Canon

Objective

English Edition

1978

Lenses

Commonly called the eyes of our cameras, lenses in fact are very much more. As the all-important system that actually forms an image on the film, we may rightfully call them the "heart" of our camera for it is the lens that determines the quality of our pictures.

But even that is only half the story. Because there would be no truly versatile SLR camera without interchangeable lenses – and where would photography be without today's SLRs? In the hands of creative photographers, interchangeable lenses turn into subtle instruments controlling mood, angle, perspective and composition.

Thus we have lenses of almost any imaginable focal length and speed, for a great variety of different uses. And while this

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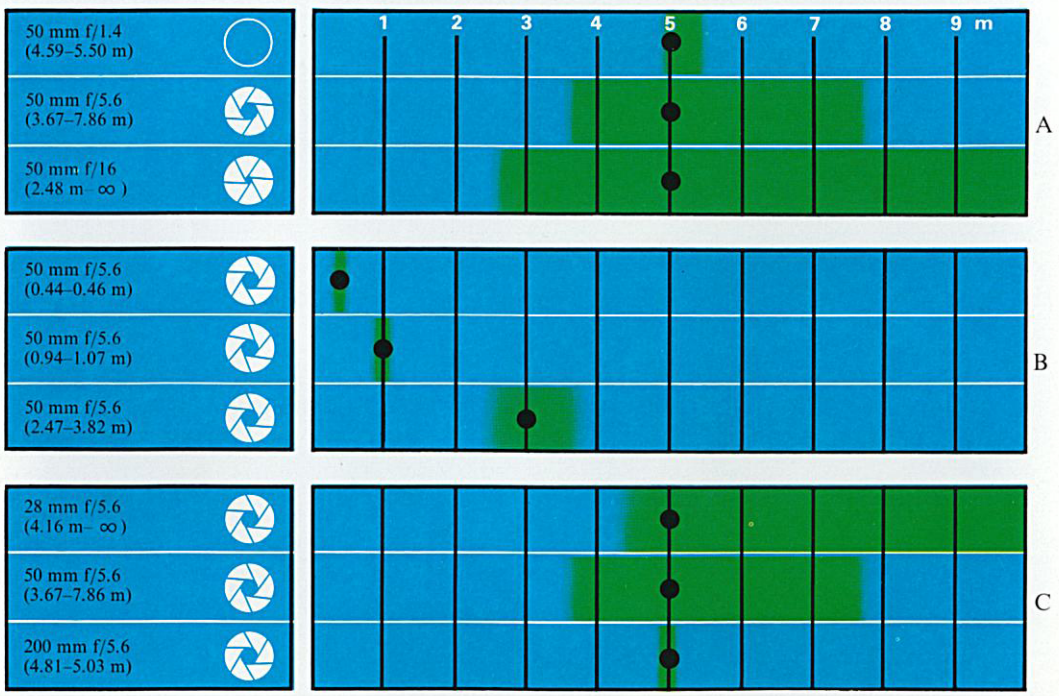
A much-used photographic term is "depth of field", since control of the sharpness in our pictures is one of the most powerful means of photographic expression. By depth of field we mean the area in front of and behind the actual plane on which you have focused, which is still recognized as "sharp" by the human eye. This zone of sharpness is essentially determined by three factors illustrated in the diagrams opposite. First, we have the aperture used for exposure (A): the wider the aperture, that is, the smaller the f-number, the shallower the depth of field. Diagram (B) shows the effect of focusing distance: the shorter the distance on which a lens is focused, the shallower the depth of field. Finally, diagram (C) illustrates the third factor, namely focal length: here also, depth of field becomes shallower as focal length goes up.
In practice, this means that in order to make a person stand out against distracting background detail you should use a lens of longer focal length at the widest possible aperture and a relatively short distance. Conversely, sharp reproduction from very close to very far would call for a short focal length, small aperture (= high f-number) and at least medium focusing distance.



But interchangeable lenses not only serve to control depth of field. The use of different focal lengths covering different angles gives us control over perspective. As long as we use different focal lengths from one and the same place, only angular coverage will change. However, if we combine a change of focal length with one of camera station, we can either emphasize the difference in size between near and far (wide-angle perspective) or play it down by using a telephoto lens.

may not apply to all the cameras on the market, it certainly holds for those in the Canon Reflex System: F-1, EF, AE-1, AT-1 and FTb. The Canon FD Series of lenses have meanwhile become a kind of hot tip among insiders, and these lenses are the common link between all of the aforementioned cameras. So you have every freedom to use them right across the entire system, perhaps combining an F-1 with an EF, an AE-1 with an FTb or whatever may best suit your intentions and your budget. The FD lenses fit any of these cameras. They are not only made for full-aperture metering, but also for automatic aperture (AE) control with Canon's electronic SLRs, the EF or AE-1, or the Servo EE Finder for the Canon F-1.

On these and the following pages we shall try to give you a complete picture of what makes Canon SLRs tick – optically speaking, that is. Being one of the most comprehensive lines of high-performance optical systems for single-lens reflex cameras available today, the Canon FD Series caters for any taste and any budget. Whatever your ambition – or your assignment – you can be sure there is a Canon lens that will optimally serve your purpose. In fact there are so many different Canon lenses that it will take us quite a number of pages to explain all their outstanding features in sufficient detail so you won't miss any of the highlights. For complete information is what you should have before selecting the lenses that will best suit the kind of work you have in mind. We are pleased to oblige.

All Canon lenses have a diamond-studded rubber focusing grip. Focusing motion is smooth and direct. The generous use of miniature ball-bearings further improves ease of operation.

A small red dot is provided as a focusing index for shooting with infrared film.

For automatic exposure (AE) control, for instance in conjunction with a Canon EF, AE-1 or the Servo EE Finder for the F-1, the aperture ring of all FD lenses has a click-stop setting marked with an "A" or a green circle.

This button locks the aperture ring in the AE setting and prevents inadvertent motion.

In normal use, the aperture of FD lenses has a presetting function. Only when the stop-down lever or button of the camera is pressed or the diaphragm-coupling lever of the lens locked does the aperture ring act directly on the diaphragm.

The solid bayonet ring of the Canon breech-lock mount secures the lens to the bayonet on the camera body. The lens itself is not turned for mounting.

The aperture simulator of all FD lenses moves in identical increments and transmits the preset aperture to the camera's metering system.

This contact serves to apply a correction for full-aperture metering at small f-numbers and, depending on the type of camera, to signal the lens speed to the metering system.

The diaphragm-coupling lever stops the lens down to the preset value a split second before the shutter operates. It can be locked at its right-hand stop to allow direct manual control of the aperture via the aperture ring.

Magic glass

Glass is a very special, almost magic material whose beauty and extraordinary capabilities have been a stimulus to man's imagination for thousands of years. Ingenious minds and skillful hands have given it myriad shapes and harnessed its light-refracting power to obtain those marvels of advanced optical technology: photographic lenses reproducing the world around us with the utmost fidelity, clarity and brilliance.

It is a long way from glass as a raw material to one of Canon's high-performance FD lenses. The problems confronting the optical designer are gigantic. Sophisticated electronic computers have doubtless wrought tremendous change. But even so, it is still man who has to instruct the machine what to do,

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There is no such thing as an ideal lens – much to the regret of optical designers and photographers alike. Each and everyone of our optical systems is a compromise. Take a single lens element, for example – a round piece of glass with two spherical surfaces. This will give you some sort of an image if you hold it at the right distance – namely its focal length – from a wall opposite a window. But that's just it: if you were to record this image on film and blow it up to the size needed for our eyes to accept it as a replica of the natural scene, you would find it full of imperfections. You would notice that an impressive number of aberrations – image errors – combine to spoil the quality of your image, making it practically useless for normal photographic purposes. An object point would not be reproduced as a point at all, but rather as some obscure, blurred disk. Light rays passing through the marginal areas of the lens would not intersect in the same plane as rays traveling along the optical axis. Nor would the different components of visible light – blue, yellow and red, for instance – come to a common focus. And while your film would be more or less flat, you would have to discover that the plane of best focus in your image is not a true plane at all but some kind of a curve, again throwing part of your picture out of focus. And as if all that were not enough, you might find that a rectangle is deformed into either a barrel or a pin cusion – leaving you to wonder why you ever did take this image for a replica of your subject in the first place.

What we have described here in very general terms are variously known in optical theory as chromatic aberration – or "color error" – spherical aberration, curvature of field, distortion, astigmatism, coma, etc.

You may now begin to appreciate the complexity of correcting an optical system for the numerous image errors. By carefully selecting different types of optical glass for the different lens elements and combining these into suitably spaced components, in addition to varying their radii of curvature, optical designers have been able to work genuine miracles, producing lenses of ever higher resolution, better contrast rendition and greater freedom from flare and reflections. In more recent times, these endeavors have been greatly boosted by two major developments: the creation of exotic new glass types with particularly desirable dispersion characteristics and the tremendous advances made in computer technology which have made it possible to trace many more rays through an optical system than had ever been possible in the past. As a result, optical designers have been able to optimize their formulas to a degree that seemed completely unattainable even twenty years ago.

Although the general quality and performance of photographic lenses have thus been improved immeasurably in the recent past, there is still one very interesting "little difference": every manufacturer has his own know-how, experience and techniques. And since approaches and solutions thus vary, it is only natural that the products of different manufacturers should have their own specific traits, their own "personality" so to speak.

Canon lenses do have quite a distinctive "personality": they are generally accepted as being among the most advanced and most powerful optical systems that are made anywhere in the world today. Their "image" is flawless – in every sense of the word. In fact, there are quite a number of developments that Canon has pioneered and that have become "general state of the art". Others again remain exclusive manufacturing secrets – and thus very distinctive traits you will find only in Canon lenses – and nowhere else.

Perhaps it's not a bad idea to invite you now to take a look behind the scenes and follow a Canon lens on its way from the raw material to a finished product.

Right now, there are more than 250 different types of optical glass available to Canon's optical designers for selection according to their refractive index and dispersion characteristics.

Glass making itself is an extremely slow and laborious process because the type of glass used in optical systems is a very special blend indeed. The different ingredients (1) – chosen to the most exacting standards – are carefully mixed and melted in special fire clay crucibles at temperatures of up to 1700° C (2). The mixture is constantly stirred until no further "gassing" occurs and all bubbles have been removed.

Next, the melt is allowed to cool down very slowly, a process which may extend over several weeks. As the crucible cools down, the glass tends to break up into pieces (3) from which only about 30% are selected for further processing. The entire rest of the material is unusable due to imperfections, such as bubbles, striae or veins.

The irregularly shaped glass blocks are then re-heated to about 900° C and molded into so-called blanks of approximately the final shape of the optical component to be produced (4).

Other, more advanced, continuous smelting techniques involve the use of platinum troughs or crucibles into which the ingredients are continuously fed. After the glass has passed various temperature-controlled stirring stages, it is automatically tapped and drops into suitable molds. The resulting blanks are then carefully cooled, or "annealed", to remove internal stresses. These continuous techniques are very economical in large-batch production.

Now the pre-molded blanks can be passed on for roughing, grinding and, finally, polishing to their ultimate shape and surface quality. Elements for Canon FD lenses are polished to within 1/10,000 mm.

It goes without saying that each of these operations is followed by stringent tests and inspections. After polishing, for example, the curvature of the lens elements is tested by placing them in contact with a so-called test plate – a glass block polished flat on one side, with the specified radius accurately polished on the other. The interference fringes – or Newton's rings – formed in the extremely thin layer of air between the two surfaces are a very reliable measure of accuracy.

The next step in line is called edging. This consists of grinding the edge of the lens to the specified diameter, making sure that the mechanical center and the optical axis of the lens are in perfect coincidence.

When the lenses have thus been centered and thoroughly checked for proper radius, thickness and freedom from optical defects, they are cleaned in special solutions agitated by ultrasound (5).

At last the optical elements as such are ready. And still, one very important process has to follow before they can be mounted: anti-reflection coating (6). Used without such treatment, every single glass-to-air surface would reflect fully 4% of the incident light. In the multi-element systems frequently used today for extreme focal lengths, speed or versatility, this can easily add up to some 50% – with the result that only half the incident light would actually reach the film. And the other half would not simply be "lost". Quite a sizable portion of it would stray in the optical system and reach the film "through the back door", casting a veil of image-degrading flare over our picture.

This is why all air-to-glass surfaces of Canon lenses are Spectra-coated in a vacuum chamber with special films only about 100 millimicrons thick (6). In some cases where the refractive index of the glass type used, the location of the element within the optical system or other criteria so warrant, the elements are even multi-coated by the Canon Super Spectra technique. This method effectively reduces reflection from individual lens surfaces to a mere 0.3%. The result of coating is not only considerably higher light transmission but improved contrast and color rendition as well.

While optical production has been going on, other sections of the company have been busy preparing the mechanical mounts which will combine the different elements into one optical system – a Canon FD lens. Here also, the utmost precision and extremely narrow tolerances are indispensable. Since Canon has successfully automated a large part of its production, many of the machine tools used have been specially developed and built by the company (7).

And when the final touches have been added, each of these lenses faces the most stringent test of all: Canon's own OTF test computer (8) which automatically checks their resolving power, contrast rendition and overall performance. Only when they have passed this final test have Canon FD lenses taken the last hurdle on their way to you.

which parameters to vary and when to stop. He has to weigh the countless possibilities which different glass types, lens elements, curvatures and air spaces offer for correcting the image-degrading errors, so-called aberrations, that abound in any spherical lens made of that magic material – glass.

Before we take a closer look at the FD line-up, let us pause briefly to put a few technical details straight. In the following, terms like "speed", "focal length" and "aperture" or "f-number" will crop up so often that we should perhaps take the time to introduce them. By "speed" we understand the relative amount of light transmitted by a lens. If the generally high speed of FD lenses has caught your eye, then you have discovered that in practically any focal-length group Canon has succeeded in creating optical systems that won't let you down even if the sun does – and this without compromising on image quality. The speed of a lens is expressed in the form of f-numbers, such as f/1.4. The smaller the f-number, the more light will the lens transmit, the higher its speed – and the larger its diameter or effective aperture. Focal length, on the other hand, determines the angle of view covered from a certain point. Hence, short focal length goes with wide-angle lenses, long focal length with the so-called telephotos whose best-known quality is that of "closing-in" on distant subjects.


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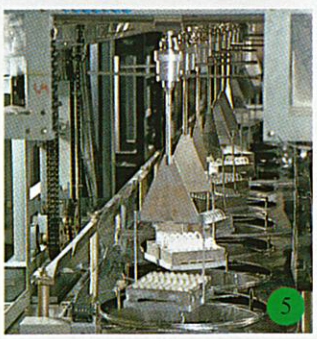
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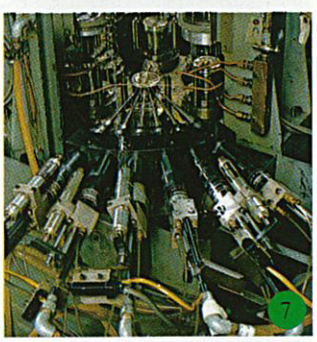
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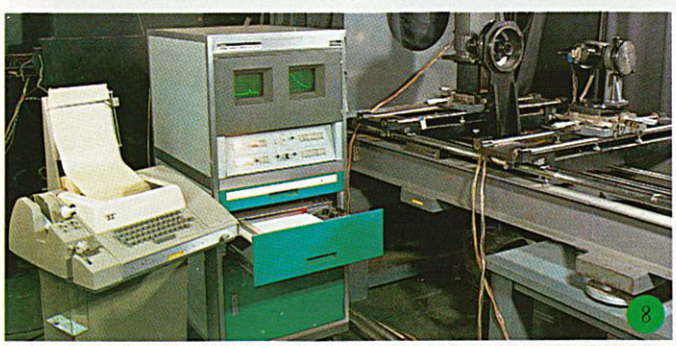
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Fish-eye and wide-angle lenses

The optical equipment of Canon SLRs starts way down at the bottom: advanced optical systems will convert your single-lens reflex for seeing the world with the eyes of a fish – capturing an angle of fully 180°. In other words, everything in front of the camera lens will be included in your picture. An entirely new world is yours to discover. The creative potential of fish-eye photography is tremendous. Its unusual perspective adds variety and impact. And you can either have a so-called circular fish-eye with only 7.5 mm focal length, which reproduces the entire 180° field in a circular image of 23 mm diameter, or one of 15 mm focal length filling the entire 24 mm × 36 mm frame.

One remarkable fact about these and all other FD wide-angle lenses is that in spite of their extremely short focal length they will

1. Fish-eye 7.5 mm f/5.6 SSC
A circular fish-eye for equidistant projection, covering 180°. Six built-in filters. For stop-down metering (no AE control possible).

2. Fish-eye FD 15 mm f/2.8 SSC
Full-frame fish-eye in focusing mount with four built-in filters and integral lens hood. Diagonal angle of view 180°.

3. FD 17 mm f/4 SSC
Super-wide-angle (104°) with residual distortion of less than 1 %. Floating System. Focusing down to 0.25 m.

4. FD 20 mm f/2.8 SSC
Particularly high-speed super-wide-angle lens (94°) with Floating System. Focusing down to 0.25 m.

5. FD 24 mm f/2.8 SSC
In spite of its high speed, a compact super-wide-angle lens (84°) with Floating System.

7. FD 28 mm f/2.8 SC
A particularly compact wide-angle lens (75°) of high resolution and outstanding contrast rendition.

8. FD 28 mm f/2 SSC
A very high-speed lens in the wide-angle category. With Floating System.

9. FD 35 mm f/2 SSC
The ideal "standard lens" for wide-angle fans. High speed, high performance, Floating System.

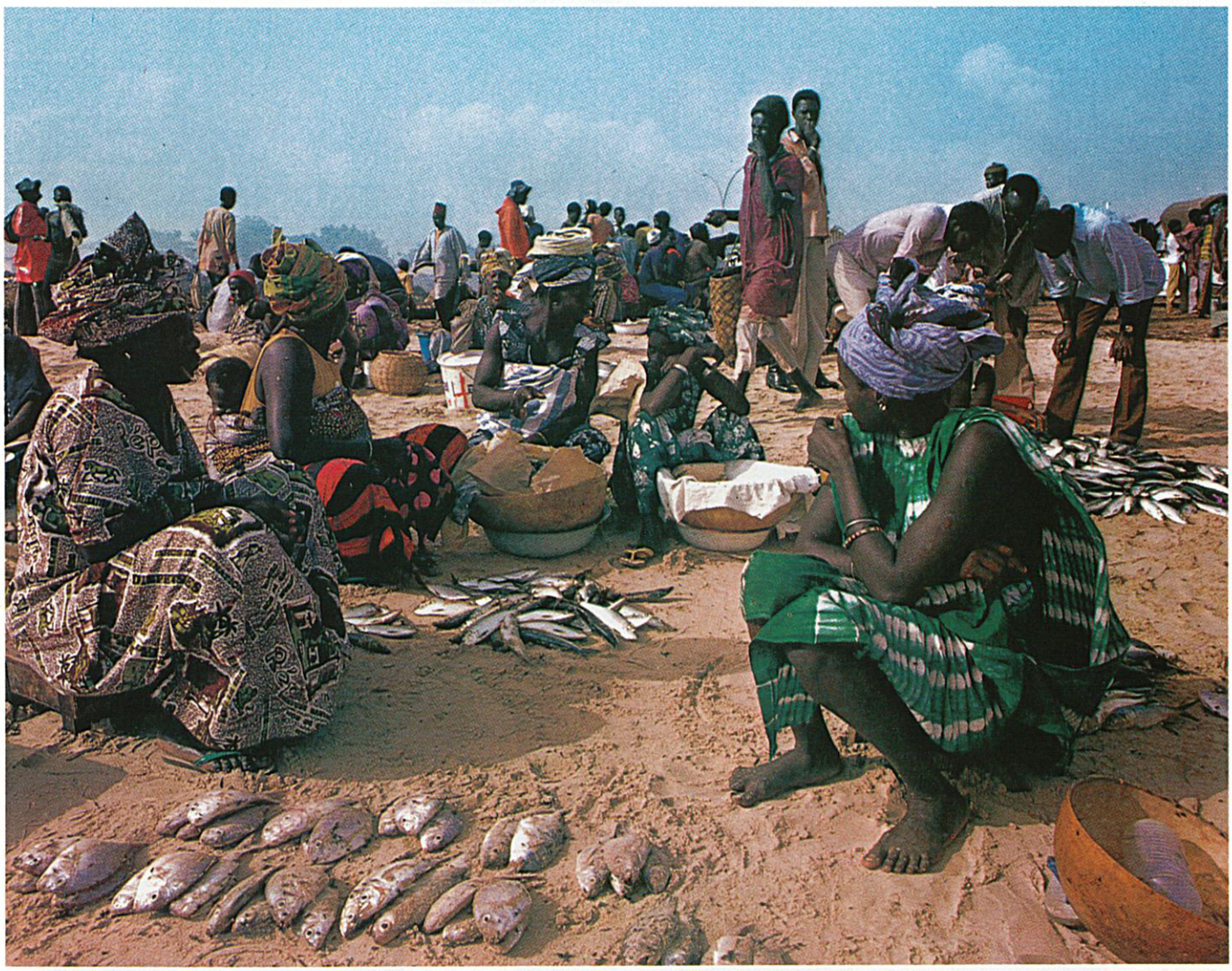
10. FD 35 mm f/3.5 SC
A budget-priced, compact lens of the most generally used wide-angle focal length. Angular coverage 63°.

preserve all the advantages of your reflex finder. All of them are of the retrofocus type, leaving enough room for the reflex mirror, although theoretically their rear lens should be located right in front of the film plane.

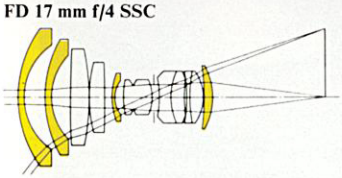
Wide and super-wide-angle lenses have only recently caught the fancy of a large public. A growing number of amateurs are becoming aware of the special impact of the "steep" perspective created by a lens of wide angular coverage. Super-wide-angle lenses give an impression of depth, space and grandeur.

Moderately short focal lengths of 28 mm and 35 mm, in turn, are indispensable for many ordinary shooting situations in cramped quarters. And they are great for dynamic shots, news coverage and similar assignments. Quite a few pros tend to use 35 mm lenses as standard. Here again, the high lens speeds which Canon offers in this category, too, are an invaluable asset.

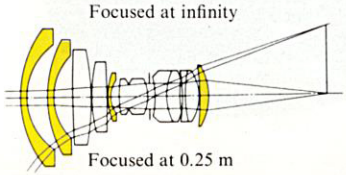
Five of the Canon super-wide and wide-angle lenses incorporate a floating-element design to keep the outstanding performance of these complex systems constant through their entire focusing range: the FD 17 mm f/4 SSC, FD 20 mm f/2.8 SSC, FD 24 mm f/2.8 SSC, FD 28 mm f/2 SSC and FD 35 mm f/2 SSC. Other lenses featuring floating elements are the three aspherical systems: FD 24 mm f/1.4 SSC AL, FD 55 mm f/1.2 SSC AL and FD 85 mm f/1.2 SSC AL (for these, see the following pages).



FD 17 mm f/4 SSC



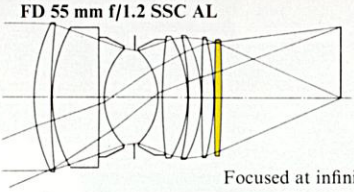
Focused at infinity



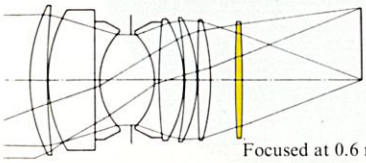
Focused at 0.25 m

Floating System
Photographic lenses are generally corrected for infinity to suit their normal use. If they are focused at shorter distances, residual aberrations increase and tend to impair performance, above all in high-speed wide-angle lenses. In order to keep the performance of these lenses constant over their entire focusing range, Canon developed its Floating System in which certain air spaces between lens elements are automatically varied during focusing.

FD 55 mm f/1.2 SSC AL



Focused at infinity



Focused at 0.6 m

Standard and aspheric lenses

Lenses with a focal length around 50 mm are generally considered as "standard" in 35 mm cameras. At this moderate focal length, relatively high speed can be obtained at reasonable expense so that modern standard lenses offer a fairly wide speed margin. And since they are normally supplied with the camera as basic equipment, they are made in large numbers and thus can be sold at attractive prices for the high performance they offer.

Canon has three different standard lenses to cater for any need and any budget: with speeds of f/1.8, f/1.4 and f/1.2, the latter even in two different versions – as a conventional spherical system and as an aspheric lens with one nonspherical surface. Why? Well, an optical law says that higher speed calls for larger lens diameters. And also by the laws of optics, the marginal rays

13. FD 50 mm f/1.8 SC
A modestly priced standard lens of particularly compact design and light weight. Six-element high-performance system.

14. FD 50 mm f/1.4 SSC
The most popular standard lens in the FD Series, equallyoutstanding for its high performance and high speed.

15. FD 55 mm f/1.2 SSC
An ultra-fast spherical lens. Versatile for all-round shooting, especially suited for available-light photography.

16. FD 55 mm f/1.2 SSC AL
Canon's aspheric standard lens for top performance at top speed. With Floating System.

18. FD 85 mm f/1.2 SSC AL
Unique speed at 85 mm. One aspheric surface guarantees optimum performance even at full aperture. With floating elements for consistently high correction down to 1 m.

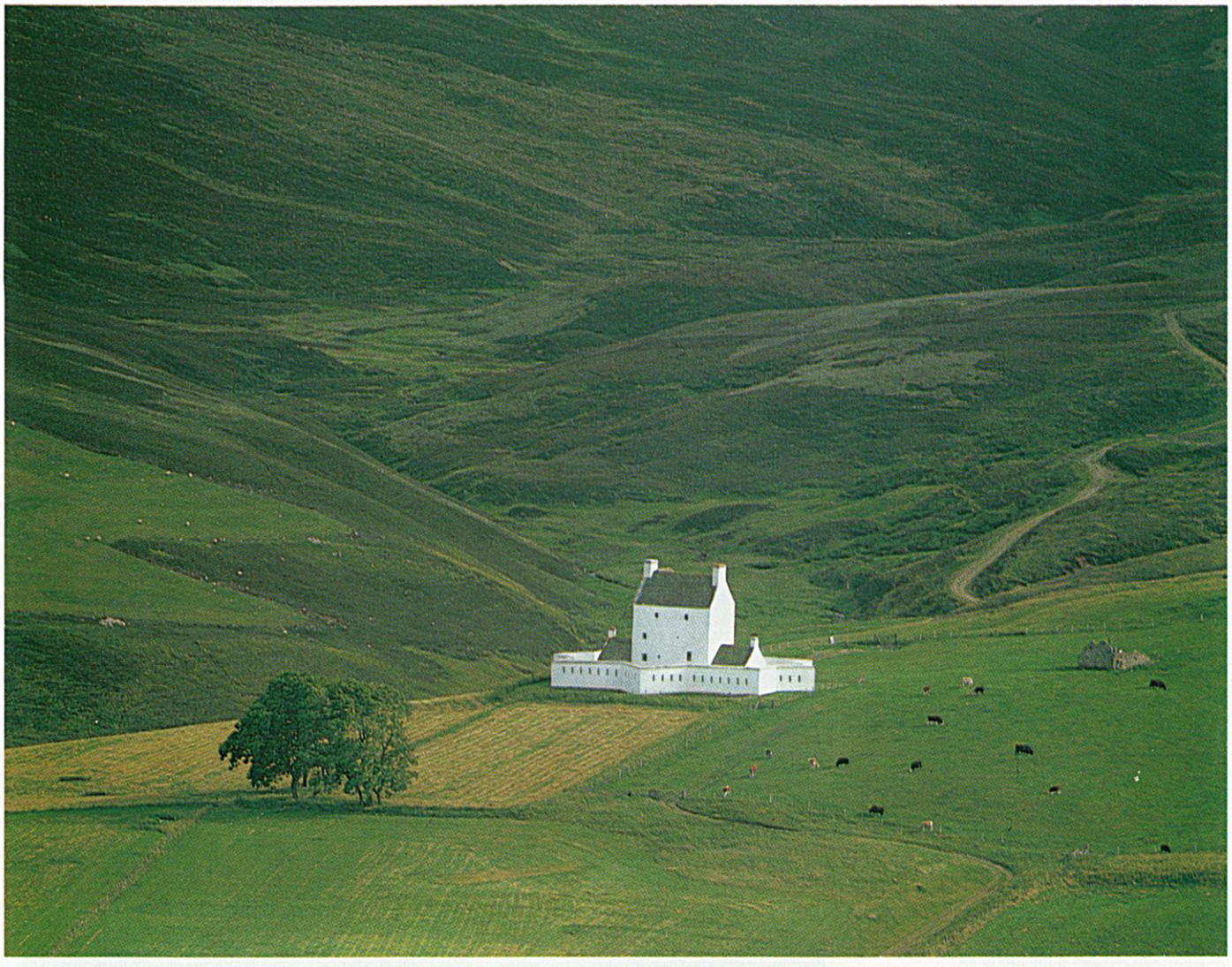
6. FD 24 mm f/1.4 SSC AL
Aspheric super-wide-angle lens (84°) of unique speed. With Floating System. Shortest focusing distance 0.3 m.

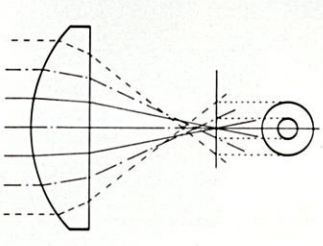
33. FD 24–35 mm f/3.5 SSC AL
The world's first aspheric zoom lens covering the range from ultra-wide-angle to wide-angle, its performance being equivalent to that of fixed-focal-length retro-focus lenses. The pro's darling.

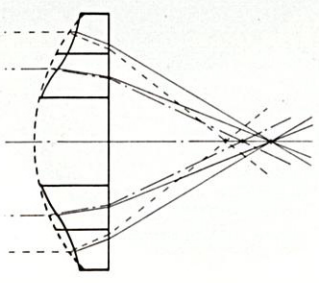
refracted by the outer portions of a lens tend to intersect at an ever greater distance from the paraxial rays as the lens diameter increases. For practical purposes this means that a loss of sharpness and contrast is unavoidable at full aperture.

To cope with this problem, optical designers came up with the idea of introducing lens elements with a nonspherical curvature in their marginal areas so as to obtain a precise intersection of all rays in the image plane. For a long time, however, such "aspheric" surfaces could not be produced mechanically. Until Canon started an extensive research program and eventually found a solution. As a result, Canon today is in the enviable position of offering mass-produced aspheric lenses at prices that are considerably more attractive than if every single piece had to be hand-figured.

Apart from the aspheric standard lens mentioned before, the Canon FD line includes two other nonspherical lenses, each of which is unique for its unprecedented speed: the super-wide-angle FD 24 mm f/1.4 SSC AL and the FD 85 mm f/1.2 SSC AL, the latter of which finally answers the prayers of photographers who prefer a slightly longer than standard focal length. With their extremely wide initial aperture, these lenses not only make possible what was previously impossible but, above all, offer a level of full-aperture performance hitherto considered as unattainable.







The secret of aspherics
Due to its radius of curvature, a lens forms a real image in a certain plane. In the ideal case, all the rays incident over a certain diameter should intersect in a perfect plane for all the object points reproduced. Unfortunately, their practical behavior falls far short of this. The larger the lens diameter required to achieve higher speed, the less satisfactory is the intersection of rays. The marginal rays intersect at an ever greater distance from the paraxial rays and thus produce an additional, much larger and blurred image of the corresponding object point. However, if the spherical curvature of the lens is preserved only in its central part and varied over the marginal areas, the marginal rays can likewise be directed into precisely the plane in which the paraxial rays meet. The resulting lens surface is "aspheric". Very regrettably, nonspherical surfaces are extremely difficult to generate in practice. Only recently has it become possible to produce aspheric surfaces mechanically by a mass-production technique specially developed by Canon.

Telephoto and super-telephoto lenses

Today we are enjoying a remarkable degree of optical freedom. We are able to approach out subject almost without effort, without actually having to move up to it. And to be sure, holding a camera right under someone's nose is not always such an agreeable thing to do, nor would all our subjects be particularly enthusiastic about it. So why not use a much simpler and more rewarding approach: a long-focus lens of which there are roughly a dozen in the FD Series – not even counting special-purpose lenses. There is a choice of lenses between 85 mm and 800 mm that are suitable for full-aperture metering and AE control. If you don't mind metering the light with the lens stopped down, there is also an FL 1200 mm. And, of course, you can always order a 5200 mm lens!

17. FD 85 mm f/1.8 SSC
A semi-telephoto lens of outstanding performance and high speed, ideal for universal use.

20. FD 100 mm f/2.8 SSC
A small telephoto lens of exceptionally compact design: it is only 57 mm long.

21. FD 135 mm f/3.5 SC
The popular version of the most widely used tele focal length, well-known for its high resolution.

22. FD 135 mm f/2.5 SC
The Canon telephoto lens of highest speed, and the first lens with a built-in hood. Excellent correction.

23. FD 200 mm f/4 SSC
An extremely popular version of a 200 mm telephoto. High performance at a moderate price.

24. FD 200 mm f/2.8 SSC
Very fast telephoto, ideal for candid work. Focusing down to 1.8 m! Extremely small and light.

25. FD 300 mm f/5.6 SSC
The overall length of this light-weight telephoto lens is only 198.3 mm. It is the first in the focal-length series to be equipped with internal focusing.

28. FD 400 mm f/4.5 SSC
The world's first telephoto lens with internal focusing: constant length in spite of focusing motion, constant center of gravity. Very high speed for a 400 mm telephoto lens.

30. FD 600 mm f/4.5 SSC
A super-telephoto lens of extremely high speed, incorporating the latest optical advances, including internal focusing. Special heat-reflecting finish to reduce lens temperature when working in the sun.

31. FD 800 mm f/5.6 SSC
Likewise a new addition to the FD Series, this super-telephoto lens sets new standards in its focal-length group. Internal focusing and heat-reflecting finish.

32. FL 1200 mm f/11 SSC
This is the Canon super-telephoto lens with the longest focal length available from stock.

Long-focus lenses tend to isolate, compress, concentrate. They pick an impressive detail which, properly presented, will speak a much clearer language than a whole bagful.
Hence they probably come closest to the essence of pictorial photography: capturing a representative part of the whole. Then there is their quality of ever more selective focus: as focal length increases, depth of field becomes shallower and the potential for selective focusing ever greater. Your subject stands out against a blurred background with an almost three-dimensional quality. In fact, distracting background detail can be eliminated almost completely. Small wonder then that professional photographers prefer long-focus lenses. Up to 300 or 400 mm they are excellent for portraiture or hand-held candid shots; in short, for anything connected with people and their environment. Only beyond this limit do we enter the field of "long-distance photography" proper.

The latest achievement of Canon in the construction of long-focus lenses is internal focusing that was used for the first time in the FD 400 mm f/4.5 SSC and is now also incorporated in the FD 300 mm f/5.6 SSC, FD 600 mm f/4.5 SSC and FD 800 mm f/5.6 SSC. Focusing is here acieved by relatively slight axial motion of the rear component, without changing the overall mechanical length of the lens in the least. Thus there is no bulky lens extension, the center of gravity does not shift during focusing, and the pitch of the focusing cam can be reduced at the longer distances, giving higher focusing accuracy in that range.

Fluorite lenses

Normal photographic lenses are usually corrected for two wavelengths in the visible region of the spectrum: blue and yellow. Without this so-called achromatic correction, the blue and yellow rays from one and the same object point would intersect in different planes – and form a blurred image. But even so, the other wavelengths in the spectrum, which we see as colors, still fail to intersect all in one plane. This residual error is called the secondary spectrum. In general-purpose photographic lenses this is not normally found disturbing. However, there are cases where chromatic correction has to be carried one step further: process lenses, for instance, are corrected for a third color – red. These "apochromatic" lenses are widely used in the graphic arts.

26. FD-F 300 mm f/2.8 SSC
With its fantastic speed of f/2.8 and genuine "fluorite performance", this lens is a crowning achievement in the 300 mm category. It includes one element of calcium fluoride and is supplied with a specially adapted 2 × extender which converts it into an FD 600 mm f/5.6 SSC suitable for full-aperture metering and AE control. As the term "specially adapted" suggests, the 2 × extender forms part of the optical formula of the lens and thus maintains its exceptionally high performance standard even at 600 mm.

27. FL-F 300 mm f/5.6
A fluorite lens of "normal" speed for the perfectionist. Like all Canon fluorite lenses, it has a built-in hood and a rotatable tripod-mounting ring.

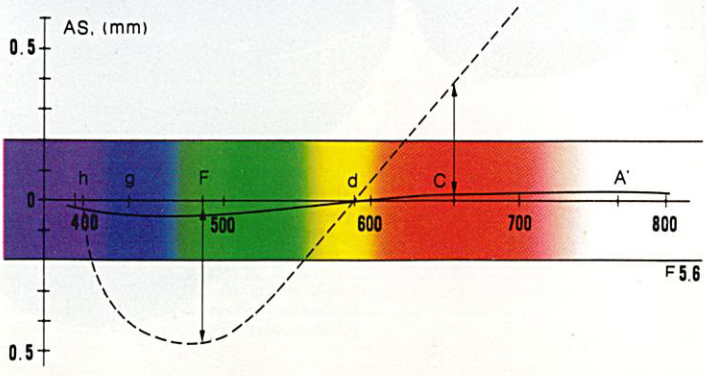
29. FL-F 500 mm f/5.6
This is the Canon fluorite lens with the longest focal length. It is entirely in a class of its own among super-telephoto lenses. With an overall length of only 300 mm, its design is extremely compact.

Although their secondary spectrum has been greatly reduced, there is a limit to what can be done with optical glass alone.

There is one nasty little catch about the secondary spectrum: it increases as a function of focal length. In other words, the deeper we get into the telephoto range, the deeper we get into trouble. That is why Canon engineers tried to break the deadlock by substituting at least one or two elements of a telephoto system by some other material than optical glass. After years of research, they settled on an artificial crystal called calcium fluoride, a material that promised to work optical miracles – if only it were available in sufficient size, purity and quantity! After extensive research, Canon finally devised a method of "growing" artificial calcium fluoride crystals that were pure and large enough to be ground into lens elements. Canon fluorite lenses had been born.

The FL-F 300 mm f/5.6 and the FL-F 500 mm f/5.6 were the first "out-of-this-world" telephotos introduced by Canon in 1969. The practically complete elimination of the secondary spectrum achieved in these lenses left professional photographers speechless. Another "optical sound barrier" had been broken, another "first" added to Canon's impressive line of optical credentials.

Meanwhile a special high-speed version has been added to this unique series: the FD-F 300 mm f/2.8 SSC.



The diagram opposite illustrates the near-perfect correction of the secondary spectrum in Canon's FL-F 300 mm f/5.6, as compared with a lens of normal correction. On the ordinate we have the color shift in millimeters. The shaded area marks the depth of field at f/5.6, the maximum aperture of the lens. On the abscissa we have the wavelengths of light in nanometers (nm), the letters h, g, F, d, C and A' denoting Fraunhofer absorption lines. The solid line staying very close to zero gives the residual color error of the fluorite lens, which remains well within the depth of field. In other words, the tiny residual error is fully absorbed by the depth of field, whereas the error of a normal lens (broken line) indicates very noticeable deviations at certain wavelengths in the visible region.

Zoom lenses

Not so long ago, it was taken for granted that a lens allowing continuous variation of focal length over a certain range – a so-called zoom lens – could not possibly have the same high performance as separate lenses of fixed focal length. And that seemed only natural because zoom lenses are pretty complex optical systems composed of many more elements than most ordinary photographic lenses.

Well, the picture has changed, at least as far as Canon's zoom lenses in the FD Series are concerned. Optical progress and new design principles have resulted in FD zoom lenses of truly outstanding performance at any focal length – even in the wide-angle range which at first seemed almost inaccessible to zoom systems.

By now, there is practically continuous zoom coverage for your Canon SLR from a mere 28 mm right up to 300 mm. Photographers favoring short focal lengths will find the answer to their prayers in the FD 28 – 50 mm f/3.5 SSC which, incidentally, is based on Canon's new two-group design principle explained below in greater detail. The FD 35 – 70 mm f/2.8–3.5 SSC, likewise a two-group design, is another compact zoom giving you tremendous freedom of motion around the normal focal length – from the most widely used wide-angle focal length up to practically semi-telephoto, to be exact.

On the telephoto side, you have a choice of three Canon zooms: the FD 80–200 mm f/4 SSC as a compact, general-purpose telephoto lens of relatively high speed and superb resolution, contrast and color rendition; the FD 100–200 mm f/5.6 SC as a moderately priced telephoto zoom intended primarily for the amateur who will contend himself with somewhat lesser speed; and the FD 85–300 mm f/4.5 SSC as a very fast "big gun" designed above all for shooting from a tripod.

Each of these zoom lenses actually replaces an entire set of ordinary lenses of fixed focal length. Take the FD 80–200 mm, for example, which not only can give you the same coverage as an FD 85 mm, 100 mm, 135 mm and 200 mm but all the intermediate settings to which there is just one answer: a zoom system. Composing your picture and filling your frame has never been easier.

In the past, zoom lenses were generally composed of four groups of lens elements. A typical point in case is the FD 85–300 mm f/4.5 SSC, shown set to 300 mm in diagram (A) and to 85 mm in (B). While this design principle is entirely adequate for longer focal lengths, it would make wide-angle zoom lenses unproportionately heavy, bulky and complex. Canon therefore perfected a design principle which relies on only two groups of components that are shifted in relation to each other as focal length is varied. As an example, diagram (C) shows the FD 35 –70 mm f/2.8–3.5 SSC in its 70 mm setting, diagram (D) in the 35 mm setting. The two-group principle allows a much more compact retrofocus construction and higher optical correction. It will be noted that in this case the diaphragm is shifted together with the rear group.

33. FD 24–35 mm f/3.5 SSC AL
The world's first aspheric zoom lens covering the range from ultra-wide-angle to wide-angle, its performance being equivalent to that of fixed-focal-length retro-focus lenses. The pro's darling.

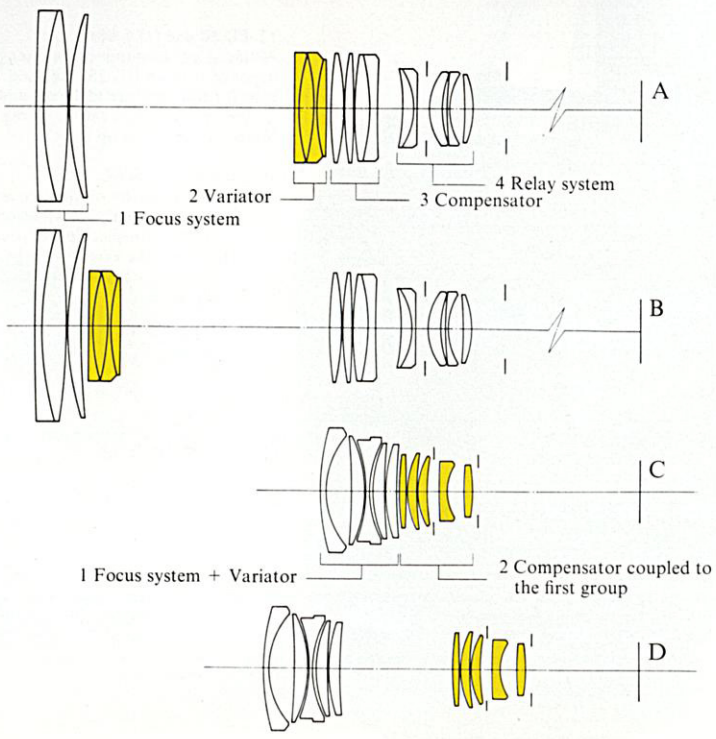
34. FD 28–50 mm f/3.5 SSC
This high-performance zoom lens covers everything from a dynamic 75 wide-angle up to standard focal length. Close-up focusing is possible down to 0.25 cm. An ideal lens for photographers with wide-angle leanings.

35. FD 35–70 mm f/2.8–3.5 SSC
A universal zoom lens covering the most widely used focal lengths from moderate wide-angle to roughly semi-telephoto, with close focusing down to 0.3 m.

36. FD 80–200 mm f/4 SSC
A high-speed "universal telephoto" which focuses right down to 1 m even when set to 200 mm! It thus opens up entirely new perspectives for close-up photography.

37. FD 85–300 mm f/4.5 SSC
With a zoom ratio exceeding 1:3.5 and relatively high speed, this zoom lens may already be counted among the supertelephoto lenses.

38. FD 100–200 mm f/5.6 SC
A budget-priced telephoto zoom lens of particularly slim design. It covers the focal-length range within which most telephoto shots are taken.



Macro lenses
Tilt and shift lens

To start with, you should not take the term "macro lens" too literally because it gives a rather one-sided picture of this very interesting type of lens. To be sure, it is an avowed purpose of these lenses to offer maximum optical performance even in the close-up and macro ranges for which our photographic lenses are not normally corrected. On the contrary, ordinary photographic lenses have been corrected for infinity, they do not have a long-enough focusing mechanism to allow close shots up to a reproduction ratio of at least 1:2, and they are mainly designed for high speed and thus remain a compromise. While this compromise is more than enough for the purposes of pictorial photography, it does begin to show its limits as soon as we enter the sphere of extreme close-ups and try to copy documents or

12. FD 50 mm f/3.5 SSC
A macro lens of standard focal length, supplied with an FD 25 extension tube for full-aperture metering and automatic aperture control, giving reproduction ratios up to 1:1.

19. FD 100 mm f/4 SC
A long-focus version of a macro lens, likewise supplied with an extension tube – FD 50 – for pictures up to life size. Here also, the extension tube preserves all the FD characteristics of the basic lens.

Why two macro lenses?
The answer is very simple: because even close-up shooting may mean different things. Thus the FD 50 mm f/3.5 SSC is ideal for normal macro-photography, copy work and duplicating slides. Moreover, it is an excellent "standard" lens wherever high speed is not absolutely necessary.

The FD 100 mm f/4 SC, on the other hand, is not only a great telephoto lens of outstanding performance but also ideal for macro shots of insects and other elusive small animals, for example, in which the greater working distance provided by the longer focal length is a decisive advantage.
In addition, the longer working distance facilitates the use of artificial light sources.

similar originals, to name just one example. It is here where the macro lens comes fully into its own because it is a "no-compromise lens". At the expense of high speed, it is designed for unusually high resolution, perfect field flattening and uniform correction right up to extremely short camera-to-subject distances. Moreover, its ordinary focusing mount goes up to 1:2, and with a special extension tube it will even take life-size pictures.

All these advantages of a macro lens, however, suggest quite a different additional use: as long as speed is of no great importance, a macro lens is the best "standard" lens you could desire. The fact that in the Canon FD Series this type of high-performance lens is also available in the telephoto range in the form of the FD 100 mm f/4 SC makes this proposition all the more attractive.

Speaking of lenses distinguished by special design features, there is another species in the Canon line that is unique in the 35 mm SLR field: a lens that cannot only be shifted at right angles to the optical axis but also offers a swing movement much like the front of a large-format camera. This TS 35 mm f/2.8 SSC was primarily developed for architectural and industrial photography where the elimination of converging verticals is absolutely essential. But apart from this it also allows depth-of-field control by the Scheimpflug rule, providing almost incredible depth of field without stopping down. This feature is in high demand, among other things, in industrial photography because more often than not this is the only way to sharply reproduce an extensive object that is not parallel to the film plane.

11. TS 35 mm f/2.8 SSC
A special-purpose wide-angle lens with swing and cross movements, primarily designed for architectural and industrial photography. For stop-down metering and manual aperture control. Swing range ± 8°, cross movement ± 11 mm.

Finger-tip control of perspective
Very extensive objects cannot normally be photographed with an SLR camera without a very marked and disturbing convergence of lines, be they vertical or horizontal. High buildings seem to topple over, or they are simply cut off. Although this perspective is natural, it may ruin a picture. The only way out here is to decenter the optical system, such as is possible in the TS 35 mm f/2.8 SSC. Utilizing the cross movement, it is possible to photograph even high – or wide – buildings without converging lines and without wasting half the frame.

The swing movement additionally provided in the TS eliminates the parallel alignment of focusing and film planes. In practical terms this means that the plane of best focus can be made to coincide with a subject viewed at an angle, without having to stop down the lens. It is thus possible to extend the depth of field to a degree that could never be obtained by stopping down alone.

Tangible progress – Canon FD lenses

When the first FD lenses were introduced together with the Canon F-1, a new era began to dawn for Canon fans everywhere: the era of full-aperture TTL metering and the latest optical advances put into practice in the form of a lens series designed to satisfy even the most exacting professional. By now, this lens series has grown into a powerful optical arsenal that is the common basis of all the cameras in the Canon Reflex System: The F-1, EF, AE-1, AT-1 and FTb.

A closer study of the FD Series clearly reveals the tangible progress made in optical design and manufacturing techniques during the past decade. New glass types of high refractive index laid the basis for entirely new design concepts. Aided by their

Technical data of Canon SLR lenses

(FD lenses for full-aperture metering and AE control, FL lenses for stop-down metering)

Item No.	Designation	Type	Angle of view	Elements/ compo-nents	Min. aper-ture	Min. focusing distance (m)	Filter diameter (mm)	Hood	Length (mm)	Weight (g)
1	7.5 mm f/5.6 SSC	Circular fish-eye	180°	11/8	22	fixed focus	6 built-in	–	62	380
2	FD 15 mm f/2.8 SSC	Full-frame fish-eye	180°	10/9	16	0.3	4 built-in	***	60.5	485
3	FD 17 mm f/4 SSC	Super-wide-angle	104°	11/9	22	0.25	72	–	56	450
4	FD 20 mm f/2.8 SSC	Super-wide-angle	94°	10/9	22	0.25	72	–	58	345
5	FD 24 mm f/2.8 SSC	Super-wide-angle	84°	9/8	16	0.3	55	BW-55B	52.5	330
6	FD 24 mm f/1.4 SSC AL	Super-wide-angle ASPHERICAL	84°	10/8	16	0.3	72	–	68	500
7	FD 28 mm f/2.8 SC	Wide-angle lens	75°	7/7	22	0.3	55	BW-55B	49	230
8	FD 28 mm f/2 SSC	Wide-angle lens	75°	9/8	22	0.3	55	BW-55B	61	343
9	FD 35 mm f/2 SSC	Wide-angle lens	63°	9/8	22	0.3	55	BW-55A	60	345
10	FD 35 mm f/3.5 SC	Wide-angle lens	63°	5/5	22	0.4	55	BW-55A	46.8	205
11	TS 35 mm f/2.8 SSC	Wide-angle with swing and cross movements	63°/79°	9/8	22	0.3	58	BW-58B	74.5	550
12	FD 50 mm f/3.5 SSC*	Macro lens	46°	6/4	22	0.21	55	–	59.5	310
13	FD 50 mm f/1.8 SC	Standard lens	46°	6/4	16	0.6	55	BS-55	38.5	200
14	FD 50 mm f/1.4 SSC	Standard lens	46°	7/6	16	0.45	55	BS-55	49	305
15	FD 55 mm f/1.2 SSC	Standard lens	43°	7/5	16	0.6	58	BS-58	52.5	510
16	FD 55 mm f/1.2 SSC AL	Standard lens ASPHERICAL	43°	8/6	16	0.6	58	BS-58	55	575
17	FD 85 mm f/1.8 SSC	Semi-telephoto	28.3°	6/4	16	0.9	55	BT-55	57	425
18	FD 85 mm f/1.2 SSC AL	Semi-telephoto ASPHERICAL	28.3°	8/6	16	1.0	72	–	71	756
19	FD 100 mm f/4 SC**	Macro lens	24°	5/3	32	0.4	55	BT-55	112	530
20	FD 100 mm f/2.8 SSC	Telephoto lens	24°	5/5	22	1.0	55	BT-55	57	360
21	FD 135 mm f/3.5 SC	Telephoto lens	18°	4/4	22	1.5	55	BT-55	85	430
22	FD 135 mm f/2.5 SC	Telephoto lens	18°	6/5	22	1.5	58	***	91	630
23	FD 200 mm f/4 SSC	Telephoto lens	12°	6/5	22	2.5	55	***	133	675
24	FD 200 mm f/2.8 SSC	Telephoto lens	12°	5/5	22	1.8	72	***	140.5	700
25	FD 300 mm f/5.6 SSC	Telephoto lens	8.15°	6/5	22	3.0	55	***	198	685
26	FD-F 300 mm f/2.8 SSC	Fluorite telephoto	8.15°	6/5	22	3.5	excl.	***	230	1,900
27	FL-F 300 mm f/5.6	Fluorite telephoto	8.15°	7/6	22	4.0	58	***	168	850
28	FD 400 mm f/4.5 SSC	Super-telephoto	6.1°	6/5	22	4.0	excl.	***	282	1,300
29	FL-F 500 mm f/5.6	Fluorite super-telephoto	5°	6/5	22	10.0	95	***	300	2,700
30	FD 600 mm f/4.5 SSC	Super-telephoto	4.1°	6/5	22	8.0	48 a)	***	455	4,300
31	FD 800 mm f/5.6 SSC	Super-telephoto	3.1°	6/5	22	14.0	48 a)	***	567	4,300
32	FL 1200 mm f/11 SSC	Super-telephoto	2.1°	7/5 b)	64	40.0	48 a)	***	853	6,200
33	FD 24–35 mm f/3.5 SSC AL	Zoom lens	84°–63°	12/9	22	0.4	72	excl.	86.3	515
34	FD 28–50 mm f/3.5 SSC	Zoom lens	75°–46°	10/9	22	1.0 c)	58	W-69B	105	470
35	FD 35–70 mm f/2.8–3.5 SSC	Zoom lens	63°–34°	10/10	22	1.0 c)	58	W-69	120	575
36	FD 80–200 mm f/4 SSC	Zoom lens	30°–12°	15/11	22	1.0	55	***	161	750
37	FD 85–300 mm f/4.5 SSC	Zoom lens	29°–8°	15/11	22	2.5	Series IX	***	243.5	1,695
38	FD 100–200 mm f/5.6 SC	Zoom lens	24°–12°	8/5	22	2.5	55	***	173	765

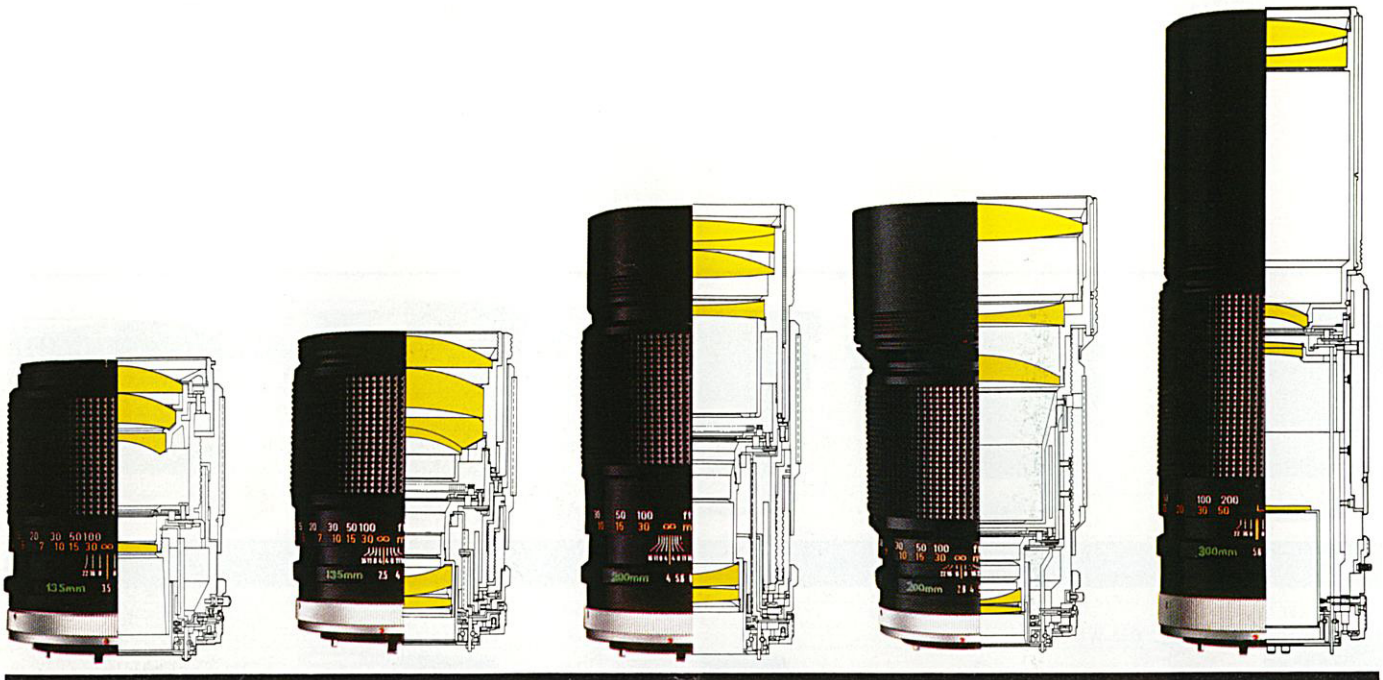
* With extension tube FD 25 ** With extension tube FD 50 *** Built-in lens hood
a) Filter of insertion type with holder b) Including elements in focusing unit c) With close-focusing capability

own, meticulously drafted computer programs, Canon engineers started exploring new solutions, continually improving the performance, speed and compactness of their designs along the way. New laser and computer-supported testing techniques were instrumental in reaching an ever higher degree of optical and mechanical precision. More recently, automation was given top priority, with the result that by now many of the operations required to make the most popular FD lenses are performed either automatically or with only a minimum of human interference. These innovations have enabled Canon to stay one step ahead of rising costs that can only be offset by more rational production.

Tangible proof of progress are the savings in size and weight that Canon has been able to make in its new FD lenses. Take long focal lengths, for example. The FD 200 mm f/2.8 SSC was the first telephoto lens in which Canon drastically reduced the diameter of the lens elements right behind the front component. The same principle has since been used in all new lenses in this category, adding immeasurably to the handling ease of these long-focus systems. In the new FD lenses of 300 mm and up, moreover, Canon has incorporated another new design principle which it was the first to introduce in the market: internal focusing. Instead of moving the entire optical system forward for focusing on subjects closer than infinity, as is normal practice, the focusing

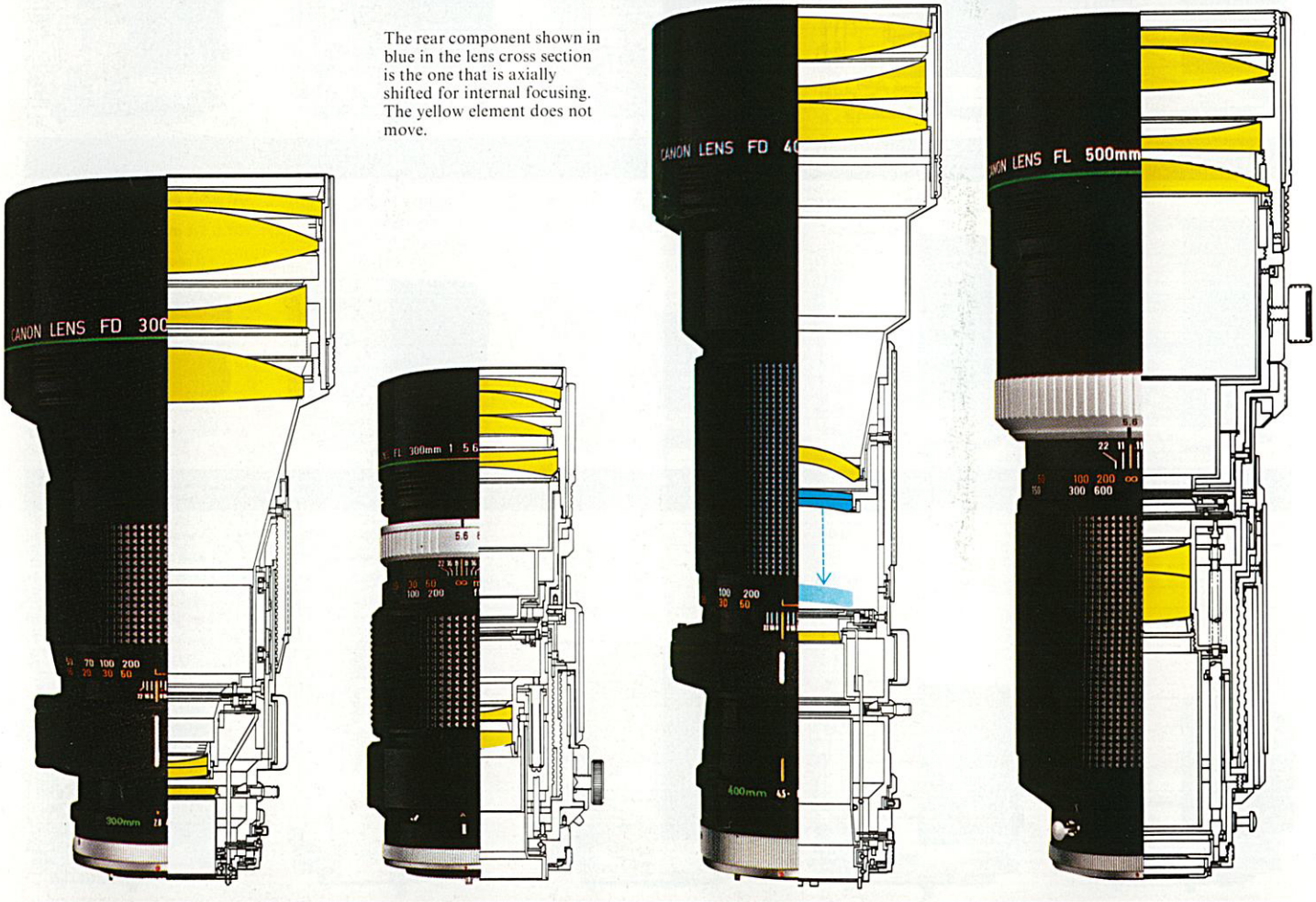
ring of the new Canon FD lenses of 300 mm, 400 mm, 600 mm and 800 mm only acts on the relatively small rear component of the system. In other words, there is absolutely no change in mechanical length as the lens is focused. And if you have ever handled a lens of that focal length, you will appreciate what this means in terms of stability. Instead of becoming top-heavy, the lens-camera unit remains perfectly stable, without any shift in its center of gravity. Moreover, the lenses can be designed for a much shorter minimum focusing distance than before, and the focusing motion can be made "non-linear". This means that at the longer distances focusing requires a slightly greater rotation of the focusing ring and thus is much smoother and more precise than would be possible with a normal helicoidal mount.

Filters in these long-focus lenses of such unusually high speed would have to be very big if they had to be attached to the front lens. This is why Canon has given them a place right inside the lens tube, behind the rear component. At this point in the light path, the filters can be very small. Changing them with their slide-in mounts is a matter of seconds. And that's just about as long as a change of filters should take in a truly advanced long-focus lens.



21 22 23 24 25

The rear component shown in blue in the lens cross section is the one that is axially shifted for internal focusing. The yellow element does not move.



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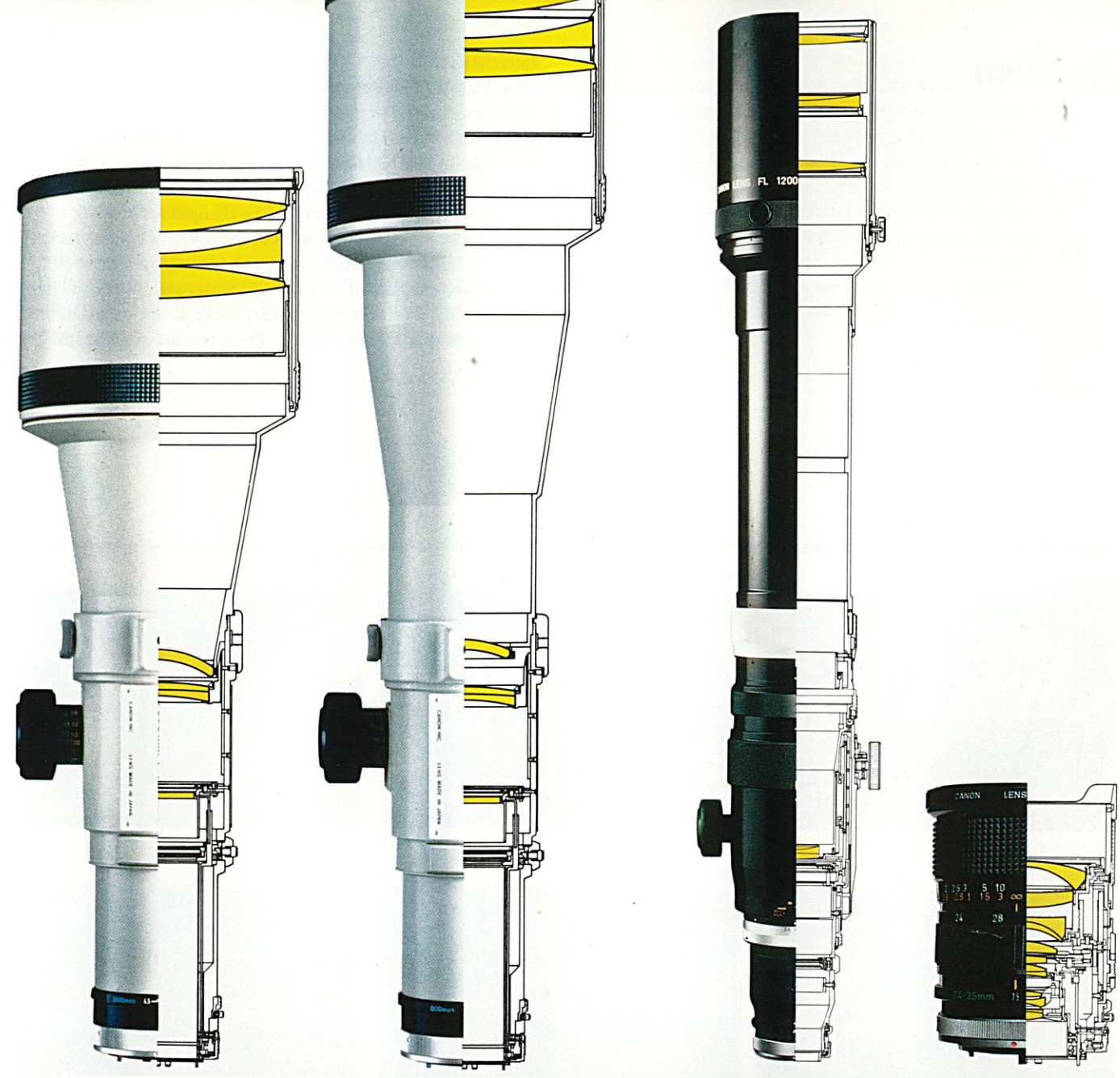

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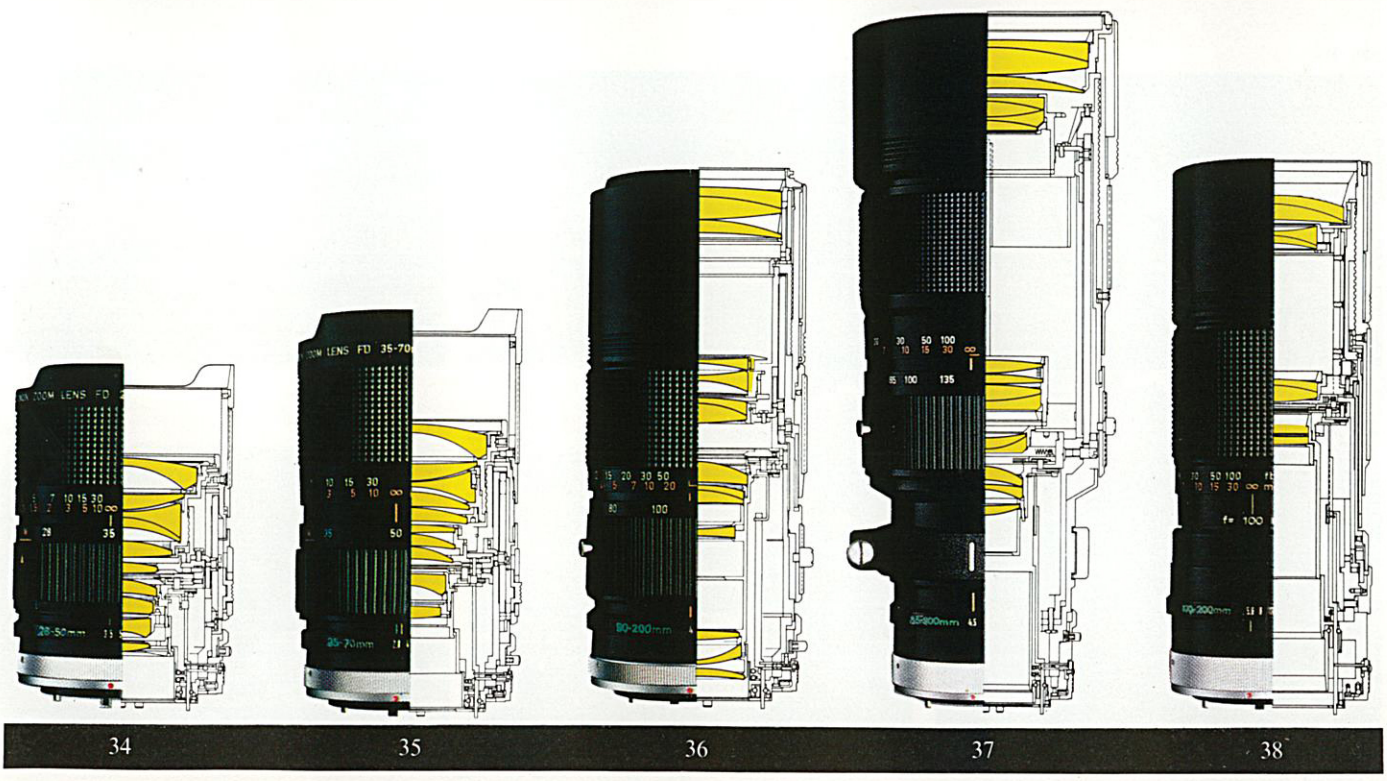
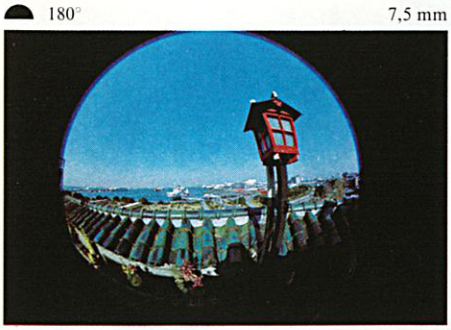


34 35 36 37 38

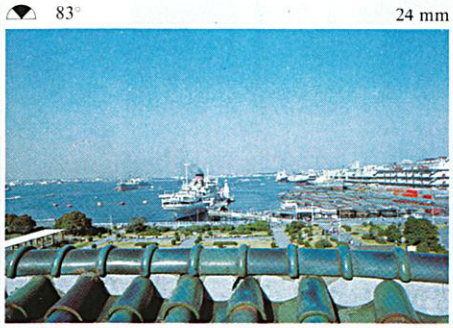
Freedom

Interchangeable lenses – that's freedom of expression, freedom of speaking your mind photographically, of conveying a message, making a point or simply capturing a subject with the most appropriate optical means. Freedom which in Canon SLR photography means just a twist of your hand, a turn of the sturdy bayonet ring of Canon's unique breech-lock mount. Within seconds, one lens can thus be changed for another – hundreds, thousands of times, as often as you may wish during the long life of your Canon camera and lenses. And there's no need to worry about wear. Canon lenses are not rotated in the camera body. Their precision seating faces do not rub against their counterparts in the camera. The lenses are inserted straight

180° 7,5 mm



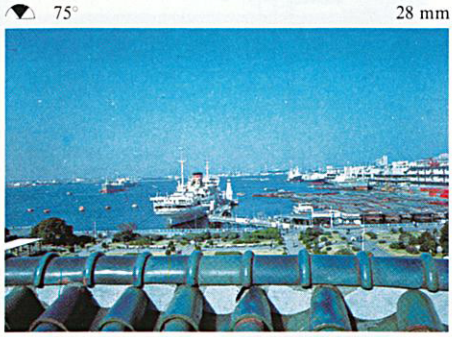
83° 24 mm



29° 85 mm

180° 15 mm

75° 28 mm



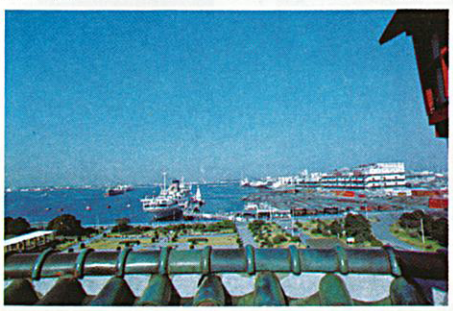
24° 100 mm

104° 17 mm

64° 35 mm

18° 135 mm

94° 20 mm



46° 50 mm

12° 200 mm

– in the position in which they are used. Turning a spring-loaded bayonet ring will do the trick of locking them safely on the camera. A design that gives you an additional degree of freedom – the freedom to vary your shooting and viewing angles as frequently as your imagination or requirements demand.

Since literally millions of Canon SLRs are in use all over the world, it is not surprising that independent lens makers have been trying to cash in on this market. And every once in a while you will find lenses of other manufacture being offered with a breech-lock mount to suit your Canon SLR. To put the record straight, it might be mentioned here that some of the meter and diaphragm-coupling elements have different functions in different types of Canon SLR. Since Canon is using automatic aperture control instead of the automatic shutter-speed control employed in a number of other advanced SLRs in the market, lens-mount specifications are of the utmost importance. Needless to say that Canon will fully guarantee only its own maximum-precision FD lenses for perfect operation with any of the Canon SLR cameras. As a matter of fact, this guarantee also covers all other lenses described in this brochure although, strictly speaking, they may not bear the "FD" label and thus be designed only for stop-down metering or manual aperture control, such as the FL types or the TS lens.

8,3° 300 mm

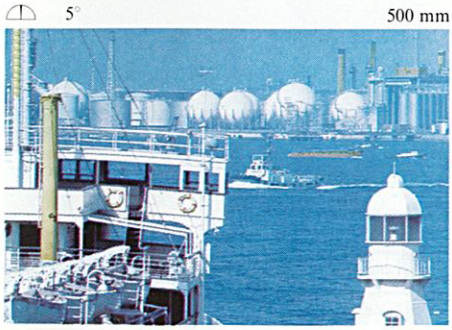
3,1° 800 mm

The comparative pictures on these pages illustrate the change in angle of view which different focal lengths give from one and the same point.
Also, they very nicely demonstrate the wide range of expression enjoyed by Canon SLR photographers.

6,2° 400 mm

2,1° 1200 mm

5° 500 mm



4,1° 600 mm

In this brochure we have been giving you the details of the impressive line of Canon interchangeable lenses. For complete information on the Canon SLRs for which these lenses were designed, please ask for our REFLEX Catalog. And if we may satisfy your curiosity about what else Canon has to offer, why not ask for our SUPER-8 and COMPACT Catalogs as well?

Canon filters and their uses

UV
Absorbs ultraviolet rays, preventing a blue cast in color photography and lack of focus in high-UV environment: at the beach, in high mountains, etc.

Y1
Light yellow filter. Darkens blue and lightens yellow. Improves sky rendition in black-and-white photography.

Y3
Standard yellow filter for better contrast in black-and-white photography.

G1
Light green filter for black-and-white. Holds back red, renders green lighter.

O1
Orange filter for even higher black-and-white contrast than with Y3. Very effective cloud rendition.

R1
Red filter for monochrome and infrared photography. Renders red practically white and blue sky almost black. Effectively cuts through haze.

Skylight
Slightly tinted (amber) filter for color photography, for warmer rendition of colors and suppression of blue haze.

CCA4-8-12
Conversion filters (amber) of different color density for lowering the color temperature. The type 12 filter will convert tungsten-type film for daylight shooting.

CCB4-8-12
Conversion filters (blue) of different color density for raising the color temperature. The type 12 filter will convert daylight film for shooting with artificial light.

ND4 and 8
Neutral-density gray filters reducing the intensity of incident light by two and three f-stops, respectively.

Filters for black-and-white photography

Diameter (mm)	55	58	72	95	Series IX
UV	•	•	•		•
Y1	•	•			
Y3	•	•	•	•	•
G1	•	•			
O1	•	•			
R1	•	•	•	•	•
ND4	•	•	•		•
ND8	•	•	•		•

Filters for color photography

Diameter (mm)	55	58	72	95	Series IX
Skylight	•	•	•	•	•
UV	•	•	•		•
CCA4	•	•	•		•
CCA8	•	•	•		•
CCA12	•	•	•	•	•
CCB4	•	•	•		•
CCB8	•	•	•		•
CCB12	•	•	•	•	•
ND4	•	•	•		•
ND8	•	•	•		•

Close-up lenses

Diameter (mm)	55	58	72	95	Series IX
240	•	•			
450	•	•			
1800	•				

Softmat lenses

Diameter (mm)	55	58	72	95	Series IX
No. 1	•	•			
No. 2	•	•			

We reserve the right to depart from catalog specifications.

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Printed in Switzerland by Weber SA, Bienne

English Edition ZC900.01.455.0378

Designed by Van Sambeek & Watano, Amsterdam (Shigeru Watano-GVN), productphotography Joost Guntenaar.