific interest to have compared their performance.

The best photographic image quality at f/1·2 was, as stated above, given by the Leitz Noctilux and the difference was quite noticeable. To a certain extent it 'cheats' by using an aspheric surface and, of course, it is by far the most expensive. Although of lower overall contrast, the fine textural detail provided by the Rokkor and Canon lenses at full aperture together with their slightly better confinement of strong highlight areas (less halation) than the Nikkor placed them next, with the rather higher overall contrast of the Rokkor over the Canon giving its pictures perhaps a little more impact. The Nikkor performance was, as might be expected, impressive, but the 'pull' in the image of light sources and strong highlights tended, despite its generally excellent performance, to reduce the photographic quality of its pictures in comparison with those from the other lenses. As regards 'good light' performance—stopped-down that is—the Rokkor and Canon gave best quality, followed by the Nikkor. The Noctilux continued to give good quality overall, but lacked the bite of very fine detail provided by the other lenses stopped-down. It has obviously been designed primarily as an f/1·2 lens. One small practical disadvantage occurs with the Canon, Rokkor and Nikkor f/1·2 lenses, which is that the overall diameter of the barrel is such that it projects below the baseplate of the cameras. Thus the camera cannot be mounted on a fair sized tripod head without jamming the focusing movement. With the Minolta the tripod head platform must not extend more than 46mm forward of the tripod bush with the Nikkor, not more than 47mm and with the Canon, 42mm. The three SLR cameras have through-the-lens metering systems available, and these wide-aperture lenses worked very well with their respective TTL systems, as might be expected from the large exit pupil of lenses of this aperture.