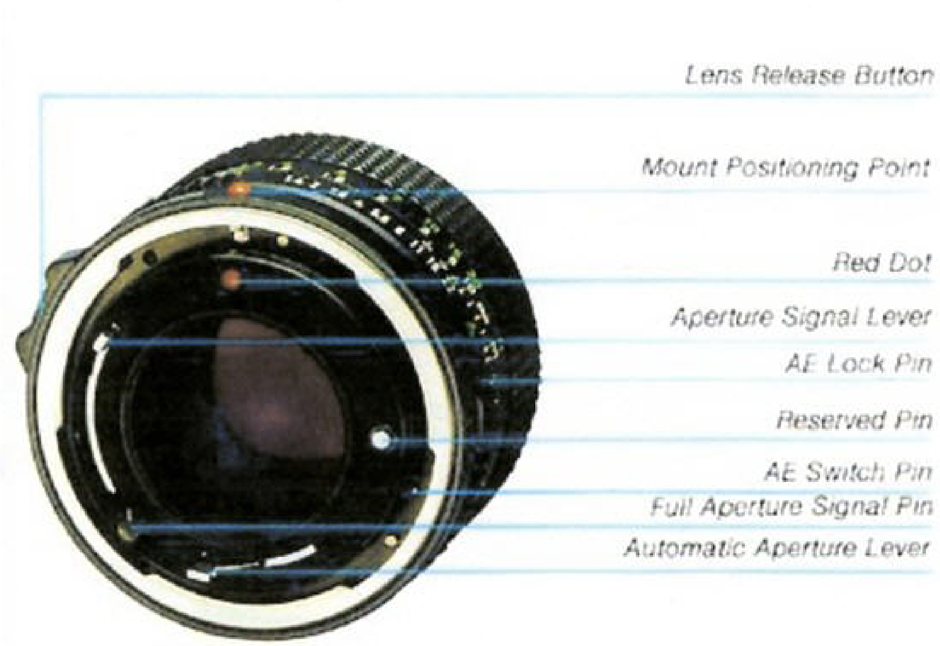
!! How do FD lenses work c̄ FD Camera's

Hi All,

There've been a few posts in the last week or two centering on how our FD lenses & bodies "communicate" with each other, so perhaps a chat on the mechanical aspects of lens & mount is timeous.

Firstly, I'm attaching a couple of pics - one of the back of an FD lens, which is labeled, and a couple of an F1N front. The eagle-eyed among you will immediately notice that the Body pics are reversed! This is so that they can be viewed & compared side by side - imagine you're looking at the lens mount from behind the camera.

First, let's look at the back of an FD lens:

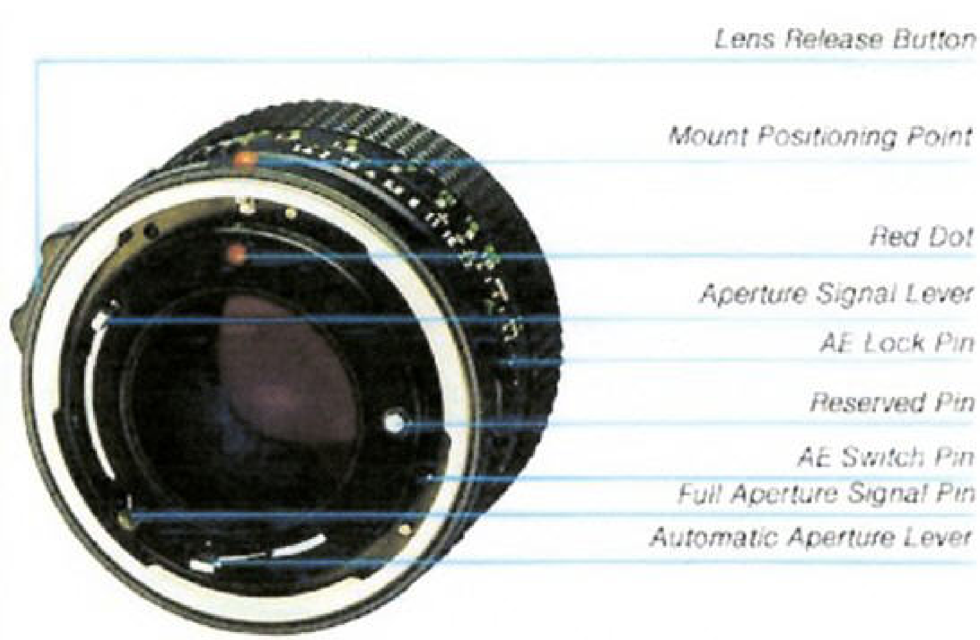


Moving around the lens you'll see an "Aperture Signal Lever". In the pic the Aperture Signal Lever is at the top of it's travel which is where it'll be with the lens set to it's widest. As the aperture ring is moved around to smaller apertures, the Lever will move down.

This Aperture Signal Lever actually sits on top of the matching lever in the body;

Continuing around anti-clockwise, at the "6 O'clock" position is the "Stop-Down-Lever" The lever in the body drives the lever in the lens across and this stops the aperture down from fully open to the value set on the aperture signal lever. When you press the shutter button, this is (almost always) the first thing that moves, and the last thing that returns at the end of the exposure (not that you'll notice given how fast it all happens).

Still with me? We're just coming to the interesting bit; the "A" setting, so here's the lens & body pics again to stop Y'All having to scroll up & down:



at the "10 O'clock" position. As the lens aperture ring is turned to smaller apertures, then the lever in the camera body is pushed downwards.

Now. Whether the lens has a maximum aperture of f1.2 or f5.6, the aperture signal lever is at the same position for full aperture and moves down (or back up) a set distance per aperture change. In effect it's signaling that the lens will transmit 1/2, 1/4, 1/8th, 1/16th, ... of the light it's presently transmitting once it's been stopped down for exposure.

If we look at the TTL meter in the camera, what it does is simply measure the brightness of the light coming through the lens and takes information about film speed and shutter speed. With a particular film & shutter speed set, the meter may for example calculate that the film needs 1/2 of the light it's getting at the moment - hence the lens should be closed by 1 stop, 1/4 of the light = 2 stops, 1/8th of the light = 3 stops, and so on... Making the appropriate indication in the meter readout.

Similarly, with a particular aperture set at 1 stop, 2 stops 3 stops, etc... below the lens maximum, the meter will be told that the film is only going to get 1/2, 1/4, 1/8th, etc of the light it's getting at full aperture and can then indicate a shutter speed.

So... As far as exposure calculation goes for the meter readout, it doesn't really matter what the actual lens maximum aperture is, it only needs to know how far it'll be stopped (or closed) down at exposure.

Still with me? I hope so.

Now onto the function of the "Full Aperture Signal Pin". Given the above, it starts to look kind of redundant, but obviously it isn't. It's a fixed pin which is bigger for "faster" lenses and smaller for "slower" lenses. It pushes in the matching pin on the body to a greater or lesser extent and thus translates the position of the aperture ring from "full aperture", or "down 1-stop", "down 2-stops", etc... Into an actual f-Number value on the viewfinder readout. In effect, it tells the meter readout where to start from in terms of "f-Number" for us to understand more easily.

... And we're round to about the "4-O'clock" position on the pics, where you'll see the "AE Switch Pin". As you rotate the lens aperture ring (and the aperture signal lever goes down - remember), you move past the lens minimum aperture and push the Aperture signal lever right down AND push out the AE Switch Pin. This pushes in the matching switch on the body and this kind of changes the rules. With the AE Switch pin "on" and hence the Aperture Signal Lever right down, the lever in the body will now drive the aperture signal lever UP to a selected point as decided by the meter (and then the lens stops down).

But what about Variable-Aperture-Zooms? (I hear you ask!) For example, a 35-70mm/f3.5-4.5? The Full-Aperture-Signal-Pin is fixed! The meter readout always says f3.5 even at Maximum Focal Length!

If you think about it... That doesn't matter. The meter will still just see the actual amount of light and stop the lens down by a set amount. The only thing that's lost is an accurate measurement of the aperture in the meter readout. You'll get an actual aperture a set amount less than the meter indication depending on the focal length selected. Simple?... Simple!

Similarly, Teleconverters & Auto Macro Extenders transmit the Lens Maximum Aperture and Aperture Signal direct without any attempt to "convert" these values in any way, so for example, f2.8 won't actually be f2.8, it'll be what's set on the lens. Still doesn't matter.

Finally, a quick word on "Stopped-Down-Metering". Most often used with Mirror Lenses & accessories without the appropriate signaling pins.

By activating the Stop-Down-Lever, you're manually carrying out the "first" step of the exposure cycle, and telling the TTL-Meter that "This is how much light the film will get" Thus, the meter indicates a shutter speed only, based purely on how much light it's getting (and film speed).

PS: Purely for the sake of completeness... The "Reserved-Pin" signaled the focal length of the lens; Longer for Telephotos & shorter for Wide-Angles.

What the FD Lenses Offer

After developing the ideal lens design in respect to sharpness and color balance there is still more to be done. The lens has to be as light as possible and provide great handling ease.
When you mount it on the camera, there should be a sense of unity between camera body and lens. The controls must be easy to work and the lens should be quickly changeable.

Small Size, Light Weight and Good Balance
With the reduction in the overall size of camera bodies, lenses have also become smaller. But simply making a lens small isn't the total answer. In fact, if the lens is made too small it may become difficult to handle. Lens size and weight are factors that must come into balance with the camera body. A large, heavy lens will be out of balance with the camera body, making the whole affair unwieldy. Taking action pictures, for instance, will be difficult. A lens that is too small or too light lacks "feel", making it difficult to hold steady. You know a lens has the balance and weight you need the moment you pick it up. It feels right in your hands.

Quick, Accurate Lens Changing
The FD mount Canon lenses can be changed in a single motion. To mount the lens, align the raised red dot on the lens with the red dot on the camera body and turn the lens clockwise. An audible click tells you the lens is locked in place. You can locate the raised red dot by feel without even looking at the lens. As illustrated on the right, to dismount the lens you press a button on the lens barrel and turn it counterclockwise. The release button, by the way, is protected against accidental operation by a surrounding rim.

Fast and Precise Focusing
Quick and accurate focusing is also extremely important in getting those once-in-a-lifetime pictures. focusing at close range is that the lens barrel extension increases. This tends to move the center of gravity of the lens forward, throwing the camera and lens off balance. Canon's Rear-group focusing system for most lenses of 200mm and longer eliminates this problem. The rear lens group moves internally without changing the overall length of the lens. With some super telephotos it takes only a slight movement of the focusing ring at longer distances to cause a substantial shift in focus, making fine adjustments difficult. Canon's use of a Vari-pitch cam system, such as in the FD 400mm f/4.5, provides greater focusing tolerance at longer distances by, in effect, "lengthening" the focusing ring's turn. Fine focusing is, therefore, easier and more precise.

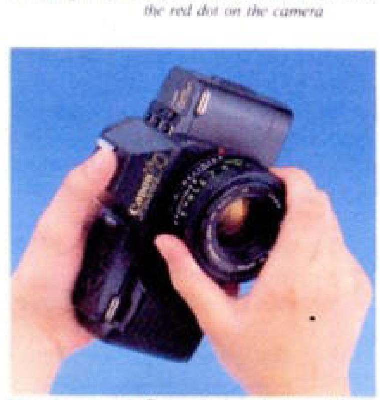
Features That Make a Lens System Great
Let's look at some of the features that are part of the Canon system of interchangeable lenses.

1. Small minimum aperture: With today's high speed, color and black-and-white films, even a shutter speed of 1/1000 may be too slow to prevent overexposure under some conditions. The FD standard and wide-angle lenses offer minimum apertures of f/22; on all FD telephoto lenses, the minimum aperture is f/32. These smaller apertures also mean greater depth of field when you need to record apparent sharpness over a subject area with extreme depth.

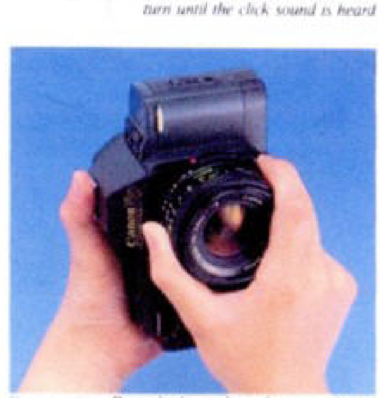
2. Close focusing lenses: Not every picture taken with a lens is made with the focus at infinity. Since some of the most effective pictures are made at the lens' minimum focusing distance, this distance on all FD lenses is kept uniformly to less than ten times the focal length of the lens.

3. A variety of lenses within one focal length group: Several consid-

Mounting, step 1. *Align the red dot on the lens with the red dot on the camera*



Mounting, step 2. *Rotate the lens clockwise 1/5th turn until the click sound is heard*



Dismounting *Press the lens release button and rotate the lens counterclockwise 1/5th turn.*

choose from the FD 300mm f/2.8L, the FD 300mm f/4, the FD 300mm f/4L or the FD 300mm f/5.6 lens. Each has advantages that meet specific requirements.

4. A group of highly specialized lenses: Whether you need a 50mm, 100mm or 200 mm macro for nature or scientific work ... a TS

Key to the Success of Canon's Breech-Lock Mount

The true test of a lens comes when you mount it on a camera and start taking pictures. It's then that all the design, skill and manufacturing expertise goes to work. And if the lens is going to deliver all the sharpness and color it's capable of, the lens mount must fit the camera with absolute perfection. To make the most of superior optics a lens mount needs six qualities:

1. Perfect fit between lens and camera body.
2. The toughness to withstand constant changing of lenses.
3. Total interchangeability of lenses with all SLR's in the system.
4. Ease and speed of mounting and dismounting.
5. Complete accuracy of alignment of signal pins, levers and other contacts.
6. Absence of wear to the camera mount and the lens mount—even after long use.

Elimination of Mating Surface Friction

Traditionally, the usual approach to lens mounts has been the use of either a bayonet or thread system. Both designs create wear on the camera and lens mounts with eventual loss of seating accuracy. This can result in the deterioration of lens performance.

A designer starts out to create a new lens mount with one important consideration—the accurate seating of the lens with respect to image formation on the focal plane. This must be designed into the mount and strictly maintained; otherwise, the distance between lens and focal plane will change, causing serious loss of image sharpness.

Canon's answer to the need for absolute lens mount accuracy is the breech-lock design which was introduced in 1959. With the Canon breech-lock system, attrition is virtually eliminated because neither lens mount nor camera mount abrade against each other during the actual mounting process. And with a FD lens mounted on the camera, a locking system holds it in place.

Accuracy of Signal Pin System

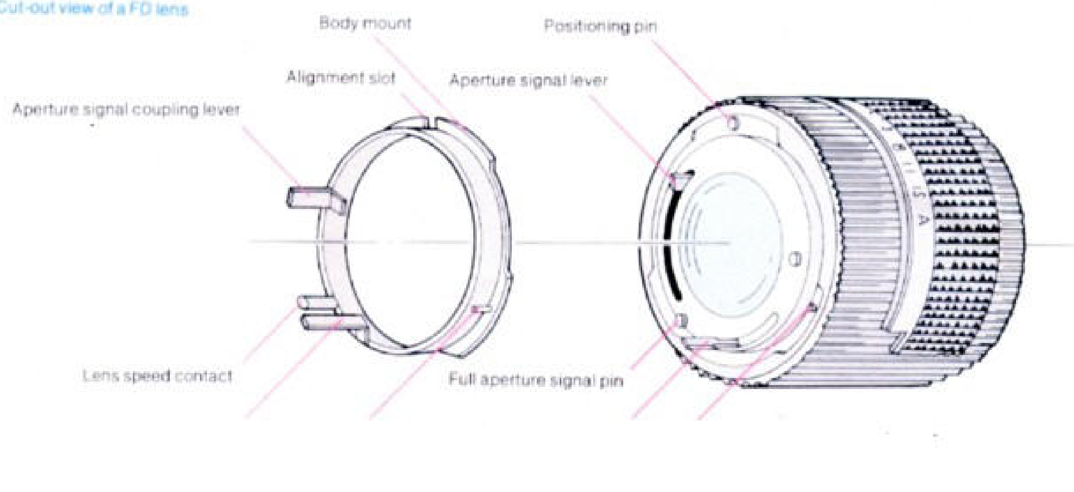
One of the other great advantages of the breech-lock system is its inherently greater accuracy of signal pin positioning. At the rear of the FD lenses are five levers and pins that transmit information between camera and lens. This signal system was first introduced in 1971. Canon's engineers and designers anticipated the extremely high level of sophistication of today's SLR's. For example, the system provided for automatic exposure before the development of Canon's AE-1, AE-1 PROGRAM, A-1, AL-1, T50 and T70 cameras which have automatic exposure control.

How the Pins and Levers Work

The full aperture signal pin transmits the maximum aperture of the lens, automatically and without indexing, to the camera body, while the AE switch pin signals whether the lens is set at "A" (for automatic exposure). The aperture signal lever transmits the selected aperture to the camera's metering system. Pressing the shutter release activates the camera's aperture lever which in turn activates the automatic aperture lever of the lens to close the diaphragm to the preset aperture. An additional pin positions the lens correctly when mounted on the camera by mating with a slot on the front of the camera mount. The last pin is in reserve.

The design of the Canon lens signal pin system has made it possible to use the lenses on Canon cameras regardless of which exposure system they employ. They can be used with the F-1's full aperture match-needle exposure system, or one of the automatic exposure systems, such as shutter-priority AE with the AE-1, shutter-priority AE and programmed AE with the AE-1 PROGRAM, five mode AE with the A-1, programmed AE with the T50 or shutter-priority AE and multi-programmed AE with the T70. One of the important mechanical advantages of the breech-lock design is that the levers and pins on the lens make contact with the camera body when the lens and body are first aligned. There is no pin rotation. With other cameras, the lens rotates with pins and levers rubbing against each other.

Figure 1 Cut-out view of a FD lens



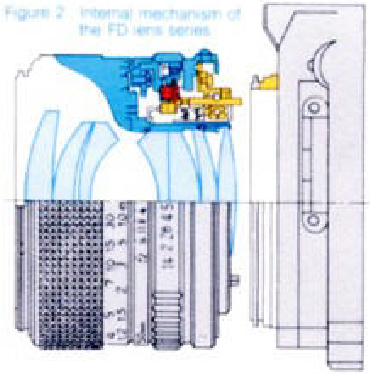
The FD Mounts—Still Breech-lock but with an Important Difference

The concept of the non-rotating, mating surfaces of the FD mount is unique.

Figure 1 on page 34 shows the FD lens breech-lock mount. To mount the lens, you first align the red dot on the lens with the red dot on the body. The positioning pin on the lens nests in the alignment slot on the camera mount. You then rotate the entire lens barrel clockwise until the pin pops out and the lens is locked to the body. The pins and levers on the FD lenses remain stationary, mating with their counterpart when you first align the lens with the camera.

Figure 2 illustrates the FD mount system. The rotating portion of the mount is represented by the blue section of the drawing. The yellow section shows the part of the lens mount that does not move when you attach a lens. The various signal transmitting mechanisms are

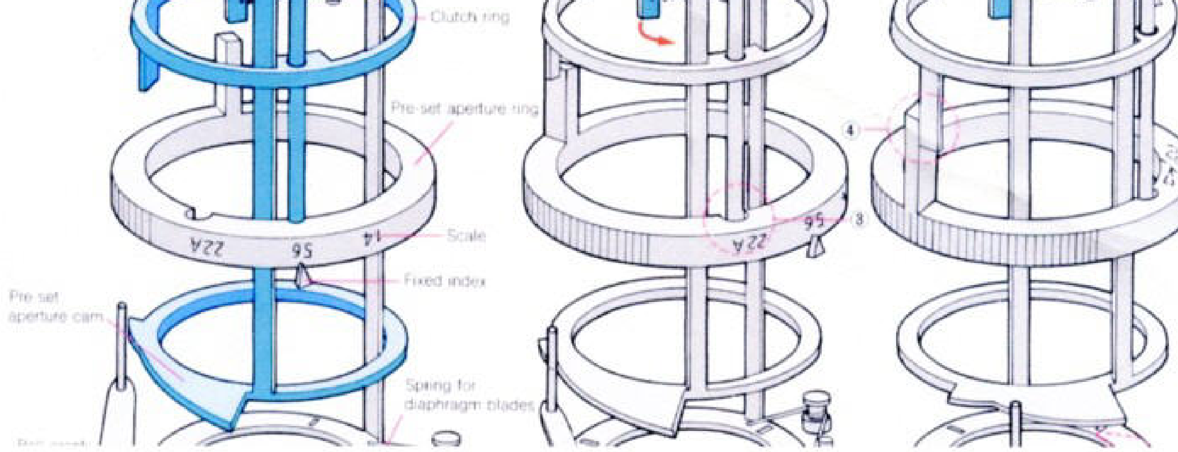
Figure 2 Internal mechanism of the FD lens series



in this yellow area. As we mentioned earlier, mounting the lens automatically positions the various signal pins and levers. As shown in Figure 3, a clutch pin allows the barrel on the FD lenses to rotate. The diaphragm, partially closed when the lens is off the camera, opens fully, as indicated at the bottom of the drawing in Figure 3, view C. The actual opening of the blades is accomplished by means of a cam and lever arrangement. Rotating the lens barrel activates the aperture cam (lower pale blue ring) which pushes on the lever. The lever in turn opens up the diaphragm blades (illustration uses only one blade for sake of clarity). There's an audible click when the lens locks in place. To change lenses, you push a button on the lens mount, releasing the lens, and rotate the lens counterclockwise about 1/5 of a turn.

Until now, we've been talking primarily about lenses in general—from a technical and functional point of view. We've also tried to give you some idea of the special features of Canon lenses and how they work. But when you get down to it, actual picture-taking is our primary concern. What are the techniques for taking successful images and how does one actually utilize various focal length lenses to achieve them? That's all coming up in the following sections. In a sense, we're about to get down to the business of taking pictures.

Figure 3 A: Cut-out view before mounting B: After the lens is mounted and rotated a little C: After the mounting is complete



Signal Transmission and Function of the FD Lenses

The FD series lenses can be used for full-aperture metering when mounted on any of Canon SLR models after the Canon F-1, EF, and FTb cameras, and also for stopped-down metering when mounted on the earlier pre-FD era's FT QL and other Canon SLR cameras.

Earlier section mentioned and illustrated Body and lens coupling was based on a newer FDn lens and here is an illustration which used an original older version of an FD lens to demonstrate.

1. **Automatic/Manual Aperture Lever** This is the conventional stopped-down coupling lever which automatically resets to full aperture opening position after shutter release.

This lever also couples with stopped-down functioning/self-timer lever on the camera body. By turning stopped-down functioning lever, stopped-down metering is also possible.

2. **Full-Aperture Signal Pin**. It is used to compensate for the metering error at full-aperture f/stop when using a large aperture lens. In order to correct this error, the full-aperture signal pin plays a role to adjust the matching needle position.

3. **Aperture Signal Lever.** This lever is a coupling lever that plays three important functions in full aperture metering:

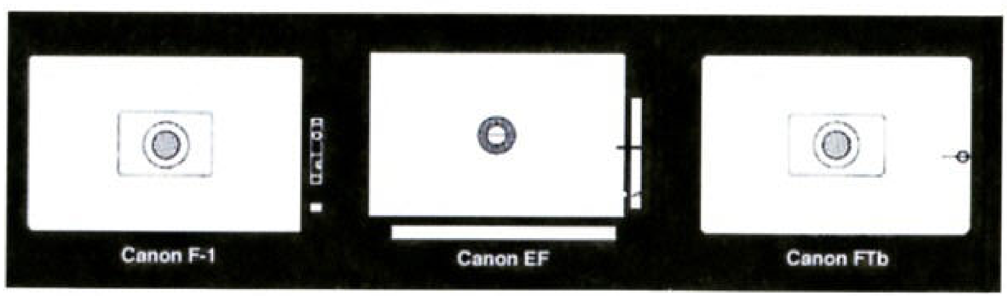
the older bodies such as the FTb or TX, it **cannot** be set at the 'A' mark.

See A variation.

6. Spare Signal Pin.
Canon indicates it is a reserved pin for developing System Accessory but I am not so sure which types of accessories would require this pin to work. May be someone out there could shed some light on this feature.

Manually Operated Aperture

When the automatic/manual aperture lever is turned all the way, it is clamped and stops. By mounting a lens in this condition, manually operated aperture can be used. This function is used when any non-automatic accessory such as bellow or extension set is used between the camera body and the lens.



Note: However, in ordinary photography using an Canon F-1, FTb, or TX, manual aperture may be used by locking the stopped-down metering lever. Below: Shown below are how older bodies handle their respective viewfinder display in manual aperture control. For newer Canon bodies has their respective sites in PIM, click here for the various **A-series** or the **T-series** models.

a) First function is the aperture transmission signal in full-aperture metering. It is coupled with the preset aperture ring to move on a synchronized oneto-one ratio and transmits the preset f/stop position to the exposure meter of the camera body. At this time, of course, light metering is full-aperture method. As soon as the shutter is released, the aperture closes down to the preset f/stop by this lever and the proper exposure is obtained.
b) Second function transmits the automatic setting of the full aperture opening f/stop to the exposure meter. Even if a lens with a different lens speed is used, the aperture signal lever is in the same position at full aperture opening f/stop. When a lens is mounted on the camera body, the full aperture opening f/stop is transmitted to the exposure meter and the aperture needle is set at a fixed position.
c) Third function is the inner setting of the preset f/stop for the automatic exposure EF camera and Servo EE photography with F-1. When the preset aperture ring is set at the 'A' mark, located outside the scale, this lever is automatically disconnected from the preset aperture ring and can be freely moved. This function is made possible in EE photography with the EF and Servo EE Finder attached to the F-1. But all these FD lenses can also be used and compatible with all FD mount automatic Canon SLR bodies that introduced in later years (In fact, other than the New F-1 in 1982, virtually all Canon bodies that followed will require batteries to power its functions (other than aperture priority AE bodies such as Canon AV-1 in 1979, the AL-1 Quick Focus camera of 1982 and Canon T-60 of 1990), these automatic bodies made by Canon feature shutter priority automation that would require a FD lens be locked at the "A" Mark.

In other words, for other older Canon bodies, this lever is turned to the proper position for closing down the aperture upon information received from the EF and Servo EE Finder. Thus the proper exposure can be obtained and unmanned EE photography is possible. During those days, lenses other than Canon FD lens do not have these features. Therefore, it is impossible to use them for EE (AE) photography. The tremendous success of the shutter priority AE based Canon AE-1 in 1975 firmly put Canon on the driver seat as being the forerunner of camera automation. I remembered Minolta was the first Japanese camera maunufacturer to react and it fact, won introduced the world's first multimode AE body slightly ahead of the equally popular Canon A-1 with their XD-7 (Or XD-11 in US) model that also combine Program AE other than the popular automatic aperture and shutter priority exposure control.

4. **EE Lock Pin**. A safety lock pin to prevent accidental movement of the aperture ring over to the 'A' mark. When this pin is pressed, the lock is released and the aperture ring can be turned. The lock pin for earlier FD lenses is located at a separate ring just above the chrome mounting ring. The newer FD lenses has it at the same aperture ring.

5. **EE Switch Pin**. When the preset aperture ring is set at the 'A' mark for EE use, the lens can be attached only to the cameras designed for EE photography. If the lens is attached to

Lens Components: Form and Function

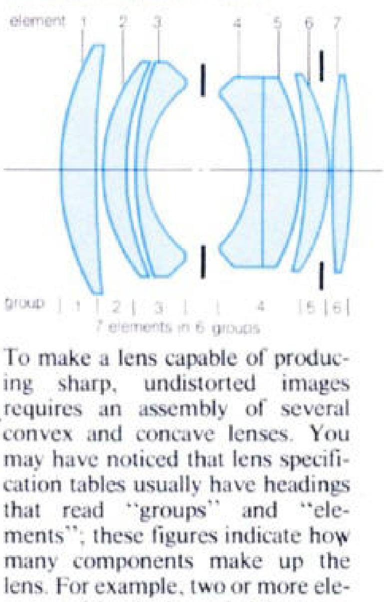
Lens Construction and Types

Thorough knowledge of the relationship between the camera body and the lens is important if you are going to make the most of the wide range of lenses that are part of the Canon SLR system. Here, we will consider the various components that make up a lens, the function and role of these elements and their relationship to the camera body.

"Lens" is a simple word, but a lens consists of a complicated assembly of various lens elements in addition to the barrel, diaphragm, mount and other mechanical components. Of these, the construction of the lens proper is particularly important.

While it is possible to take a picture with just one simple convex lens, the results would not be sharp over the whole field. Color reproduction would also be less than desirable.

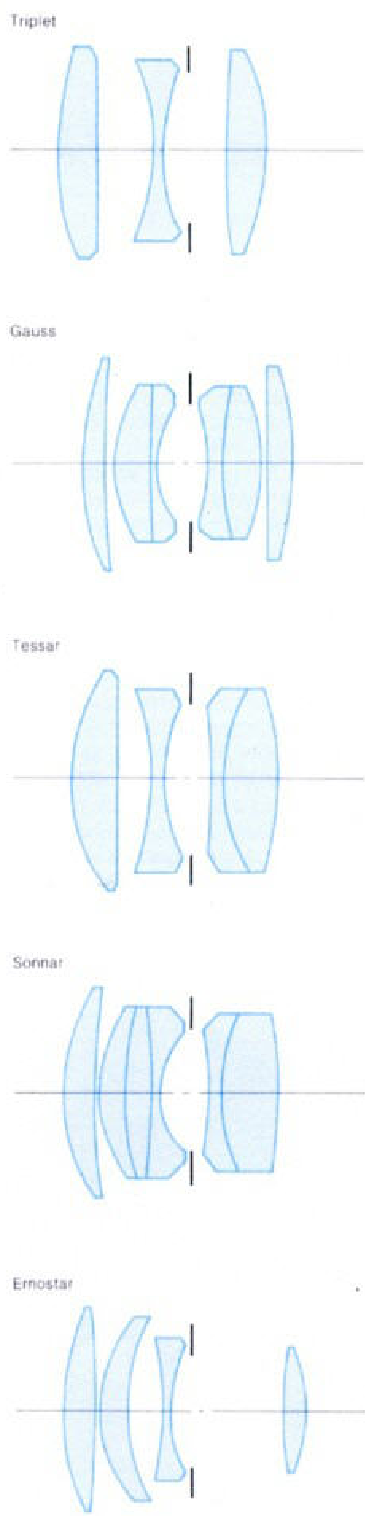
Construction of FD 50mm f/1.4 lens



7 elements in 6 groups

To make a lens capable of producing sharp, undistorted images requires an assembly of several convex and concave lenses. You may have noticed that lens specification tables usually have headings that read "groups" and "elements"; these figures indicate how many components make up the lens. For example, two or more elements (simple lenses) joined together count as one group. The number of elements and groups depend on lens design. However, the number of elements and groups in a lens increases as aperture grows larger, angle of view grows wider and, in the case of a zoom lens, more than one focal length is incorporated in its design. These multiple elements and their design improve overall lens performance. There is an infinite variety of concave and convex lens combinations. However, when the purpose and performance of lenses have similarities (for example, wide-angle lenses), the lens combinations closely resemble each other. By grouping similar lenses, it is possible to classify them into certain types.

Lens Types



The majority of lenses can be classified as symmetrical or asymmetrical types. A symmetrical lens design consists of identical elements on both sides of the lens diaphragm; the representative example is the Gauss type. Most standard lenses are designed closely along this line.

Asymmetrical lenses are types in which the structure and positions of the lenses in front of and behind the diaphragm differ. Typical examples are the Triplet and Tessar types.

Lens designs commonly used today include Xenotar, Sonnar, Ernostar and Retrofocus. Among the special lens types there are the mirror reflex, or catadioptric, lenses and zoom lenses.

The Mechanics of Focusing

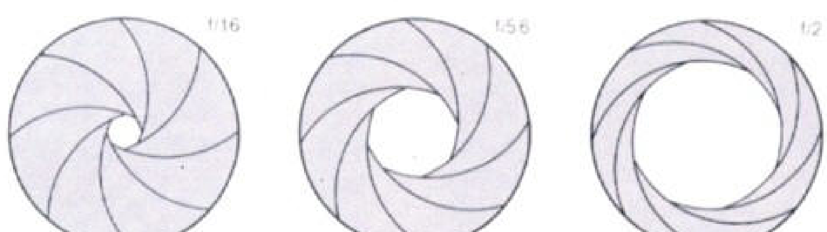
Focusing on a particular subject involves moving the lens in relation to the film plane—either closer or farther away. This is usually accomplished with a helicoid arrangement. A helicoid is actually a series of threads on the lens barrel nested in a second series of threads. As you turn the focusing ring the barrel rides on the helicoid, moving the lens elements. With most designs the lens itself does not rotate; instead, it moves back and forth. Normally it takes less than one complete turn of the focusing ring to move the lens from its closest focusing distance to infinity. In some lens systems, notably zoom lenses, only the front group of lenses moves when you focus. And with long telephotos only the rear group of lenses moves during focusing.

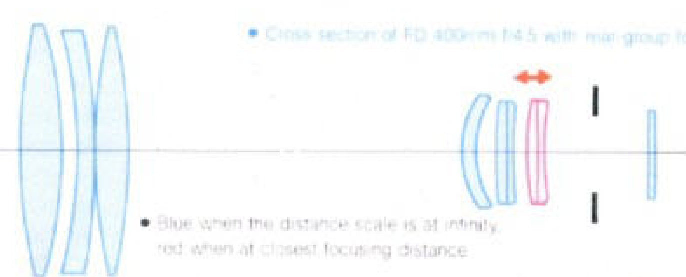
The Function of the Diaphragm

If you look directly into the lens barrel with the lens stopped down you will see the diaphragm, a set of metal blades for varying the size of the lens opening. Known as the aperture, this opening regulates

the amount of light that goes through the lens. You can adjust the size of the aperture by turning the aperture ring on the outside of the lens barrel. The size of the aperture is indicated by a series of numerical markings called f-numbers or f/stops which are engraved on the aperture ring. The numbers actually refer to the ratio of the diameter of the opening to the focal length of the lens. A small number, let's say 1.4, indicates a large opening. A large number, 16 for instance, indicates a small opening. Thus as the numbers become larger the aperture becomes smaller allowing progressively smaller amounts of light to reach the film. Moving from a given aperture to the next smaller reduces the amount of light by half. In addition to controlling the amount of light, the aperture also controls the depth of field. When your subject is in focus, there is a certain area in front of and behind it which will also be in focus. This area of sharpness is called depth of field and varies depending on the aperture. Depth of field is also affected by lens focal length and shooting distance, and tends to be greater in the background than in the foreground.

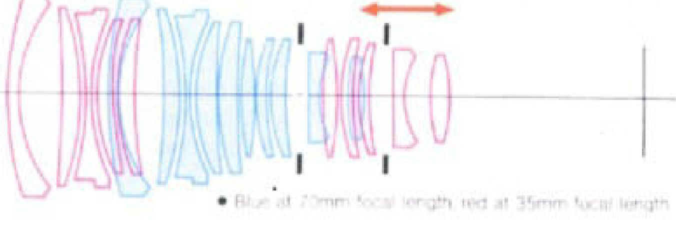
Aperture also has an effect on lens aberrations which are unavoidable image defects. These aberrations affect the ability of a lens to record a point of light as a point, and a straight line as a straight line.





• Cross section of FD 400mm f/4.5 with rear group focusing

• Blue when the distance scale is at infinity, red when at closest focusing distance



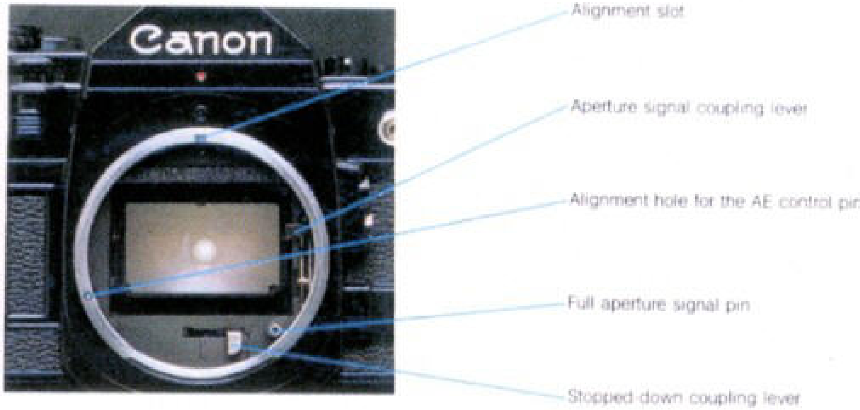
• Two-group design used in FD 35–70mm f/2.8–3.5

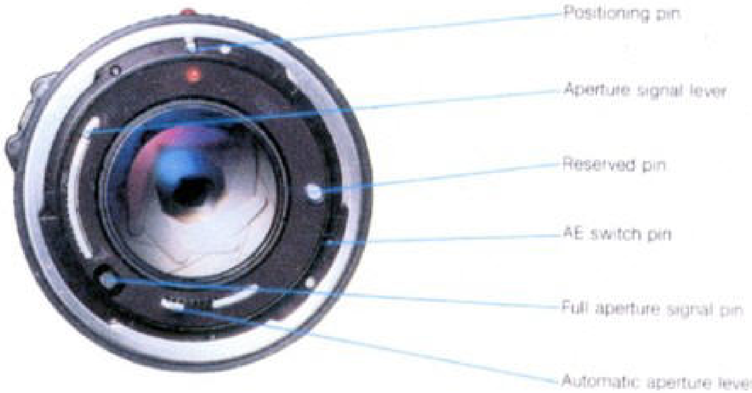
• Blue at 70mm focal length, red at 35mm focal length

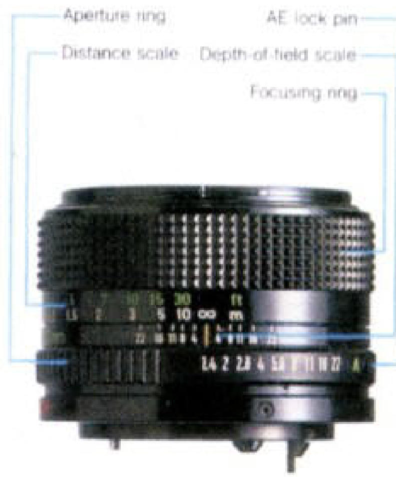
The Lens Mount and What It Does

Basically, the lens mount fastens the lens to the camera—but there's a lot more to it than that. If you'll look at the rear of a Canon lens mount you will see several levers and pins. These devices serve to transmit and receive information to and from the camera. For example, data to and from the camera's light meter is transmitted through these pins and levers. In addition, the signal from the shutter release to the automatic diaphragm mechanism is sent through the lens mount/camera coupling system.

There are two lens mount types: thread (or screw) and bayonet. Until recently, the thread mount was extremely popular. Not only manufacturers of cameras employing this mount, but independent lens makers also produced thread mount lenses. As cameras became more automatic and sophisticated, however, the thread mount began to be considered obsolete. It was







simply impossible to retain the precision needed to assure accurate coupling of camera and lens. Constant lens changing produced wear that caused misalignment. In addition, changing thread mount lenses is a slow process. The bayonet mount is considerably faster, more able to absorb punishment and can retain the required precision. Canon's approach to the bayonet mount concept is unique. Its features are explained in greater detail on page 34.

What Those Numbers Mean

Take a look at virtually any lens designed for 35mm cameras and you'll see several groups of numbers. Once you discover the functions of the various indications you'll find them extremely useful.

First, let's look at the front of a lens. Typically you will see something on the order of 50mm 1:1.4, 85mm 1:1.8 or other combinations. The first number, for example, 50mm, indicates the focal length which is an indication of the lens' angle of view and image magnification. Anything less than 50mm is a wide-angle, and generally anything more than 50mm is a telephoto lens. As discussed previously, the second number, for example, 1:1.4 or f/1.4, indicates the maximum aperture or widest opening of the lens. The larger the aperture, the greater its speed or light gathering power. A series of f/stops on the aperture ring indicate the diaphragm range (largest to smallest opening). Numbers may typically range from f/1.4 to f/22 or f/2.8 to f/32. There is also an "A" setting after the smallest aperture. This setting is used for automatic exposure operation on certain camera models.

A second series of numbers on the focusing ring indicate distance and range from the minimum focusing distance to infinity. The closest focusing distance varies with the focal length. Shorter focal length lenses—standard and wide-angle—permit shorter camera-to-subject distances than telephoto lenses. The exception to this are the macro lenses which are designed for very close focusing. The focusing distance is indicated in meters and feet.

On the lens barrel adjacent to the distance scale is the depth of field scale. As mentioned on page 9, the depth of field scale denotes the zone of acceptably sharp focus in front of and behind the subject. Depth of field is an important factor in controlling the effect of a picture and will be discussed in more detail in the section, "Understanding Depth of Field."

In addition to the basic focal length lenses such as wide-angle, standard and telephoto, there are specialized lenses which have added controls for particular purposes. Zoom lenses, for example, have a control for varying focal length. The Canon TS 35mm f/2.8 lens has mechanisms for tilting and shifting the lens to adjust perspective and to control depth of field. Fisheye lenses have extreme coverage with a 180° angle of view. We'll discuss these special lenses later in greater detail.