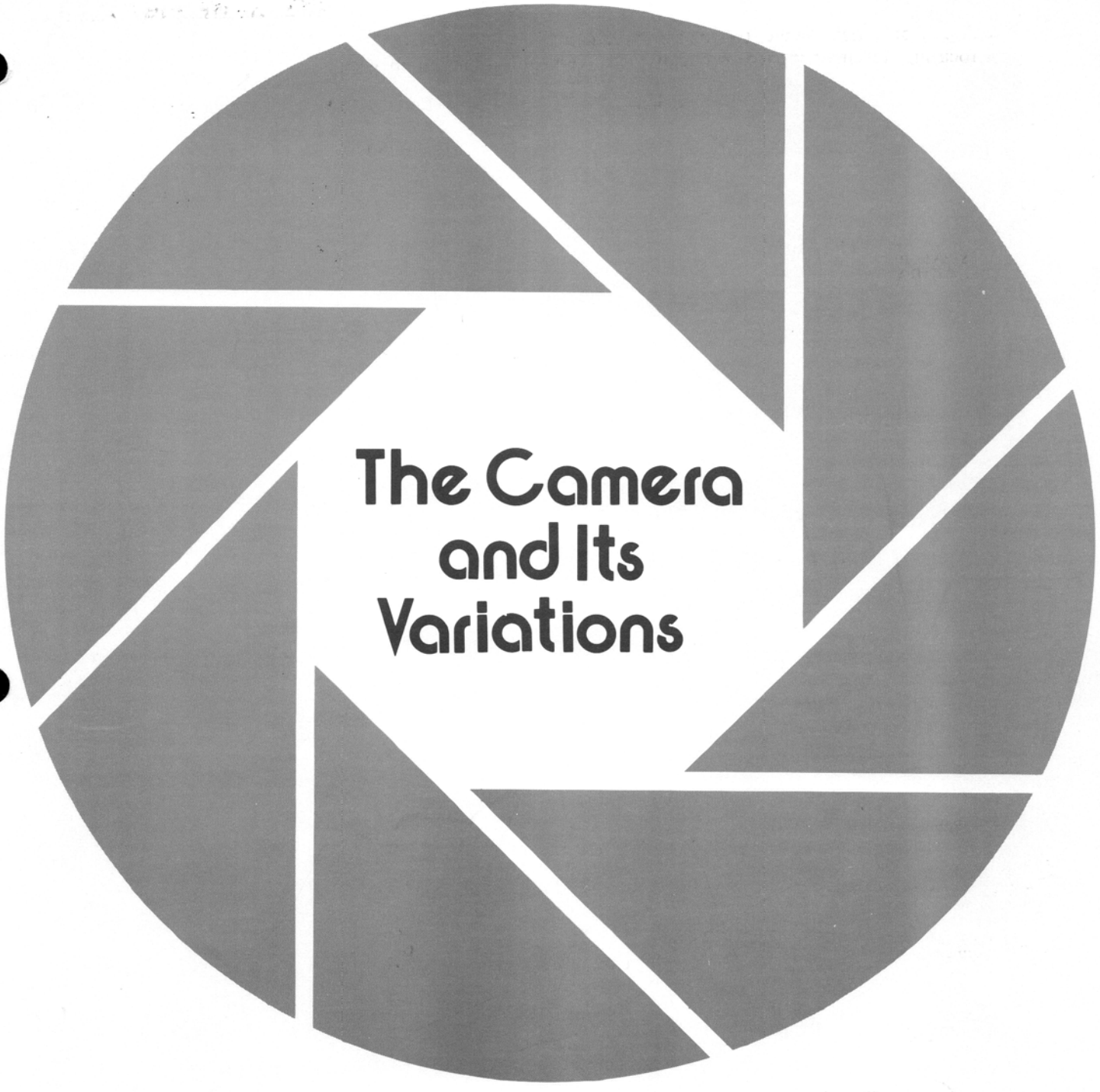
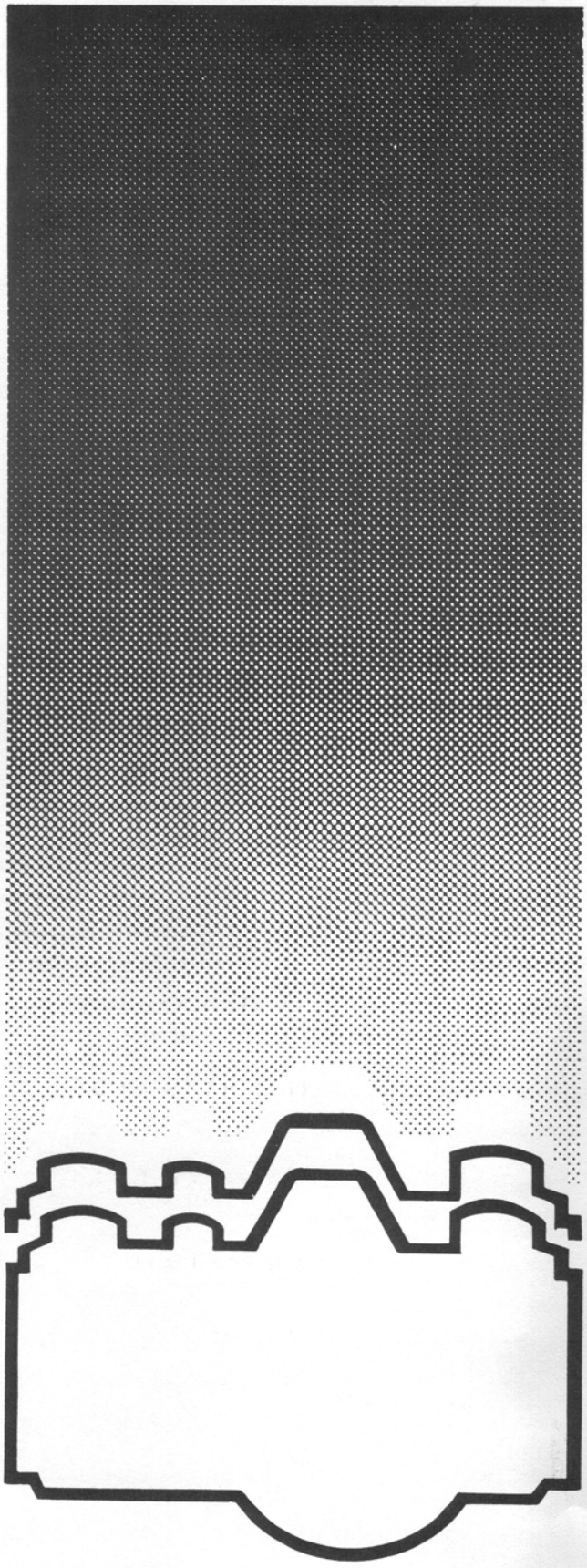


The Camera and Its Variations



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The Camera and Its Variations

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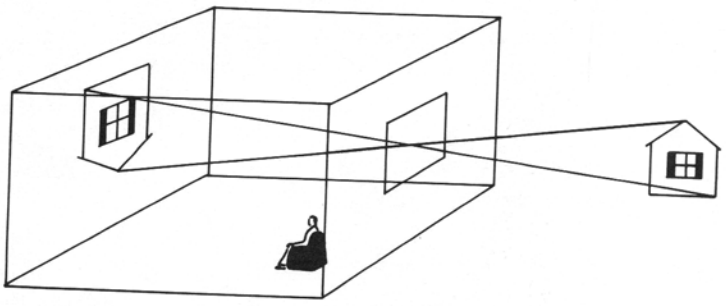
National Camera, Inc.
Technical Training Division

THE FIRST CAMERA

Some time or another, you've probably noticed an effect which is, in fact, the beginning of all photography. Perhaps you were in a darkened room. The shades were drawn. The sun was shining outside and there was a tiny hole in a window shade through which a few of the sun's rays passed across the room. There on the wall or floor appeared a round spot of light which was an accurate image of the sun's disk.



The optical principle on which photography is based.

If the day was bright enough, and the room was dark enough, you might even have seen an upside-down image of a building or some trees which were some distance from the shaded window. We have no way of knowing how many people observed this strange effect before it was put to practical use.

Its first users were artists. They saw the accurate image of a scene cast by the light passing through that little hole. And they used the image to make sketches or drawings, perhaps even on the wall itself.

THE CAMERA OBSCURA—ITS MEANING

This principle was first built into a machine by 17th century artists. They used a box with a tiny hole at one end. There was a translucent screen at the other end so that the image of a desired object could be cast on the screen through the little hole. The image was copied or traced and the result was a drawing of the subject.

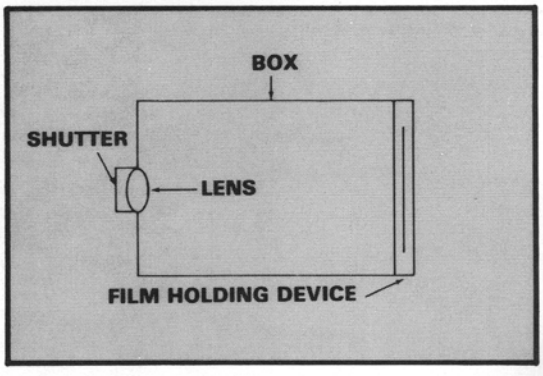
The machine was called the "camera obscura," Latin words meaning "dark room." The word "camera" is the Latin word for room.

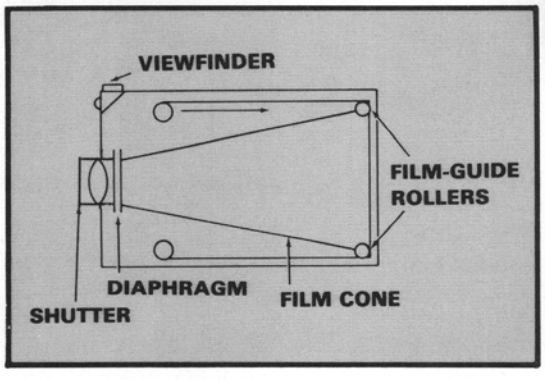
So how does the Camera Obscura work? Well, consider that light reflected from various parts of an object travels in straight lines. The light passes through the pinhole to reach the screen at the other end of the box. Since light is reflected from each portion of the object in greater or lesser intensity, all of the beams pass through the pinhole. And they strike the screen together to make up an image of the object.

The first camera wasn't much more complex than the Camera Obscura. But there were a couple of significant advances that changed the camera from an artist's tool to a machine capable of taking pictures on its own.

One important advance was the invention of film to replace the screen at one end of the box. Film is a light-sensitive material that makes a permanent record of the image. After the image is recorded on the film, the film must be "developed"—treated with chemicals to make the image visible.

A second important advance was the replacement of the pinhole with a lens. The function of the lens is the same as the pinhole—to form an image of the scene. But the lens is a piece of glass or clear plastic that's capable of actually bending the light rays. As a result, the lens works much faster than does the pinhole. It may take only a fraction of a second for a lens to burn the image onto the film.





BASIC PARTS OF A CAMERA

There're many types of cameras. But they all include the same basic parts.

1. First, there's a box or structure to hold the other parts in their proper relationships.
2. At one end of the box, there's a device for holding the film on which the image will be projected.
3. At the other end of the box, there's the lens which gathers the light from an object and projects that light onto the film.
4. The shutter blocks off the light coming through the lens when you don't want to project the image. The shutter may be at either end of the box. But it can be quite simple—perhaps nothing but a cap which you place over the lens to shut out the light.

These few items are the only required parts of a camera. All of the other gadgets and accessories are merely additions to those basic parts—added to make it more convenient to use the camera or to get better pictures. But the camera itself remains a simple, four-part machine.

THE BOX CAMERA

A box camera is just that—a box. It's the most basic or simple camera, with only minor additions to the four parts.

The plate (film)-holding mechanisms in the first box cameras were merely slots into which a glass plate could be inserted prior to the exposure. The plate, being sensitive to light, was loaded in a darkroom. The loaded camera was then rushed to the site of the photograph and the exposure was made immediately. The reason for the urgency was that the plate was

coated with a liquid emulsion by the photographer and the exposure had to be made while the plate was still wet.

Exposures were long and the use of a lens cap as a shutter was quite the standard procedure. Later in the nineteenth century, methods were devised to prepare dry photosensitive materials. The practice of photography then became much more convenient.

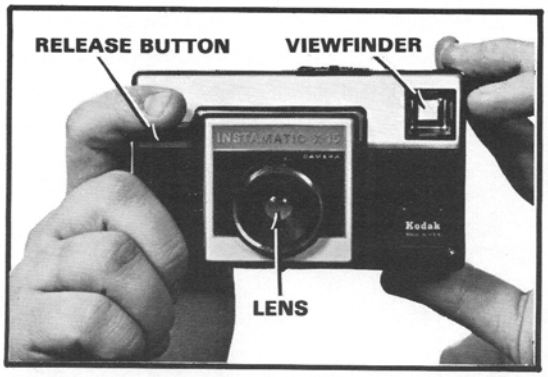
The next important development was the coating of the sensitized material on a flexible base, rather than on glass. And soon George Eastman placed the first roll-film camera on the market. A far cry from today's box camera, Eastman's brainchild was a cumbersome thing. It was loaded at the factory with a roll of film sufficient for 100 exposures and then mailed to the photographer. Upon shooting all the pictures on the roll, the photographer mailed the camera back to the factory for processing of the film and reloading.

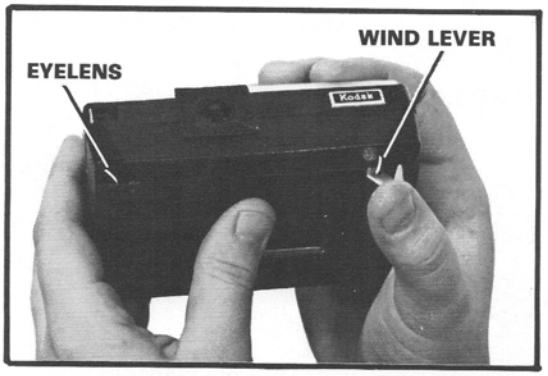
Eastman's roll-film camera discarded the use of a lens cap as a shutter. Instead, it had a simple spring-operated device which passed an opening between the lens and the film for a uniform period of time. This mechanically operated shutter provided a fixed exposure time for the film. Every picture was exposed in exactly the same way. But under good conditions, the photographer ended up with a hundred round pictures.

That was the basic box camera. And it's much the same today. With the invention of paper-backed roll film came freedom of the camera owner from the ties of the camera manufacturer. Now he could load his own camera. The box camera didn't improve or change appreciably for many years. In fact, the modern box camera is still the right camera for many people because it's so simple to use.

In addition to the four basic parts of the camera, there's another device on most box cameras. For convenience, a means of aiming the camera is usually included. In early box cameras, the photographer aimed by simply sighting along the edge of the box. But most cameras now provide some sort of **viewfinder.**

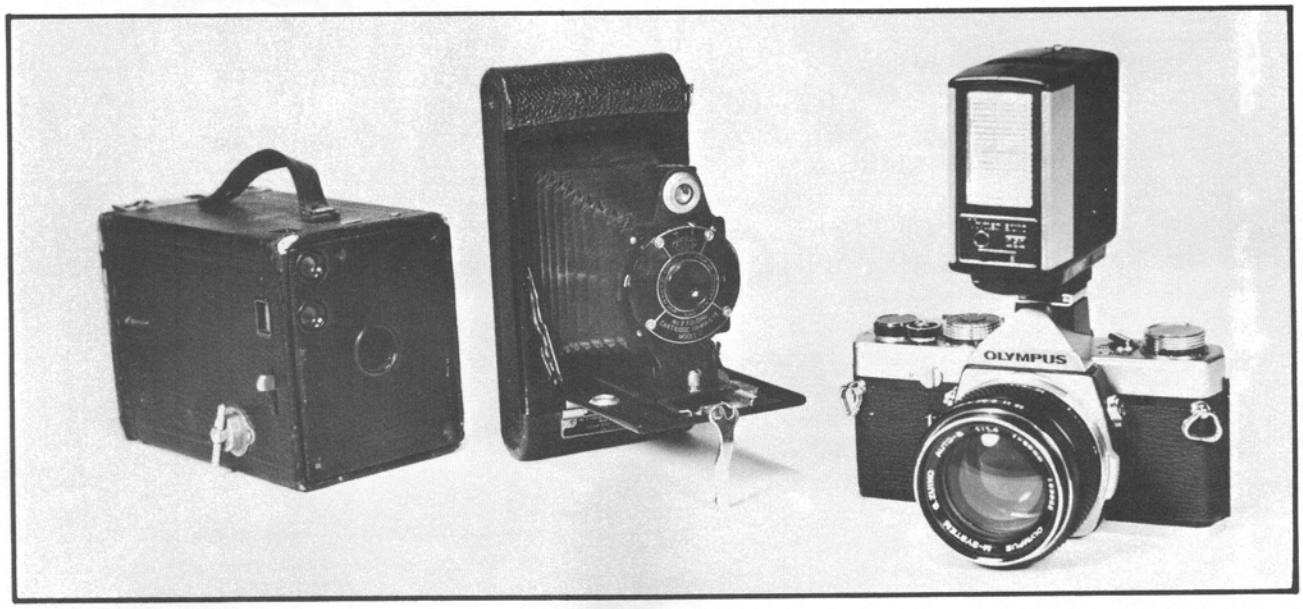
A viewfinder is a sighting device. It allows you to see what you're going to get on the film. The viewfinder may simply be a small camera attached to the body of a big camera. But, rather than film, the viewing "camera" may substitute a piece of ground glass or an eye lens so you can view the picture.





Here's a modern box camera. Pushing the release button actuates the shutter to uncover the lens. After taking a picture, you just advance the wind lever. That moves the film forward so you can take another picture. Simultaneously, the wind lever tensions the shutter for the next exposure.

For beginners and snapshooters, the box camera is ideal. Just learn how to load and advance the film, aim the camera and trip the shutter and you're all set to take pictures. But there are limitations to what you can do with a box camera. Its versatility may be greatly increased by adding more controls to the four basic parts.



Three steps in the evolution of the camera — an early box camera, an early folding camera, and a modern miniature camera.

WHY CONTROLS?

There's a good reason for the simplicity of the box camera. Many people want the pictures, but not the fuss. They don't want to take the time to learn about more complex cameras. That's fine—for them. But the serious photographer needs more.

Adding creative camera controls gives the photographer more to say about the picture. Now, he can create—not just shoot. The three creative controls we'll be covering are common to nearly all refined cameras. Here they are:

1. **The shutter-speed control**
2. **The diaphragm control**
3. **The focusing control**

THE SHUTTER-SPEED CONTROL

The basic box camera delivers one shutter speed. Every time you trip the shutter, the film receives light for the same length of time. Typically, the chosen shutter speed provides suitable exposures for most conditions—providing, that is, you're shooting pictures outdoors in bright sunlight.

But a more versatile camera has a control to change the shutter speed. With a slower shutter speed, the shutter stays open longer. So the light reaches the film for a longer period of time.

Shutter-speed calibrations are in fractions of a second. If you set a shutter speed of 1/2 second, the shutter allows light to strike the film for 1/2 second. That's a "slow" shutter speed. A "fast" shutter speed really splits a second—like 1/1000 or even 1/2000 second.

The range of slow shutter speeds goes like this: 1 second, 1/2 second, 1/4 second, 1/8 second, and 1/15 second. Also, there's a middle-of-the-road speed range—1/30 second, 1/60 second, and 1/125 second. The fast speeds on a typical camera are 1/250 second, 1/500 second, and 1/1000 second.

So a shutter-speed scale may look like this:

1 second	
1/2 second	
1/4 second	**SLOW SPEEDS**
1/8 second	
1/15 second	
1/30 second	
1/60 second	**MEDIUM SPEEDS**
1/125 second	
1/250 second	
1/500 second	**FAST SPEEDS**
1/1000 second	

The speed-setting control on the camera is usually a knob or dial. Fig. 1 shows a couple of examples. You can identify the speed-setting control fairly easily—just look for the shutter-speed calibrations. As in our examples, the calibrations on the camera normally don't include the numerator of the shutter-speed fraction. The calibration for 1/125 second is "125"—for 1/2 second, it's "2."

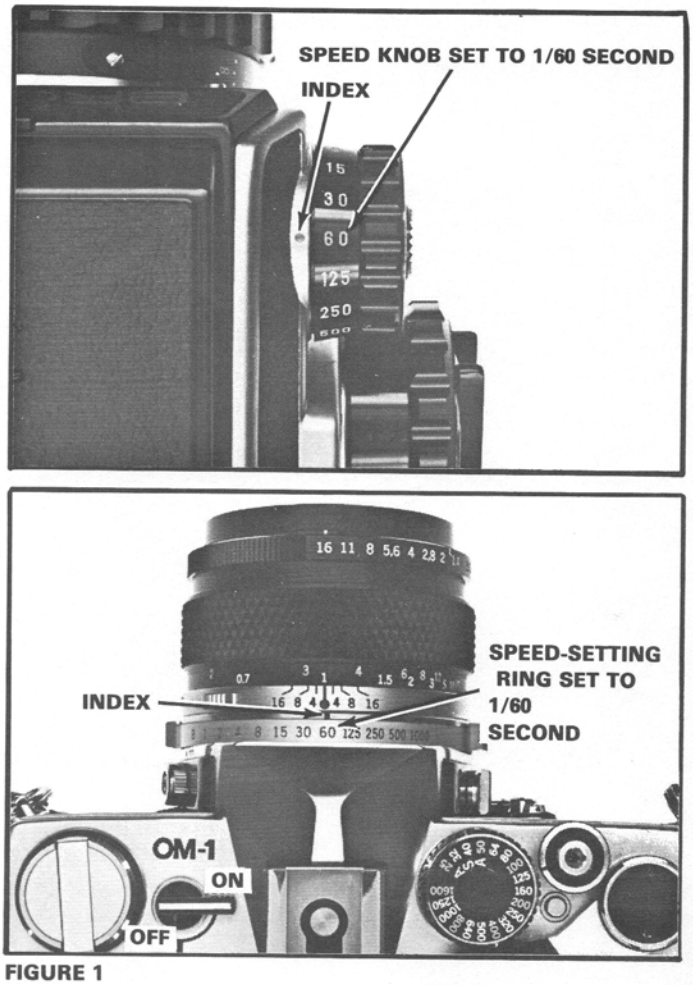


FIGURE 1

RELATIONSHIP OF SHUTTER SPEEDS

All of the shutter speeds have a definite relationship to one another. Pick any shutter speed on the scale. The next faster shutter speed is twice as fast. The next slower shutter speed is twice as slow.

Suppose, for example, that you've set the shutter to 1/500 second. If you then set 1/1000 second, you'll have a faster shutter speed—twice as fast. 1/1000 second exposes the film for half as long as does 1/500 second.

Rather than 1/1000 second, let's say you had selected 1/250 second. How does that compare to 1/500 second? 1/250 second is twice as slow. It exposes the film for twice as long as does 1/500 second.

Not all shutter speeds work out so precisely. For example, to the mathematician 1/8 second isn't precisely twice as long as 1/15 second. But for photographic purposes, you can consider that you're getting half the exposure at 1/15 second as you are at 1/8 second.

The chart we showed earlier has the full range of shutter speeds you'll normally find in sophisticated cameras. Less refined cameras may offer a limited speed range—just the shutter speeds you need most often. So you may be wondering, "Why so many shutter speeds?"

Well, for one thing, the different shutter speeds provide a precise control of the exposure—in many different lighting conditions. If you're shooting pictures outdoors—in the bright sun—you might need a fast shutter speed, maybe 1/500 second. The shutter opens and closes so fast that the film gets only a brief look at the scene. A shutter speed faster than 1/500 second might not allow light to reach the film long enough for the proper exposure. A slower shutter speed might allow the light to reach the film for too long a time.

Indoors—or in dim light—you need a slower shutter speed. Since there's not much light, you must allow the light to reach the film for a longer period of time. That gives the existing light more time to burn the image onto the film. Rather than 1/500 second, you might set 1/30 second.

So exposure control is one purpose of the speed range. But there's another control as well—a creative control. Let's say that you're photographing a fast-moving subject—perhaps a horse at a gallop. And your shutter speed is 1/30 second. Light reaches the film for 1/30 second. In photographic terms, that's a relatively long period of time.

Chances are your picture will be a blur. Especially if the horse is running across the picture. To freeze this action, you need a faster shutter speed—maybe 1/500 second. Yet if the horse is running toward or away from the camera, 1/30 second may do the job.

What difference does the direction of travel make? It's all relative, according to what the film sees in a certain period of time. If the horse is running across the field of view—parallel to the film—its position changes a lot while the shutter is open. 1/30 second can't stop the action. But the horse's position changes very little during a 1/500-second exposure.

Now, consider that the horse is running toward or away from the camera position. As far as the film's concerned, the subject movement is less—even though the horse is running at the same speed. The change in position is less. And a slower shutter speed can stop the action.

On the other hand, some blur may be desirable. Blur shows motion. Some subjects, frozen by a fast shutter speed, may appear to be standing still. So you may wish to introduce some intentional blur. Your picture then says, "This subject is moving—fast."

You've now seen two reasons for the multiple shutter speeds:

1. **Exposure control**
2. **Action-stopping**

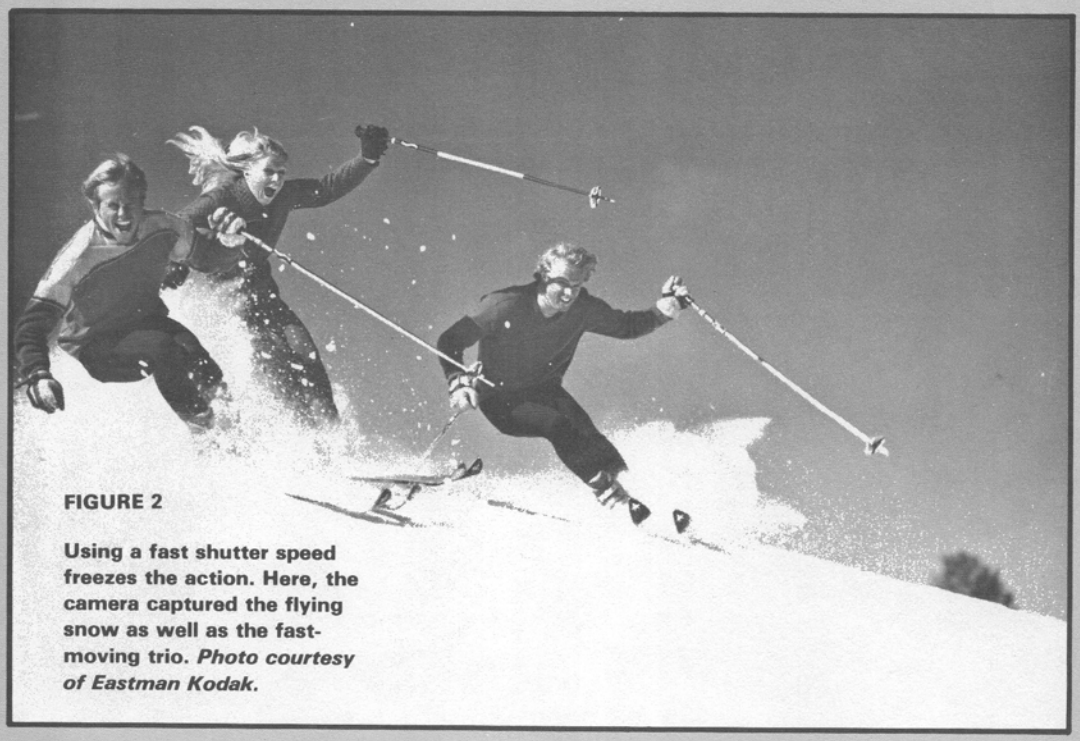


FIGURE 2

Using a fast shutter speed freezes the action. Here, the camera captured the flying snow as well as the fast-moving trio. *Photo courtesy of Eastman Kodak.*

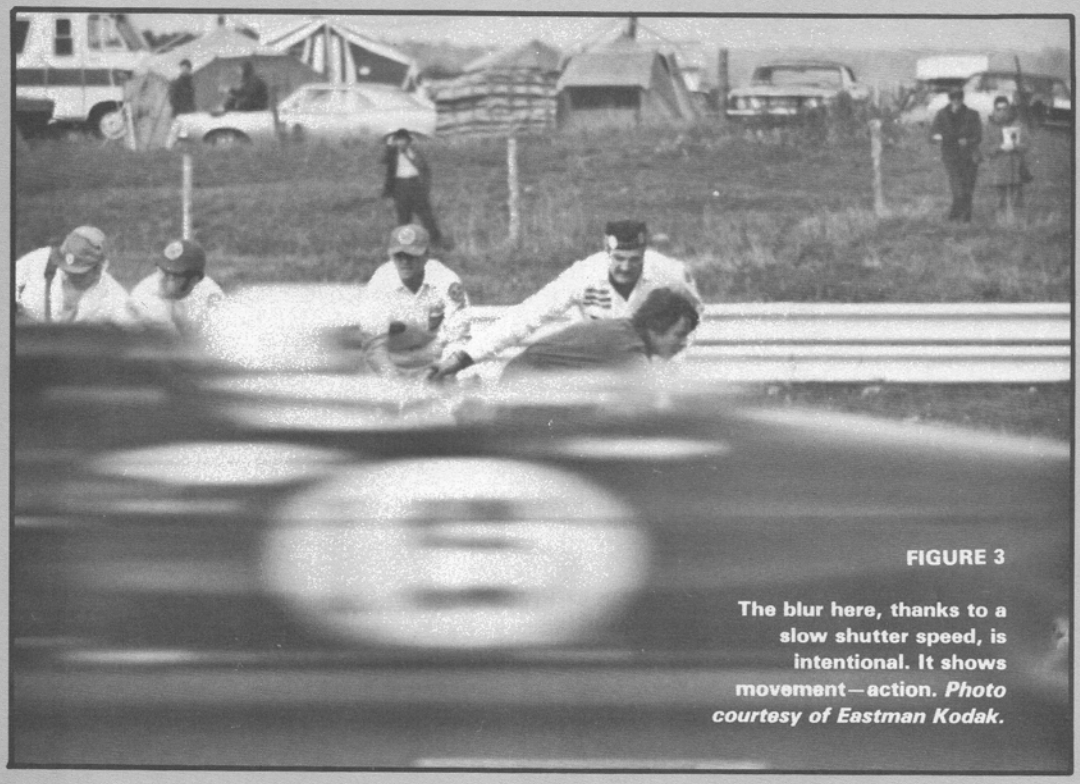


FIGURE 3

The blur here, thanks to a slow shutter speed, is intentional. It shows movement—action. *Photo courtesy of Eastman Kodak.*

FIGURE 4

Holding open the shutter on "bulb" captured these multiple bursts from a fireworks display.

BULB AND TIME CONTROLS

Most of the refined cameras have an additional shutter-speed setting—**BULB,** usually shortend to "B." A few cameras also offer a **TIME** setting—"T." Let's see what happens at "B" and at "T."

At BULB, you depress the release button and the shutter stays open. That means light strikes the film for as long as you hold down the release button. When you let the release button return, the shutter closes.

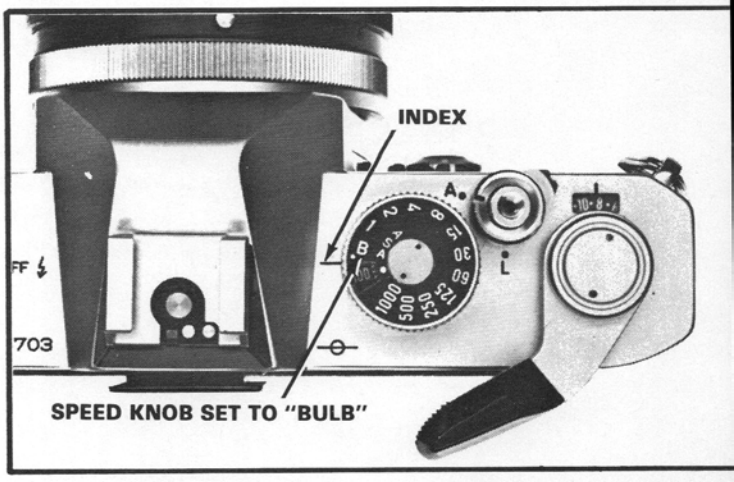
So BULB allows you to control the length of the exposure with your finger. This control permits pictures in very dim light—light so dim that even the 1-second shutter speed is too fast to do the job. Naturally, you'd have to be photographing a subject that doesn't move (unless you're after a blur). And you'd have to lock the camera in position so it doesn't move. Camera movement, like subject movement, results in a blurred picture.

There're other creative uses for the BULB setting. For example, say you're photographing a fireworks display at night. By holding open the shutter on BULB, you can catch several bursts in the same picture. That can be quite an effect. You'll learn other uses for the BULB control as you progress in the course.

Like the BULB setting, the TIME setting holds open the shutter. But here, you don't have to hold down the release button. Push the release button once to open the shutter—push the release button a second time to close the shutter. On TIME, you can lock the shutter open and walk away from the camera. Light continues to burn the image onto the film until you push the release button a second time.

There's one variation in the TIME operation. With some cameras, depressing the release button a second time doesn't close the shutter. The shutter stays open until you select a different shutter speed.

FIGURE 5



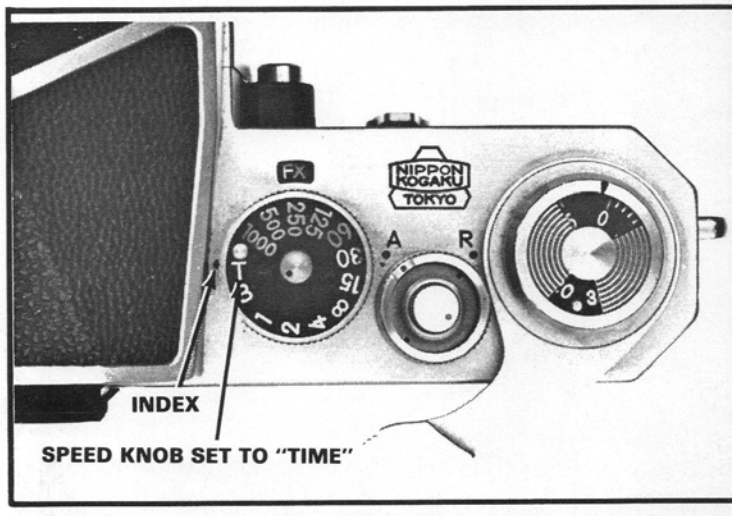


FIGURE 6

The shutter speed is only one of the variables built into a camera to control the exposure. The other variable is the **DIAPHRAGM OPENING.** We'll examine the diaphragm control in the next topic.

FIGURE 7

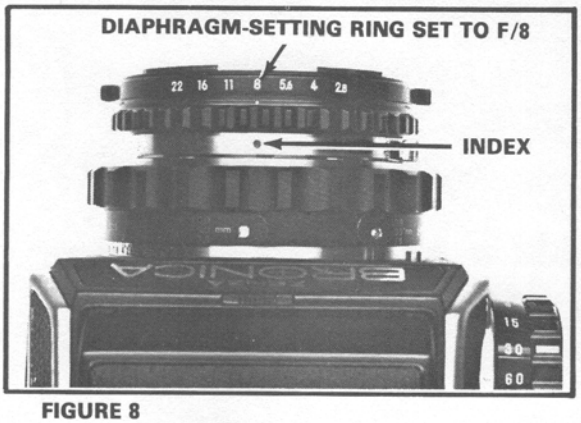


FIGURE 8

THE DIAPHRAGM CONTROL

Most refined cameras have an adjustable diaphragm. The **iris** diaphragm consists of a set of overlapping leaves. Turning the **diaphragm-setting control** causes the leaves to swing in one direction or the other. And the hole at the center of the leaves gets bigger or smaller, Fig. 7.

The hole at the center of the leaves is the diaphragm opening. This diaphragm opening controls the **intensity** of the light reaching the film—how much light passes through the lens. A larger hole allows more light to pass through the lens to the film. A smaller hole allows less light.

> Remember, the shutter governs **how long** the light reaches the film. The diaphragm opening controls **how much** light reaches the film.

Now, suppose that you want more exposure to the film. You have two choices. For one, you can set a slower shutter speed—that allows the light to reach the film for a longer period of time. Or you can set a larger diaphragm opening. Then, the film sees more of the existing light.

If you want to cut down the exposure, you can set a faster shutter speed. Just as effective—set a smaller diaphragm opening. The smaller diaphragm opening cuts down the intensity of the light reaching the film.

Diaphragm openings have their own calibration system. But diaphragm-opening calibrations aren't quite as obvious as are the shutter-speed calibrations. You might think that a diaphragm would be calibrated in fractions of an inch or in millimeters. But it's not. It's calibrated in f/numbers.

The f/number is a ratio—a ratio that requires a little mathematics to tell you the exact size of the diaphragm opening in inches or millimeters. But it tells you the relative size of the diaphragm opening at a glance. Here's how—

Take a look at a typical diaphragm scale, Fig. 8. Here, you'll find calibrations like

f/22
f/16
f/11
f/8
f/5.6
f/4
f/2.8.

Notice the relationship between the size of the diaphragm opening and the f/number. The larger the f/number, the smaller the diaphragm opening. Seem backwards? Maybe, but there's a reason.

We mentioned that the f/number is a ratio. To be more precise, it's the focal length of the lens divided by the diameter of the lens opening. As yet, we haven't discussed lens focal length—that's the subject of a later text. So all you really have to remember at this point is one rule:

The smaller the diaphragm opening, the larger the f/number. F/16 is a smaller opening than is f/8. F/4 is larger than f/22.

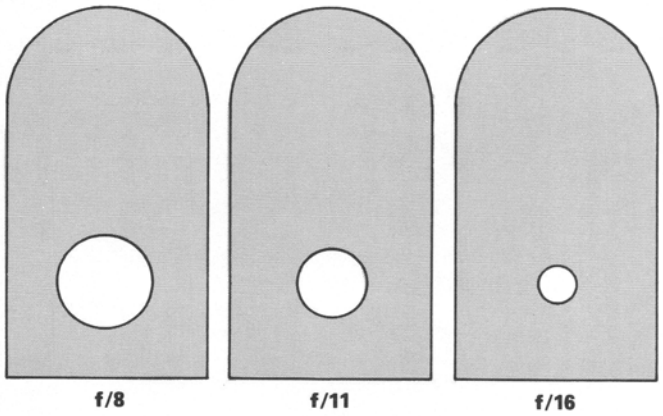


FIGURE 9
Waterhouse stops—masks with varying sized holes that provided the diaphragm opening in early camera designs. The photographer dropped the proper mask into a slot in the lens mount.

Some of the f/numbers may seem pretty strange—like f/2.8 and f/5.6. Why pick numbers that come out decimals? Like the shutter speeds, the diaphragm openings have definite—and functional—relationships to one another. Again, setting the next calibration doubles or halves the exposure to the film.

As you now know, f/4 is a larger diaphragm opening than is f/5.6. But there's more to it than that. In effect, f/4 is twice as large as is f/5.6. It allows twice as much exposure to the film.

Similarly, f/16 allows half as much light to pass as does f/11. And twice as much light as does f/22.

We can now examine the relationship of the f/numbers to the shutter speeds. Say you're set to 1/250 second and f/16. And you want twice as much exposure to the film. You can get the desired result by setting a shutter speed of 1/125 second—or by setting a diaphragm opening of f/11.

What would happen, then, if you set 1/125 second and the next smaller f/number? Now, you're at 1/125 second and f/22. You've doubled the exposure time over the original setting of 1/250 second. And you've halved the light intensity by setting f/22 rather than f/16. So your new settings have cancelled out—the exposure to the film is the same as it was at 1/250 second and f/16.

Frequently, you'll see the diaphragm opening referred to as the **f/stop.** The term "stop" carries over from bygone days when the diaphragm opening was controlled by a stop—a plate with a hole the proper size. The photographer had a series of stops with openings of different sizes. To control the aperture, he simply inserted the desired stop behind the lens. F/stop—f/number—diaphragm opening. They all mean the same thing.

Figure 10

Sometimes you want good depth of field—everything in the picture sharp and clear. But limiting the depth of field can often result in a more effective picture. In this example, only a small portion of the subject is in sharp focus. The rest forms a soft blur of shapes to frame the subject.

TRANSMISSION STOPS

Some camera systems use the term **transmission stop.** Or **T/stop.** As far as taking pictures is concerned, T/stop means the same thing as does f/stop. A T/stop of T/11 allows twice as much light as does a T/stop of T/16—half as much as T/8.

The only difference between T/stops and f/stops is the method of measurement. Remember the f/stop is a mathematical ratio between the lens focal length and the diameter of the opening. But the T/stop results from actually measuring the amount of light passing through the lens.

So T/stops are more accurate than are f/stops. They tell you how much light actually passes through the diaphragm opening—not how much light should pass according to a mathematical formula.

DEPTH OF FIELD

You've seen one function of the different f/stops—controlling the amount of light reaching the film. But, like the different shutter speeds, f/stops also allow a creative control. It's called depth of field.

Depth of field refers to the distance in front of and behind the subject that's in acceptable focus—the area that appears sharp. If you have a photograph handy, take a look at the subject of the picture. The subject should appear in sharp focus. Then, examine the area in front of the subject. And the area behind the subject. Do these areas appear sharp? Or blurred?

The f/stops allow you to control the sharpness of the areas in front of and behind the subject. With shallow depth of field, these areas appear blurred. And with wide depth of field, these areas appear sharp. The greater (or the wider) the depth of field, the greater the depth of sharpness.

To increase the depth of field, set a smaller f/stop. At f/16, for example, there's quite a distance in front of the subject that appears sharp. And there's quite a distance behind the subject that appears sharp. Much more so than at f/2.8.

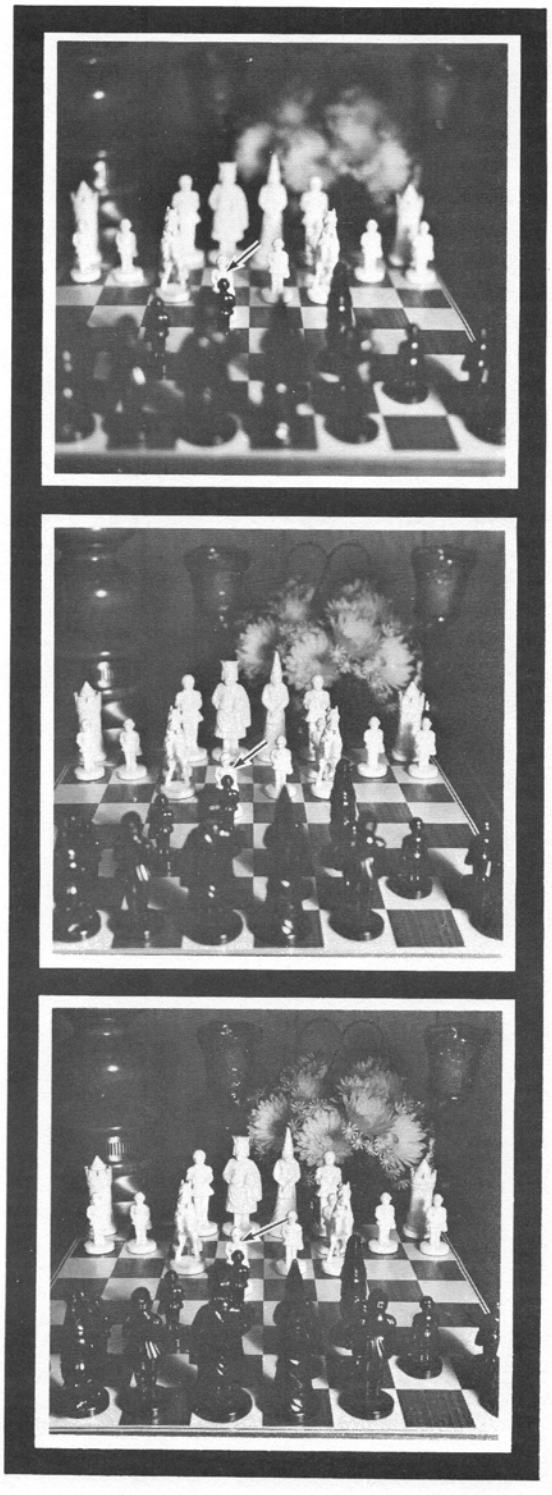
The smaller the diaphragm opening, the greater the depth of field.

A wide range of f/stops gives you a choice in the amount of depth of field. So depth of field is a creative control. Perhaps the foreground and the background in a picture are disturbing—they steal attention from the subject. Here, your f/stop selection provides a valuable control. You can make the background and the foreground look softer—slightly out of focus—by setting a larger diaphragm opening. Then, the subject really stands out.

Or perhaps you want the entire picture to be in sharp focus. In that case, you need a small diaphragm opening.

The diaphragm control is just one of the factors affecting depth of field. You'll learn about other factors as you progress through your course. And, in your photography assignments, you'll learn more about using depth of field as a creative control.

FIGURE 11
Depth of field—what a difference an f/stop makes. The first picture was shot at f/2.8, the second at f/8, and the third at f/22. In each picture, we focused on the pawn marked by an arrow.



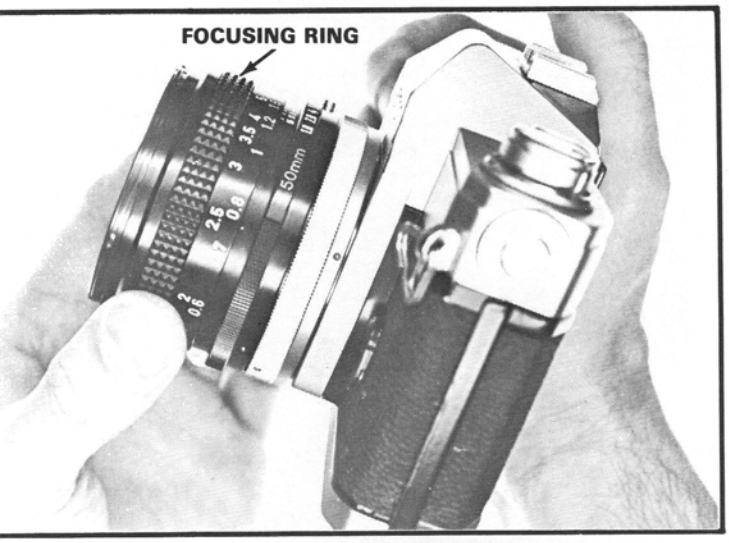


FIGURE 12

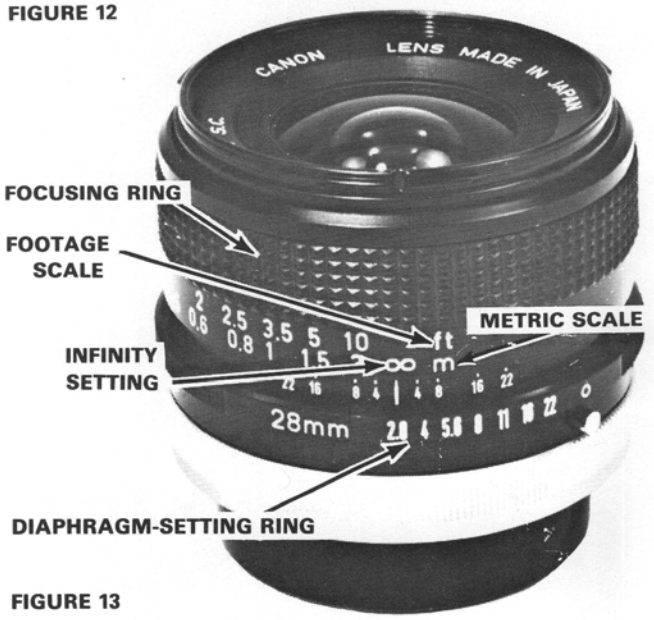


FIGURE 13

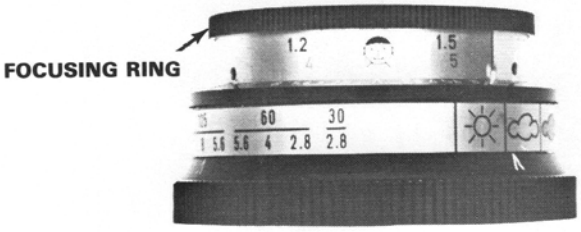


FIGURE 14

This focusing ring uses pictures to mark normal distance settings for typical shots. The person's face shown here marks the proper setting for portraits—between 4 and 5 feet.

THE FOCUSING CONTROL

We've already talked about focus. A subject that appears sharp on the picture is **in focus.** A subject that doesn't appear sharp may be **out of focus.**

The focusing control allows you to decide which part of the picture will be sharp. Most of the refined cameras allow you to change the position of the lens. Then, you can move the lens closer to the film or further from the film. The position of the lens controls the sharpness of the subject. Moving the lens according to the subject distance—that's called **focusing.**

Usually, the focusing control is a ring encircling the lens, Fig. 12. Turning the **focusing ring** moves the lens in or out—toward the film or away from the film. Notice the calibrations on the focusing ring—in feet and in meters, Fig. 13. That means you can focus the lens according to the distance between the film and the subject.

Simpler cameras use **fixed-focus lenses.** You can't change the distance setting. Usually, the factory sets the lens for the average distance of the subject in most snapshots—around 15 feet. The camera then relies on depth of field to assure that the rest of the picture is acceptably sharp.

But a focusing lens allows you to zero in—concentrate on the area of the picture you want to be sharp. Say, for example, you're shooting a picture of a sunset. Your subject is a long ways away—beyond the maximum distance setting of the focusing ring. In photographic terms, that's **infinity.** The subject, for all practical purposes, is an infinite distance from the camera.

Here, you'd use the "infinity" setting of the focusing ring. The word "infinity" isn't on the focusing-ring scale. Instead, there's a symbol meaning "infinity." The infinity symbol looks like a figure "8" lying on its side, Fig. 13.

For a closer subject, use the appropriate distance setting. If the subject is 15 feet away, turn the focusing ring to 15 feet. Your subject will then be sharp—in focus. How about the areas in front of and behind the subject? That depends on the depth of field. Depth of field, you'll recall, depends on the f/stop.

Guessing the distance setting can be a problem. So many cameras use a **zone-focusing** technique. For example, the focusing ring shown in Fig. 14 has pictures for typical distance settings. If you're shooting a portrait, turn the focusing ring until the picture of a person's head aligns with the focusing scale index. A picture of mountains or some type of scenic marks the proper setting for distant subjects.

But more sophisticated cameras usually have focusing aids—gadgets that allow you to "measure" your subject distance. Then, you don't have to try and guess how far away your subject is.

One such focusing aid is the **rangefinder.** As you look through the rangefinder, you usually see two images. Then, as you turn the focusing ring, the two images merge into one.

When you see a single image, you know that the focusing ring is set for the proper subject distance.

As you progress through the course, you'll learn about the various focusing aids—how they work and how the adjustments are made.

You've seen that you can use your depth of field as a creative control. But how do you know how much depth of field you have? Many lenses have scales to provide this information. The **depth-of-field scale** is next to the focusing scale, Fig. 16.

The depth-of-field scale shows your depth of field at a glance. In Fig. 16, we've set the focusing ring to 7 feet. Let's say your diaphragm opening is f/16. The lines on the depth-of-field scale extending from the "16" calibrations (one on each side of the index) show you the limits of your depth of field.

So read the depth of field from the focusing scale, At f/16, the scales show that everything between 5 and 10 feet will be acceptably sharp, Fig. 16. Notice how the larger apertures indicate a more limited depth-of-field range.

Some lenses have movable depth-of-field indicators. The depth-of-field indicators on the Hasselblad lens shown in Fig. 17 move as you set the diaphragm opening—closer together for larger f/stops, further apart for smaller f/stops. Again, you can read your depth-of-field limits directly from the focusing scale.

Locate the focusing-scale calibrations in Fig. 17 that align with the depth-of-field indicators. The indicators tell you that everything between 10 feet and 25 feet will be in acceptable focus.

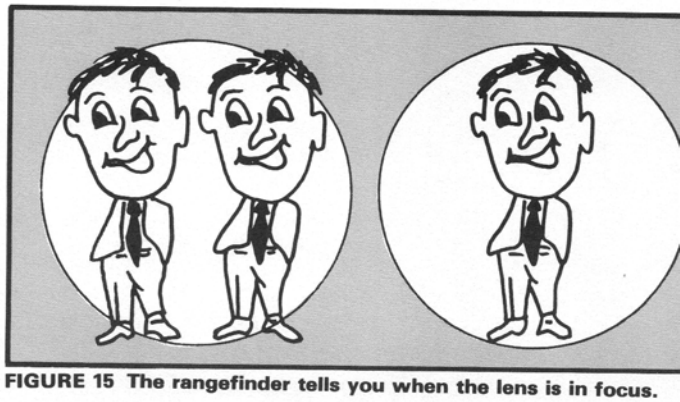


FIGURE 15 The rangefinder tells you when the lens is in focus.

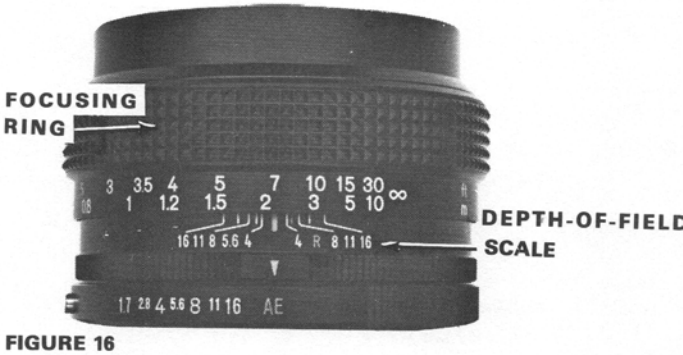


FIGURE 16

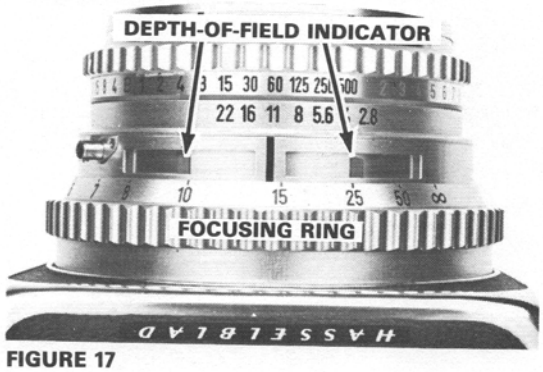


FIGURE 17

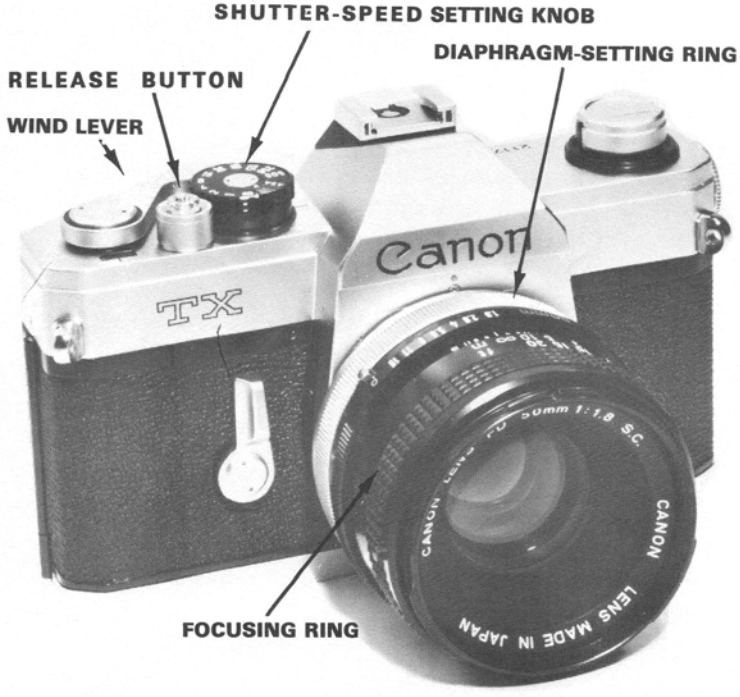


FIGURE 18
Picture controls in a typical, sophisticated camera. ***Photo courtesy of Canon.***

FIGURE 19
A spool of 120 roll film. A piece of tape holds the end of the paper backing. Remove this tape to load the film.

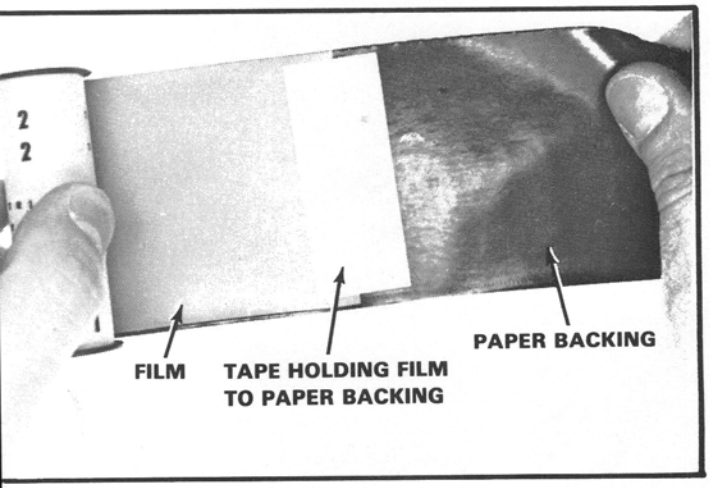


FIGURE 20
This is the side of roll film you never see—the inside. A piece of tape holds the film to the paper backing. So pulling the paper backing pulls the film through the camera.

FIGURE 21
The Kodak Brownie Starmite, an early box camera using 127-size roll film. 127-size roll film is similar to 120-size roll film. But its format is smaller.

THE BOX CAMERA REVISITED

We mentioned the box camera earlier in your text. The box camera pictured on the last page of that section really fits the term—it looks like a box.

You don't often see cameras like that one anymore. But you do see their more sophisticated descendents. The box-camera category goes beyond cameras that look like boxes.

By definition, a box camera is any camera which has all of its major parts fixed—immovable. So you don't have the picture controls we talked about in the last section (focusing control, diaphragm control, shutter-speed control).

Even a folding camera, such as the one pictured earlier can fit the box-camera category. The folding camera adds a touch of sophistication—the **bellows.** A bellows forms a flexible, lighttight connection between the camera body and the lens/shutter assembly. It collapses, like an accordian, to make the camera more compact for storage and carrying. The folding camera doesn't look like a box. But if it has fixed focus, one shutter speed, and one diaphragm opening, it fits the category. The advantages of the early box cameras still remain—easy to use for just about anyone, even the beginner.

But in one respect, the earlier box cameras aren't so easy to use. That's in loading the film. The box cameras we're talking about use 620-size, 127-size, or 120-size roll film, Fig. 19.

"Roll film" describes how the film is packaged. It comes in a roll. A paper backing wraps around the actual film. This paper protects the film from light.

To load the film, mount the roll at one side of the camera—in the **supply chamber.** And pull the paper backing across to the other side—to the **take-up chamber.** Hook the paper backing in the slot of the take-up spool. Advancing the wind mechanism then wraps the film and paper backing around the take-up spool, until the first frame of the film is in position. That sounds easy enough. But it's quite a chore to some people.

The whole film-loading problem found a solution in the 1960s. That's when Kodak made one of the greatest of contributions to beginning photographers—**instant film loading.** The **film cartridge** was born. Cartridge-load cameras soon swept the picture-taking world. And in many stores, they continue to be among the best sellers of all camera types.

THE 126-CARTRIDGE LOADS

Kodak, such a great innovator in photography, has become the tradename most familiar to the majority of the people—so much so that many people continue to call every camera a "Kodak."

And many people continue to call every cartridge-loading camera an "Instamatic." That's Kodak's tradename for their cartridge-loads.

You'll be servicing many types of "Instamatics"—from different manufacturers, in different price ranges, in varying degrees of sophistication. But they all have one thing in common—they all use drop-in-loading film cartridges.

The camera shown in Fig. 22 uses the 126-size cartridge—that was the first type. The entire roll of film is inside the lighttight cartridge. To load the camera, you just open the camera back and drop in the cartridge, Fig. 23. Close the camera back and advance the wind lever until it locks. You're now ready to take pictures.

The simplest of the 126-cartridge loads are true box cameras. The lens has fixed focus—you can't change the focus setting. Normally, the manufacturer sets the lens to the best position for most snapshots—around 12 - 15 feet. A small, fixed diaphragm opening then provides good depth of field. So subjects at other distances are reasonably sharp.

There are usually only two shutter speeds. One for available-light shots (outdoors), another for flash exposures. Flash exposures normally require a slower shutter speed. So the camera automatically selects the slower speed when you install the flashbulb.

As you might expect, the simple cartridge-loads are the least expensive. For more money, you get more features. Like full-focusing lenses. And shutters that automatically program different shutter speeds. The top-of-the-line cartridge-loads may have all the features of the most refined cameras.

FIGURE 22
A 126-size (pronounce "one twenty-six") cartridge-load camera. Open the camera back by pushing up the back latch.

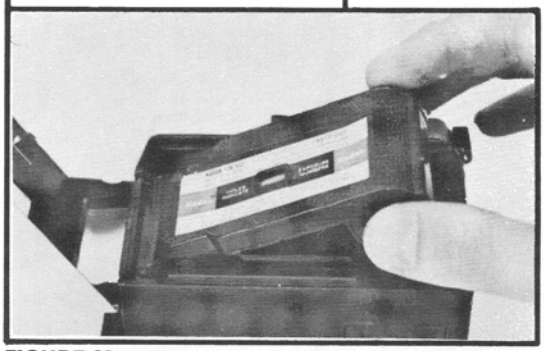


FIGURE 23
Dropping in the 126 film cartridge. Shown here is a test cartridge. Technicians use the test cartridge when checking repaired cameras for proper operation. You can use the test cartridge over and over.

THE 110-CARTRIDGE LOADS

Kodak followed up the success of the 126-cartridge loads with a new benefit — **pocket-sized compactness.** The 110-cartridge loads are very similar to the 126-cartridge loads. But they're much smaller, Fig. 24

The 110-size cartridge looks like a miniature version of the 126-size cartridge, Fig. 25. Like its larger cousin, the 110-size cartridge comes with various types of film.

Now, many manufacturers produce 110-size cartridge-load cameras. But to most people, all these tiny cameras are known by Kodak's tradename—**Pocket Instamatics.**

The 110-cartridge load almost looks like a harmonica. The release button is at the top of the camera, Fig. 26. But there's no wind lever. You advance the film and simultaneously cock the shutter by using the **thumb slide** at the bottom of the camera, Fig. 27.

It takes two strokes of the thumb slide to fully advance the film. Then, the thumb slide locks—you can't advance it again until you release the shutter.

There's a variety of models. They're all very similar, even those made by other manufacturers (they have to be—they're all designed around the same cartridge). The differences are in the refinements. Again, like the 126-cartridge loads, the top-of-the-line pocket cameras have a full range of features.

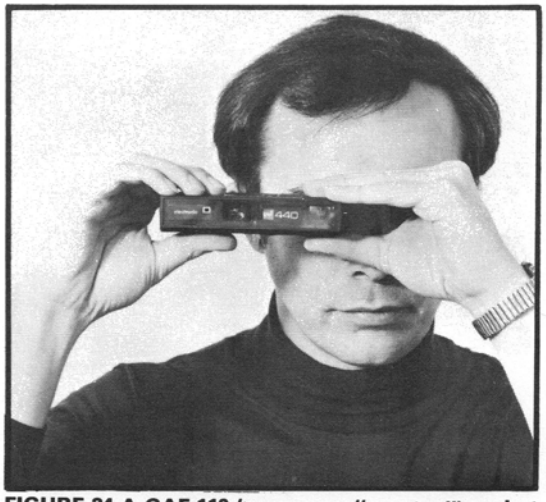


FIGURE 24 A GAF 110 (pronounce "one ten") pocket camera. "440" is the camera model.

110-size Cartridge

126-size Cartridge

FIGURE 25

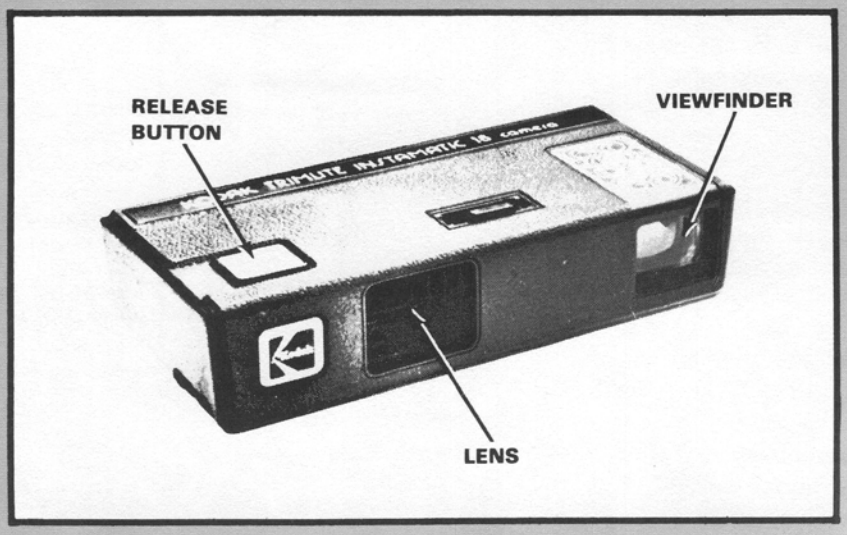


FIGURE 26
A Kodak Trimlite Instamatic. There's a series of Trimlite models that covers a range of features and prices. *Photo courtesy of Eastman Kodak.*

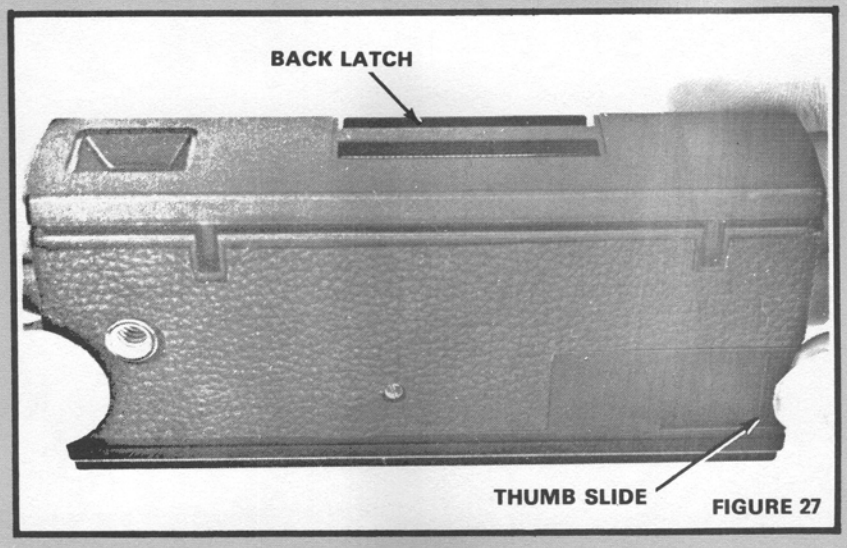
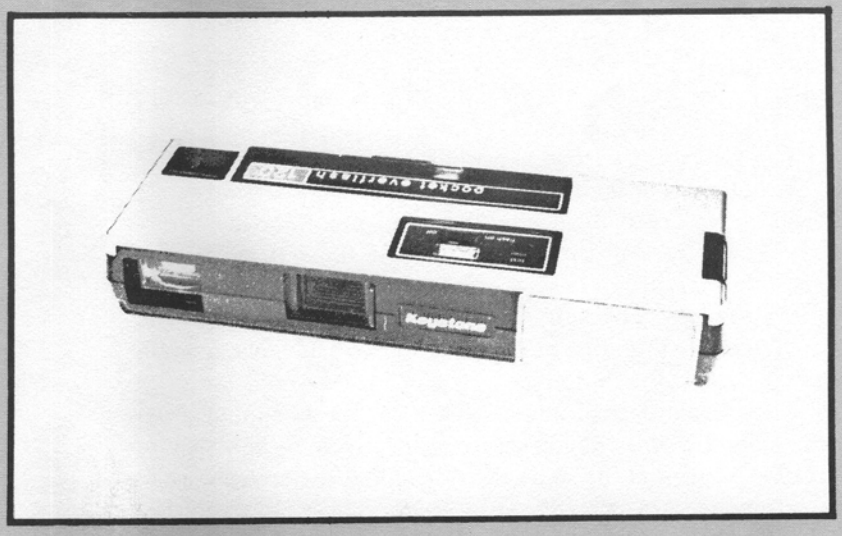


FIGURE 27

FIGURE 28
A 110-cartridge load with built-in electronic flash. The benefit—you never need flashbulbs. You'll learn other advantages of electronic flash later in your course.



THE 35mm CAMERA

The name "35mm" refers to the film size. 35mm is the size of the film used in making professional movies, those you see in a theater. And the first 35mm still camera, the Leica, was really designed around this 35mm film

35mm film comes packaged in a lighttight cassette, Fig. 29a. There's no paper backing. A **film leader**—a section of film—extends from the cassette. This leader has already been exposed to light. So its only purpose is for loading the camera.

First, you put the film cassette in the **supply chamber,** Fig. 29b. Then, you pull the film across the camera. And hook the leader to the **take-up spool.** The film now extending from the cassette has been exposed to light—it won't be used for pictures.

Notice the perforation holes on both edges of the 35mm film. The **sprocket** inside the camera, Fig. 29b, engages the perforation holes. So when you load the camera, you must make sure that the teeth on the sprocket are engaging the perforation holes in the film.

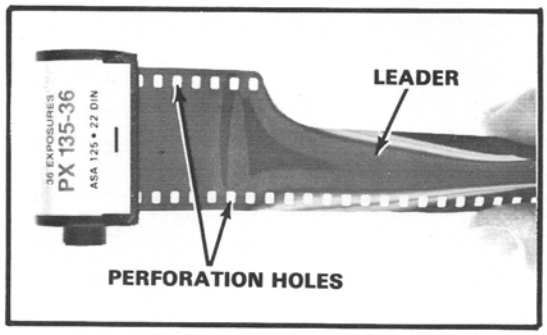
As you advance the wind lever, the take-up spool turns. That's what advances the film. The film wraps around the take-up spool. The sprocket also turns. But the sprocket isn't advancing the film—it's **metering** the film. It's making sure that the proper amount of film advances each time.

The sprocket always turns the same amount during the wind stroke. But the take-up spool doesn't. How much the take-up spool turns depends on the amount of film you've wound. As the film wraps around the take-up spool, the spool's diameter increases.

So the take-up spool would like to pull across more and more film each time you advance the wind lever. If it could do that, you'd have uneven spacing between the film frames. So instead, the take-up spool turns until the sprocket stops the film. Then, the take-up spool "slips"—it stays put even though you continue to advance the wind lever. A slip-spring mechanism inside the take-up spool provides the slipping action.

Once all the pictures have been taken, you must return or **rewind** the film to the cassette. Push the **rewind button** to disengage the sprocket—the sprocket can then turn freely in the reverse direction. Then, turn the **rewind knob** or **rapid rewind crank** until all the film is wound back into the lighttight cassette.

FIGURE 29a
A 35mm film cassette. Notice the shape of the leader extending from the cassette.



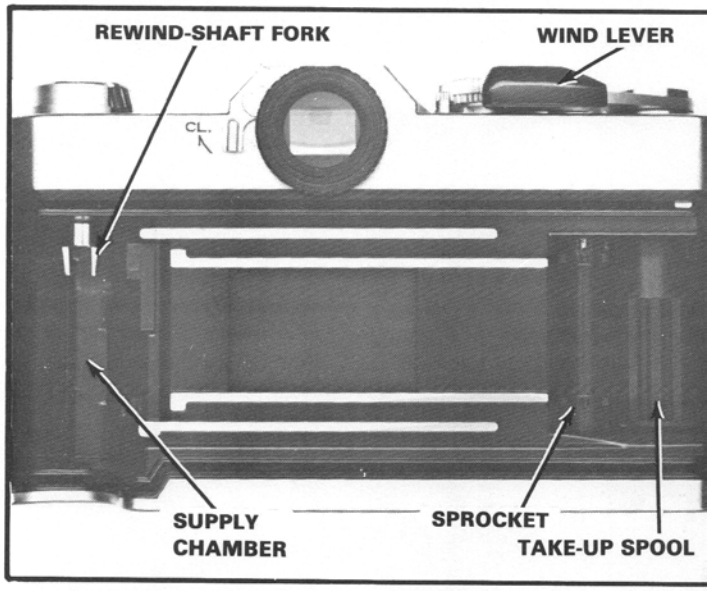


FIGURE 29b

35mm FORMATS

The 35mm cassettes are available in 20-exposure rolls or in 36-exposure rolls. Plus, you can get just about every film type in the 35mm size. You have a lot more variety in 35mm film types than you do in cartridge-load film types. So there's one benefit of the 35mm camera—it'll handle more types of film.

FIGURE 30
Full-frame 35mm format (actual size).

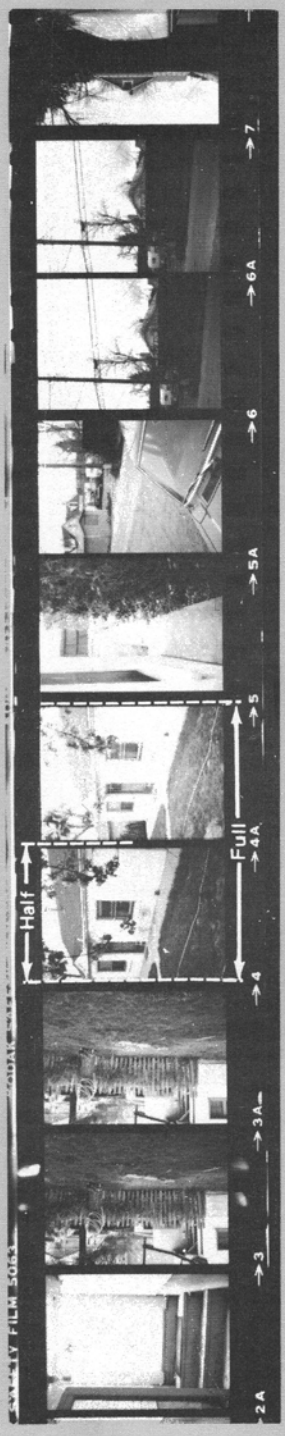


FIGURE 31
Half-frame 35mm format (actual size).

Most 35mm cameras use the **full-frame format,** shown actual size in Fig. 30. Notice that the full frame measures approximately 35mm horizontally. The film processor then enlarges the tiny image to make a picture of the desired size. There's another name for the full-frame format—**double-frame.**

By contrast, a **single-frame camera** uses about half of the full frame, Fig. 31. You'll normally see the single-frame camera referred to as a **half-frame camera.** Since the half-frame camera exposes just half of the full-frame format for each picture, you get twice as many exposures per roll—72 exposures with a 36-exposure roll, 40 exposures with a 20-exposure roll.

So in one respect, the half-frame camera has an advantage over the full-frame camera—more exposures per roll. But there's also a drawback. Since the half-frame camera uses a smaller format, it gives you a smaller image. The film processor must then enlarge that half-size image twice as much to get the same size picture. And the quality generally suffers as the amount of enlargement increases. You'll learn about the problems in making a large picture from a small film size a little later in your course.

Chances are you won't encounter too many half-frame cameras these days. At one time, half-frame cameras enjoyed widespread popularity. The main reason for the popularity was the smaller size of the cameras (compared to full-frame 35mm cameras).

However, modern technology has really scaled down full-frame designs. Modern full-frame cameras may be as small or smaller than the half-frames—an example is the Minox shown in Fig. 32. As a result, the half-frame cameras have just about vanished. And our discussion of 35mm camera types will stick to full-frame formats.

TYPES OF 35mm CAMERAS

You'll sometimes see the 35mm camera referred to as a "miniature" camera. Compared to other cameras of the day, the first 35mm camera was indeed very small. Compared with some of the other types now available, most 35mm cameras aren't all that miniature. But the 35mm camera is nonetheless a compact, comfortable unit.

There are two basic types of 35mm cameras:

1. **the viewfinder type**
2. **the single-lens reflex**

Each type has its own advantages and drawbacks. So we'll look at them both.

THE 35mm VIEWFINDER-TYPE CAMERA

We mentioned that the first of the 35mm cameras was the German-made Leica. The Leica became the prototype for the swarm of 35mm designs that followed. Some were direct

copies—others offered their own contributions. The Leica is still going strong today, although greatly refined and improved. Fig. 33 compares a Leica of the 50's with a modern Leica.

Notice that the IIIf shown in Fig. 33 uses a separate window for the viewfinder. The M5 combines the viewfinder with one of the rangefinder windows. That's where the name "viewfinder-type" comes from. You'll also see the same cameras referred to as **rangefinder-type.** But not all viewfinder-type cameras have rangefinders.

As you've learned, the purpose of the viewfinder is to compose the picture. However, the image seen through the viewfinder always appears sharp—in focus, regardless of the lens setting. So the viewfinder doesn't help you in focusing the lens.

That's why many viewfinder-type cameras have rangefinders. The rangefinder, you'll recall, is a focusing aid. It optically measures the distance between the camera and the subject.

With a **noncoupled rangefinder,** you first look through the rangefinder to measure the subject distance. Then you look at the distance reading on the rangefinder scale. And you set the camera lens to the distance setting you noted. The noncoupled rangefinder may be built into the camera body. Or, you can get a noncoupled rangefinder as an accessory unit.

Most rangefinder-type cameras today, however, use **coupled rangefinders.** That means the rangefinder measures the subject distance as you focus the lens. Set the rangefinder by turning the lens' focusing ring.

One type of rangefinder has its own eyelens at the back of the camera. So you have two eyelenses—one for the rangefinder and one for the viewfinder. You look through the rangefinder eyelens to focus the lens. And you look through the viewfinder eyelens to compose the picture (Leica IIIf). But in many rangefinder-type cameras, the rangefinder is built into the viewfinder. You can then compose your picture and focus the lens while looking through the single eyepiece (Leica M5).

FIGURE 32
The tiny Minox 35EL uses 35mm film and weighs less than 7 ounces. The front "door" folds over the lens and viewfinder for additional compactness when you're carrying the camera.
Photo courtesy of Minox.

THE LEICA IIIf

A MODERN LEICA, THE M5

FIGURE 33

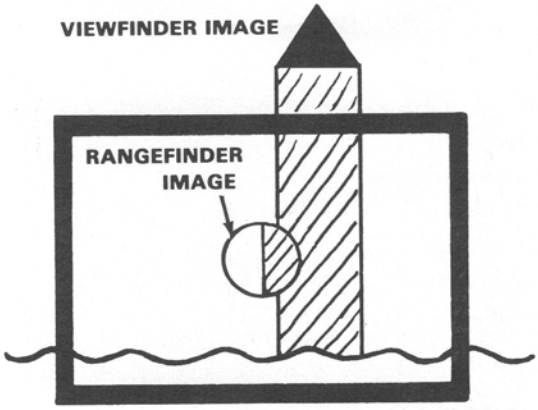


FIGURE 34

The split-image rangefinder separates an out-of-focus image. In this example, the rangefinder provides an image which superimposes on the image formed by the viewfinder. It's easiest to focus on vertical lines in the subject. And adjust the lens until the separated vertical lines come together.

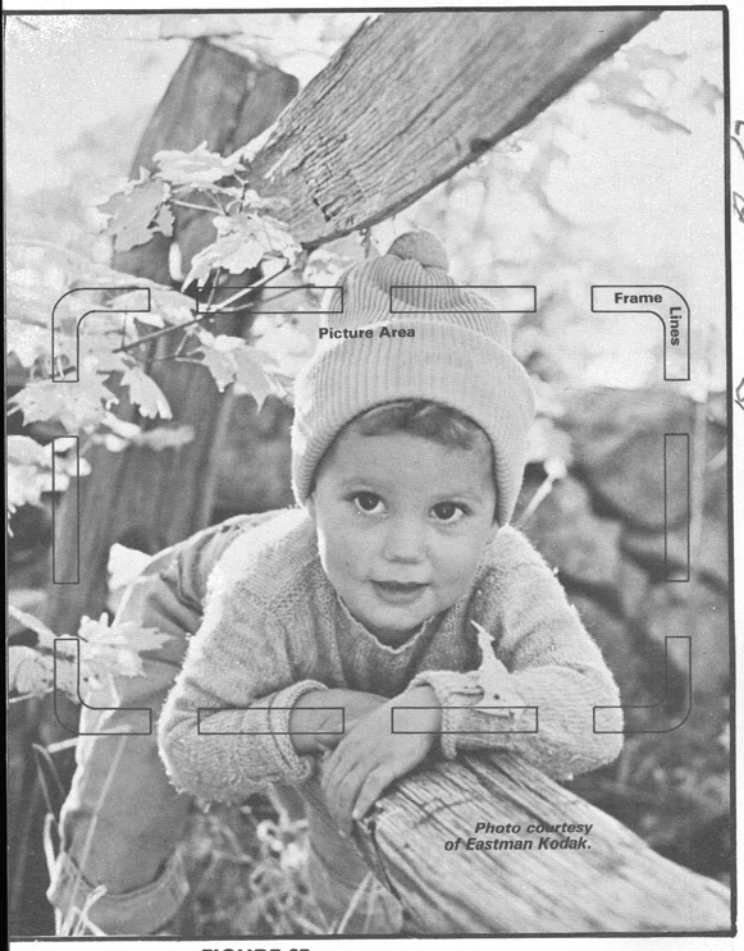


FIGURE 35

The type of rangefinder we discussed in the "Focusing Control" section is the **superimposed-image type.** That's where you see two images. You then focus the lens until the two images merge into one.

Another type is the **split-image rangefinder,** Fig. 34. Here, the rangefinder optically chops the subject in half. So you focus the lens until the two halves come together.

Either type of rangefinder is very fast to focus—that's one of the main benefits of the rangefinder-type camera. With a good rangefinder, it's easy to bring those two images together.

Simpler cameras may not have a rangefinder. If the camera has a full-focusing lens, you may have to guess the subject distance. And set the lens to the estimated distance setting.

Or, as we mentioned before, the nonrangefinder camera may use a zone-focusing technique. The focusing ring may be marked for normal subject distances. Sometimes, the different standard settings have click-stop positions. Other cameras may have the "normal" focusing distance marked in red or some other color—like "20 feet." Then, the photographer leaves the focusing ring at the red calibration for most pictures.

There's one drawback to the rangefinder-type camera (or any camera that has a separate viewfinder system). The viewfinder sees a slightly different picture than does the lens. That's because the viewfinder sits above and to one side of the lens, Fig. 36. The result—what you see isn't exactly what you get.

So the image formed on the film may not be exactly what you thought you were getting. A slight difference between what the lens sees and what the film sees—that's called **parallax** (pronounced pair' a lacks).

Parallax isn't much of a problem at long camera-to-subject distances. But it does become a problem when photographing close-ups. Then, it's possible for the lens to completely miss the subject you're viewing.

Many rangefinder-type cameras use special parallax masks inside the finder. These masks may move as you focus the lens. They then control the viewfinder image according to the lens-to-subject distance. Other cameras use frame lines in the finder. Frame lines, such as shown in Fig. 35, may move as you focus the lens. With sophisticated cameras, installing a different lens automatically selects the frame lines you see—different frame lines for different lenses.

All you have to do is compose your subject within the frame lines. A portion of the subject that's outside the frame lines won't be in the lens' field of view.

Parallax-compensating masks or frame lines help in composing the picture. But there's still a problem at extreme close-ups. And that's one of the reasons another type of 35mm camera has enjoyed such widespread popularity—the single-lens reflex. With the single-lens reflex, you view the subject through the same lens that takes the picture. What you see is what you get.

THE 35mmSINGLE-LENS REFLEX

Here's the most popular type of all the refined cameras—the 35mm Single-Lens Reflex, or SLR (pronounce each letter). Single-lens because there's only one lens, Fig. 37. Reflex because you actually view the subject through the same lens that takes the picture.

"Reflex" refers to the optical system that allows you to view through the lens. The camera optically redirects the light to your eye. Optical components bend the light path through the camera.

Consider what happens inside the single-lens reflex. The light comes through the lens. A **mirror** then catches the light, Fig. 38. Now, the mirror sends the light straight up. And the light forms the image on the **focusing screen.**

The focusing screen may be a piece of **ground** glass—glass that's ground or frosted on one side. The image forms on the ground, or frosted, surface. Most of the modern SLR's, though, use a plastic **Fresnel lens** (pronounced fre-nell′) as the focusing screen. The Fresnel lens acts to provide a brighter image. Notice the ridges in the Fresnel lens, Fig. 39. If you could extend each ridge, as indicated by the dotted lines, you'd have a series of lenses. These lenses act to amplify the light.

If the lens is properly set to the subject distance, the image on the focusing screen appears sharp—in focus. An out-of-focus image appears blurred on the focusing screen. You then focus the lens until the image on the focusing screen appears sharp.

View the focusing-screen image in Fig. 38 by looking straight down on the camera. That's **waist-level viewing.** Hold the camera at waist level to compose the picture and to focus the lens.

Normally, a **hood,** Fig. 38, blocks off stray light. Without the hood, the light around you makes the focusing-screen image hard to see. There's often a **magnifier** in the hood to increase the image size—that makes it possible to focus precisely.

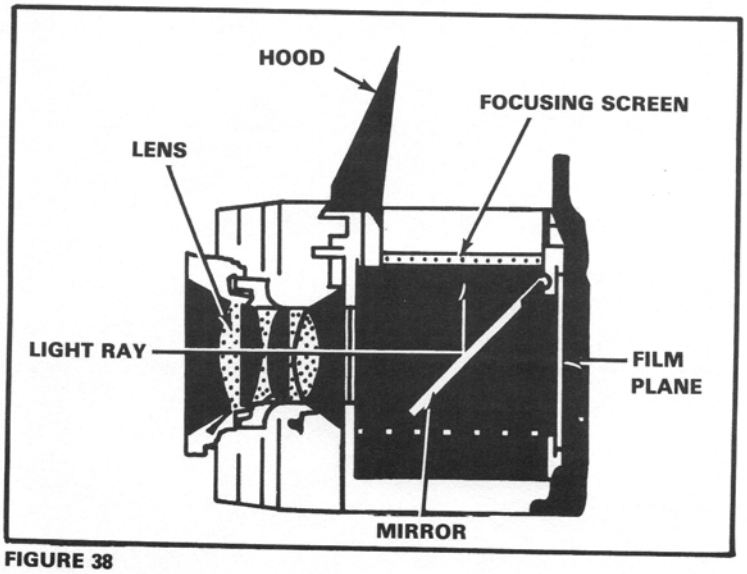


FIGURE 38

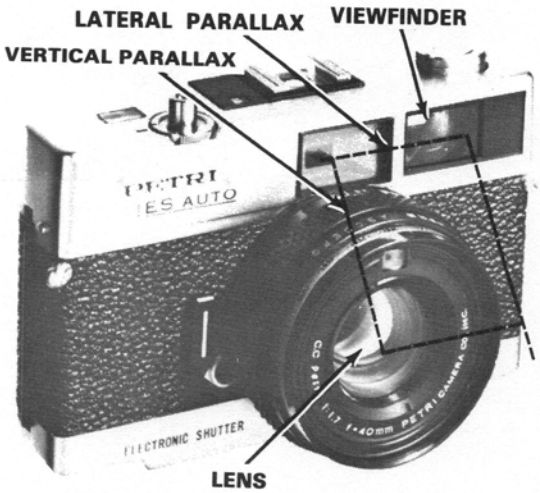


FIGURE 36

FIGURE 37

A complaint you'll sometimes hear about SLR's is that they're too large and heavy compared to other camera types. But cameras like the Olympus OM-1 and this Canon AE-1 proved that an SLR doesn't have to be large. These super-small SLR's are as compact as many rangefinder types. In the AE-1, everything is electronically controlled—there's a miniature computer inside the camera. So the camera, though electronicallycomplex, is mechanically simple.

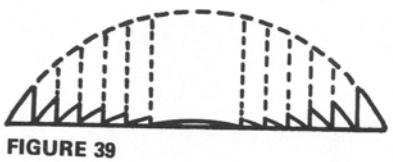
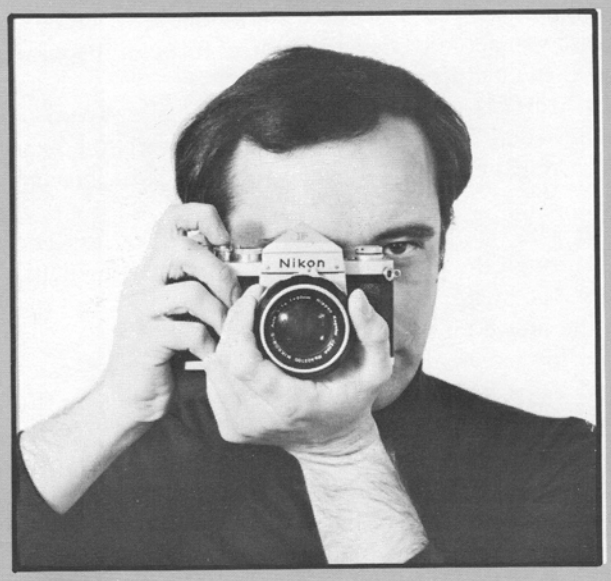
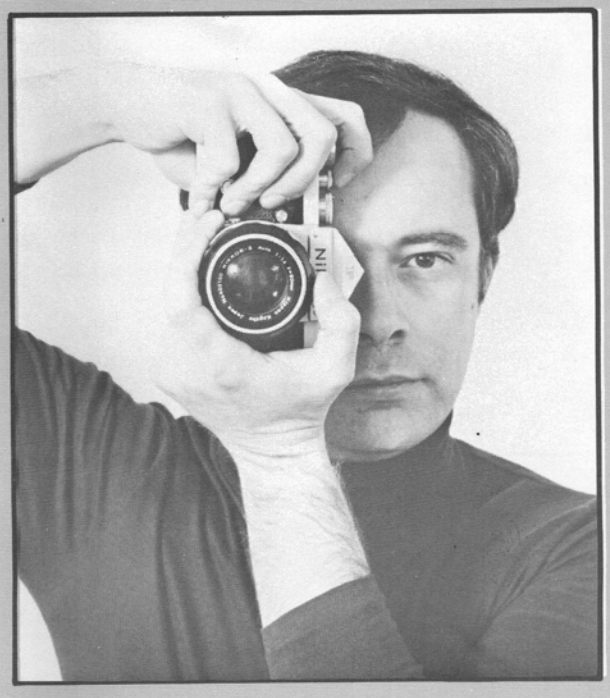


FIGURE 39



HORIZONTAL



VERTICAL

FIGURE 40
With the 35mm format, you can get either a vertical picture or a horizontal picture—it just depends on how you hold the camera.

The image on the focusing screen then appears reversed from left to right—like a mirror image. That's because the camera's lens does two things to the image. For one, it turns the image upside down. It also reverses the image from right to left. Turning the image upside down is called **inverting** the image. Reversing the image from right to left is called **reverting** the image.

If you place a ground glass at the picture area, you'll see the image formed by the lens. But the image is inverted and reverted—upside down and reversed from left to right. The mirror in the SLR corrects the image in one plane—it turns the image right side up. But the image remains reversed from right to left on the focusing screen.

The reverted image isn't really a problem—you soon get used to it. But most people prefer eye-level viewing. Then, you hold the camera at eye level, Fig. 40.

Eye-level viewing requires another optical trick—bending the light path back to the eye. Here's where the roof-angle **pentaprism** comes in. "Penta" means "five." So the pentaprism has five outer sides. But it only has three internal surfaces that actually affect the light.

The pentaprism sits above the focusing screen. The light then bounces off the three reflecting surfaces of the pentaprism as shown in Fig. 41. Now, you can see the focusing screen while holding the camera to your eye. Plus, the pentaprism reverts the image. So the image appears right side up and correct from left to right.

So far, we've just discussed the viewing system in the SLR. And you may be wondering how the SLR can take a picture. After all, doesn't the mirror block the light path to the film? It does indeed. But when you push the release button, the mirror flips up as shown in Fig. 42. Now, the light can pass through the open shutter to the film.

After the exposure, most SLR's automatically return the mirror to the position shown in Fig. 41. That's called an **instant-return mirror.** But in some SLR's, the mirror remains up until you advance the film to the next frame.

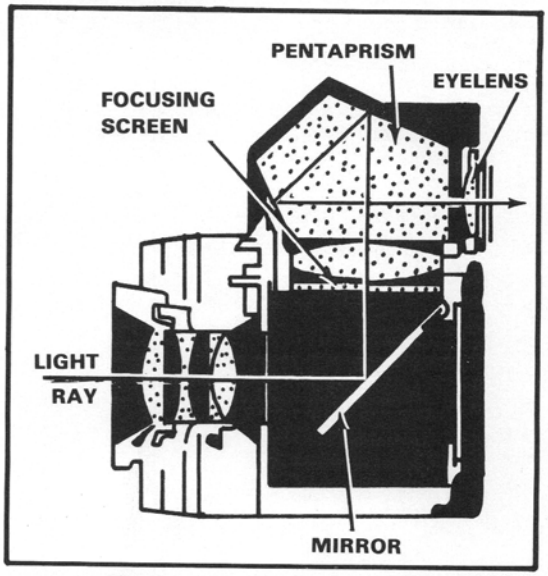
You can't see the image while the mirror is up, Fig. 42. So, for an instant, the image blacks out. It reappears when the mirror returns. The disappearing act of the image is called **blackout,** one of the main objections to the SLR.

Blackout isn't much of a problem with the instant-return mirror. At a fast shutter speed, you hardly notice it. But it does bother some people. So here's one of the benefits of the rangefinder-type camera—no image blackout.

Also, there's a slight time delay with the SLR—a lag between the time you push the release button and the time the shutter fires. That's because the mirror releases the shutter. And it takes a fraction of a second for the mirror to move out of the light path. If you're shooting action pictures, you might have to allow for the time delay.

Another objection to the SLR is the noise and vibration caused by the mirror movement. Modern SLR's dampen the

FIGURE 41
The pentaprism bends the light to your eye. And the eyelens magnifies the image. Since our drawing is two-dimensional, you can only see two of the pentaprism's three internal reflecting surfaces. The pentaprism causes the distinguishing "hump" in the top cover of most SLR's.



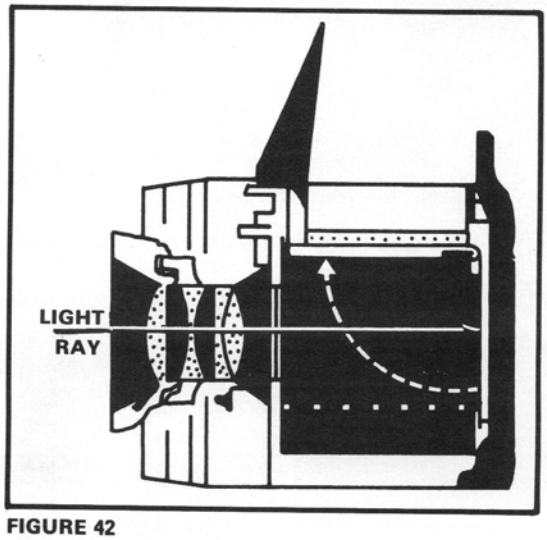


FIGURE 42
As the mirror moves up, it releases the shutter. That assures the mirror is out of the light path before the shutter opens.

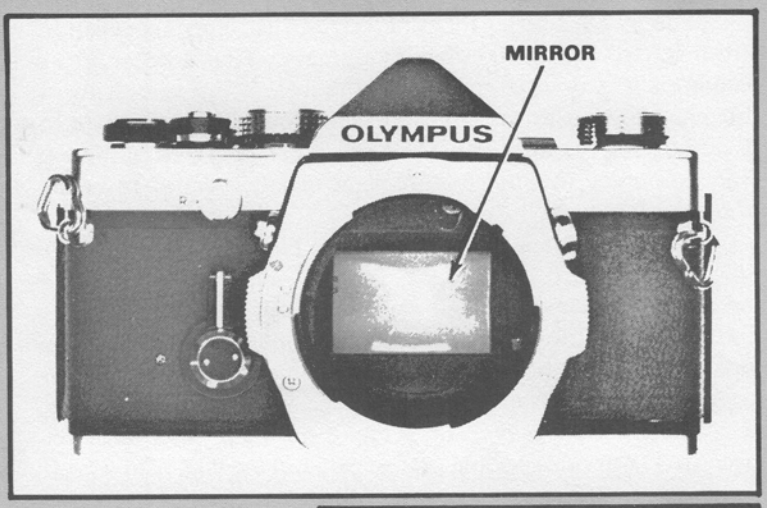


FIGURE 43
The "box" that holds the mirror and its driving parts is the mirror cage. Inside, the mirror cage has a dull-black finish. Dull-black paint soaks up light to prevent internal reflections. In some SLR's, the mirror cage has a light-thirsty corrugated-metal finish or a special suedelike finish.

FIGURE 44
Unwanted internal reflections result when the paint inside a camera gets chipped or scratched. Those reflections could fog the film. A special paint like this is valuable for touching up scratches in dull-black finishes. This one's a Kodak product, handled by many photo stores.

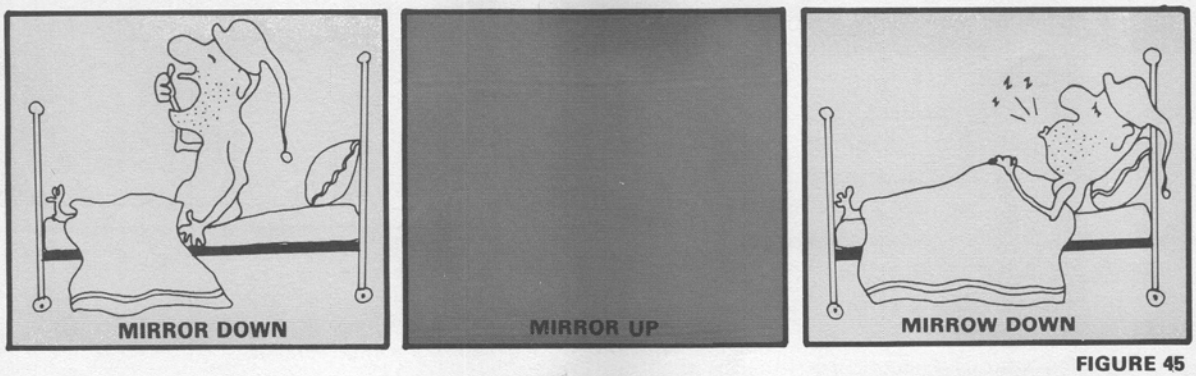


FIGURE 45
The objection to blackout—did you really get the picture you wanted? Or did your subject move?

mirror movement with sophisticated mechanical devices. But nonetheless, the SLR can't match the rangefinder-type camera for quiet operation. Chalk up another benefit to the rangefinder-type camera—quiet operation.

Why, then, is the SLR so popular? To many people, the advantages far outweigh the drawbacks. And the main advantage is the through-the-lens viewing—seeing the same image that the film sees.

We mentioned earlier that the through-the-lens viewing eliminates parallax. Most SLR's show you slightly less through the finder than you actually get on the film. That's an allowance for framing error—there's less chance you'll accidentally cut off part of your subject. Also, some film mounts block off part of the film area. Allowing you a little extra on the film takes care of what you may lose when the film is processed. So the SLR has a big advantage in close-up photography.

The through-the-lens viewing makes the SLR one of the most versatile of all cameras. The SLR can do just about everything. So it's especially attractive to the pro and to the advanced amateur—their interests reach to many types of photography.

Some SLR's extend their capabilities by providing many interchangeable components—and many accessories. Practically all SLR's feature interchangeable lenses. Several offer interchangeable focusing screens.

For example, the standard focusing screen often has a split-image **focusing aid** in the center. That helps you focus. You don't have to judge visually when the image is in sharpest focus—you just focus the lens until the two halves of the image come together. Fig. 47 shows the two optical wedges that split straight lines on the focusing screen. And Fig. 34 shows what you can see through the finder. But with a reflex-type camera, the image outside of the focusing aid appears blurred—out of focus—until you set the lens for the subject distance.

Another standard focusing screen has a **microprism focusing spot.** Here, a cluster of tiny prisms breaks up the out-of-focus image. The microprisms bring together a properly focused image to form a clear picture.

Some photographers may prefer another type of focusing screen. Perhaps a focusing screen with no focusing aid. Or one with lines or grids that help frame the image.

Also, some SLR's offer interchangeable finders. The pentaprism finder is usually standard. But some people may prefer the waist-level finder. The waist-level finder can be helpful for candid shots—situations where you don't want the subject to know you're taking a picture.

Besides interchangeable components, many SLR's accept special accessories. **Motor drives** attach to the camera to advance the film and release the shutter. The motor drive supplies all the power. All you have to do is hold a button depressed. You can then fire off pictures at a blistering pace—maybe 3 frames per second or faster. The motor drive appeals especially

FIGURE 46
Some wide-angle lenses extend so far into the camera body that they interfere with the mirror. So many SLR's have a mirror-lock-up feature. Turning a knob or pushing a button manually raises the mirror. Then, you can no longer see through the lens—you have to use an accessory finder. Photographers also use the mirror-lock-up feature to eliminate mirror vibration when shooting long exposures. They first compose the picture. Then, they lock up the mirror. And finally, they release the shutter. That way, there's no camera vibration caused by the mirror's action.

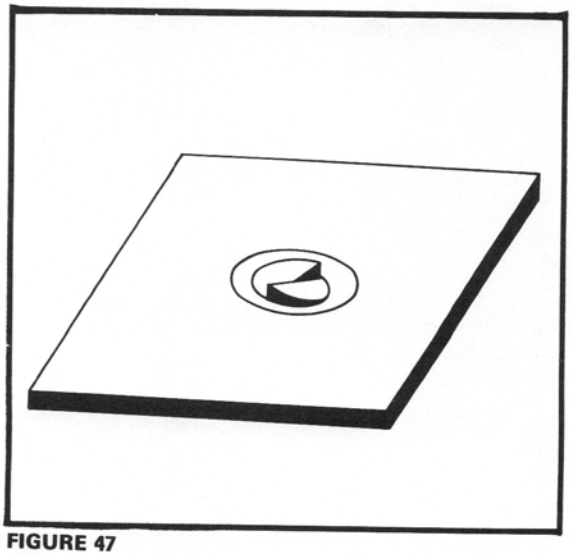


FIGURE 47
The split-image focusing aid—a pair of optical wedges in the center of the focusing screen chops an out-of-focus subject in half.

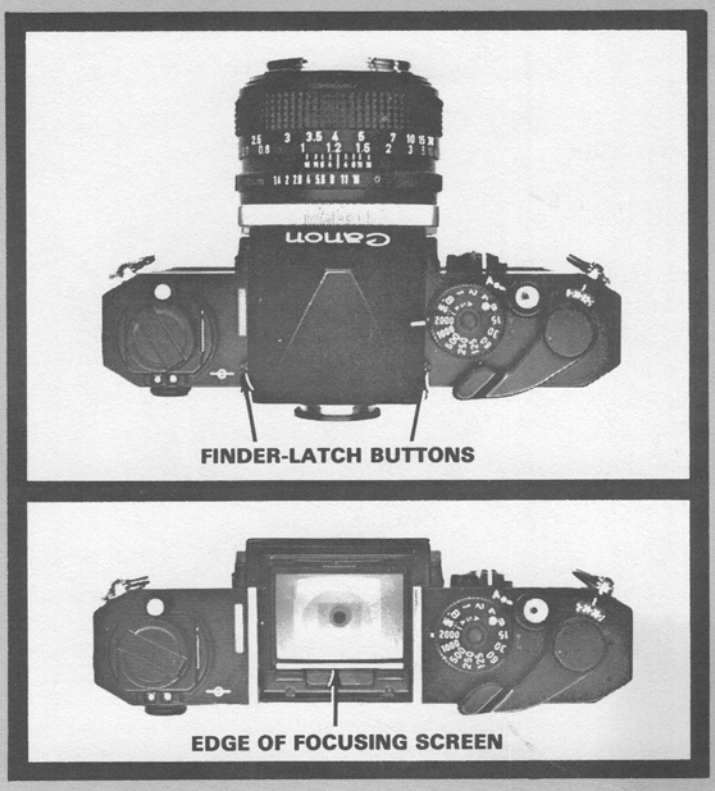


FIGURE 48
Different cameras use different techniques for replacing the finders and focusing screens. With the Canon F-1, first depress the two finder-latch buttons. Then, slide out the finder toward the back of the camera. Lift out the focusing screen by inserting your fingernail under the rear edge.

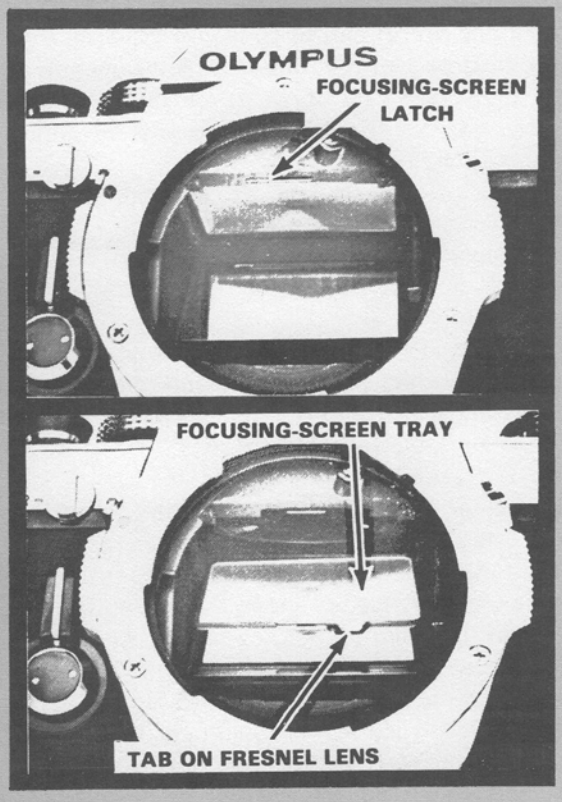


FIGURE 49
The Olympus OM-1 doesn-t have interchangeable finders. But you can interchange the focusing screens. First, remove the lens. Then, use a small "pick" to push the focusing-screen latch toward the back of the camera (Olympus supplies the "picks" with the focusing screens). The hinged focusing-screen tray now swings down. The number on the focusing-screen tab identifies the type—make sure this number goes up when you replace the screen.

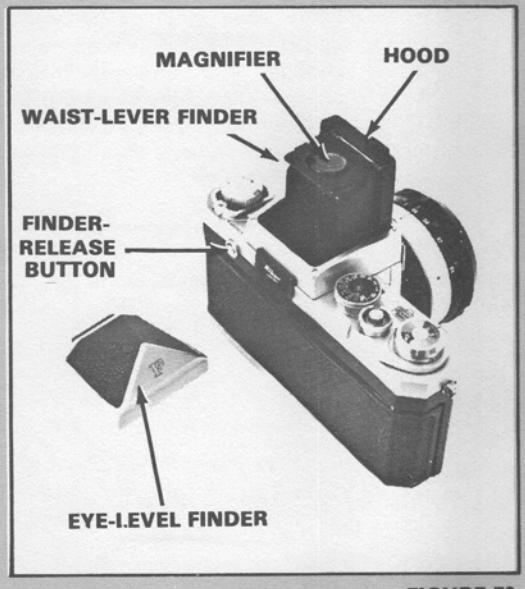


FIGURE 50
With this accessory waist-level finder, you can hold the camera at your waist. Waist-level viewing is handy for pictures of children and other subjects where you need a low shooting angle.

FIGURE 51
Cameras which accept motor-drive units have removable backs. Removing the camera back allows you to install a special film back which holds several feet of film. Shown here is the 250-exposure film back on the Minolta XK motor-drive unit. This back holds 33 feet of film. ***Photo courtesy of Minolta.***

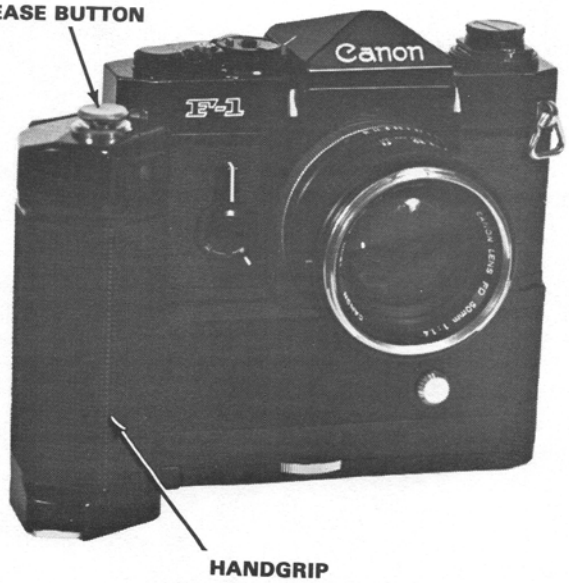


FIGURE 52
A camera equipped with a motor-drive unit. This is the Canon MF motor drive—it's capable of shooting up to 3.5 frames per second.

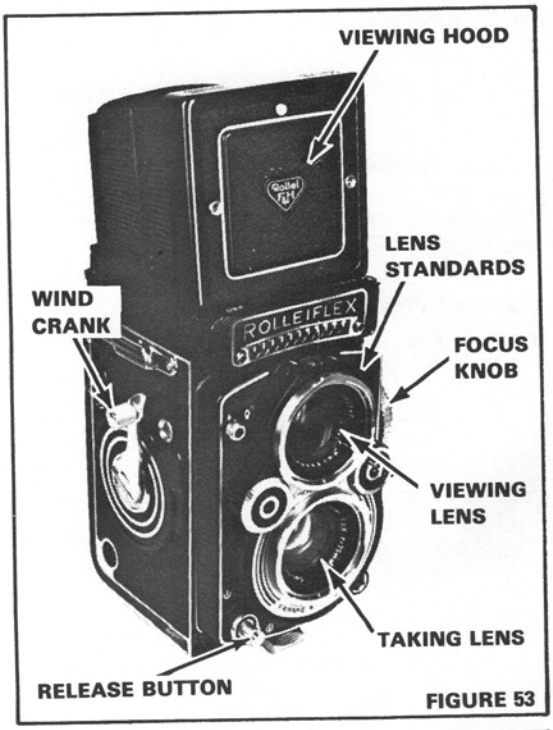


FIGURE 53

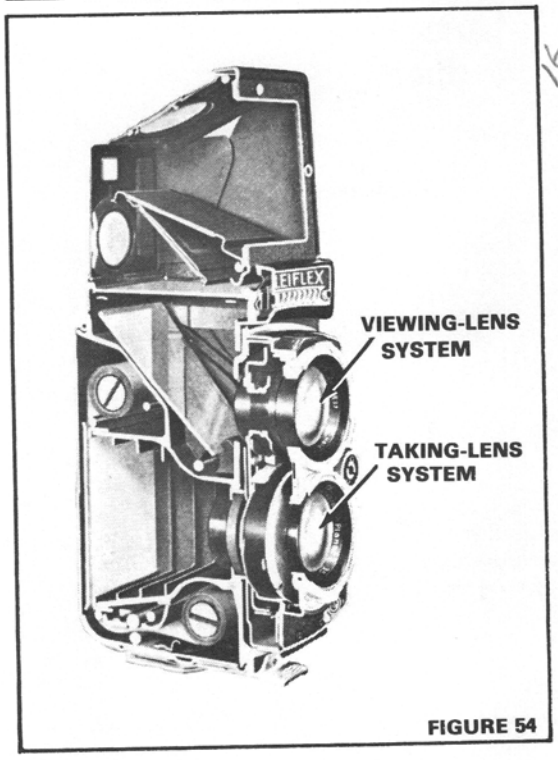


FIGURE 54

to the professional. If he can shoot pictures fast enough, surely one of those shots has the picture he wants.

We'll be covering other accessories as you proceed through the course. These accessory items allow you to "build" a camera around your particular needs. That's why 35mm SLR's which have a complete range of accessories are called **camera systems.** More than just a camera—a complete photographic **system** for every picture-taking purpose.

THE TWIN-LENS REFLEX

There's another type of reflex camera—the Twin-Lens Reflex, or **TLR.** "Twin-lens" refers to the two lenses at the front of the camera, Fig. 53. The lower lens takes the picture. You view through the upper lens.

The TLR is almost like two cameras in one body. The top portion is a reflex viewing system. Like the system in the SLR, there's a mirror that catches the light. The mirror then routes the light to the focusing screen. However, unlike the SLR's mirror, the TLR's mirror is fixed in position. It doesn't move.

The lower section of the TLR is a basic straight-through camera. Its lens matches the lens on the viewing system. Usually, both lenses mount to the same panel—the **lens standard.**

A focus knob on the side of the camera moves the lens standard—closer to the film or further from the film. So you focus both lenses at the same time. When the upper lens is in the best position, you get the sharpest image on the focusing screen. That means the lower lens is also in the proper position (according to the lens-to-subject distance).

Since you're viewing through a separate lens, there's once again the parallax problem. The viewing lens sits above the taking lens. So it sees a slightly different view of the subject. Most TLR's have parallax frame lines on the focusing screen. Some have movable masks that automatically shift position as you focus.

The big advantage of the TLR is that there's no blackout problem. You always keep the subject in view. Plus, since the mirror never moves, the operation is very quiet.

Rolleiflex was the first of the TLR's. And it's still the name most frequently connected with the TLR. Other manufacturers were quick to copy the Rolleiflex design—so much so that at one time the picture-taking world seemed blanketed with TLR's.

But most of those TLR's died out. There're only a few models remaining. Rolleiflex, Yashica, and Mamiyaflex are the brands you'll most frequently encounter. And these still enjoy widespread popularity.

At one time, you could get TLR's in many different film formats—including 35mm. No more. Now, practically every TLR you'll see is a **medium-format** camera. That means they use either 120 film or 220 film.

Why "medium" format? Well, you can consider the other sizes we've discussed (126, 110, and 35mm) as small formats. A

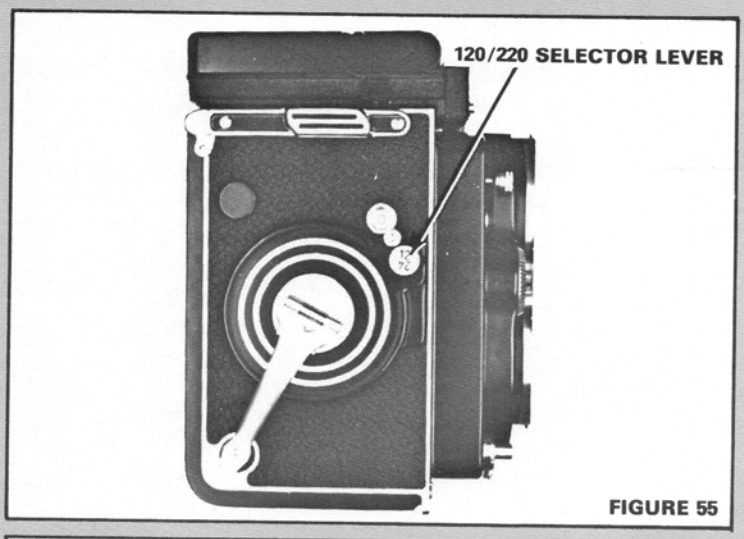


FIGURE 55

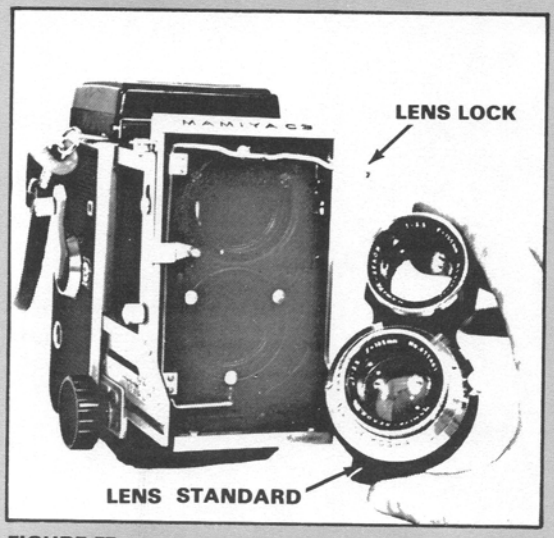


FIGURE 57
Disengaging the lens lock in the Mamiyaflex TLR allows you to remove the complete lens standard. Notice that the lens standard contains the viewing lens, the taking lens, and the shutter.

THE MAMIYA C330f TLR FIGURE 56

large format would be 4 x 5'' or 5 x 7''. 120 film can produce 12 negatives, each 2-1/4'' square. 220 gives you the same size negative. But you can get 24 pictures per roll rather than 12.

Many TLR's accept both types, 120 and 220. With the Rolleiflex in Fig. 55, the counter dial counts to ''12.'' If you're using 220 film, you need a counter dial that counts to ''24.'' So the Rolleiflex just counts to ''12'' twice. Set the counter-control lever to the 220 position. After you've shot your first 12 exposures, the film-advance mechanism locks. You then know to set the counter-control lever back to the 120 position. The counter dial flips back to ''0.'' And you can shoot your second 12 exposures.

The film-wind mechanism in the Rolleiflex is also typical. The **wind crank** at the side of the camera both cocks the shutter and advances the film. Turn the wind crank clockwise until it stops. Then, turn the wind crank counterclockwise until it stops once again. You're now ready to take a picture.

One drawback to the TLR design is that lens interchangeability presents a problem. Suppose you want to use a different lens for a different picture effect. That means you must replace two lenses—the taking lens (which also includes the shutter) and the viewing lens. Having to pay for two lenses and a shutter increases the cost. So most TLR's don't have interchangeable lenses.

The Mamiyaflex, Fig. 56, is an exception. Here, you can interchange the complete lens standard. Interchangeable lenses come as a matched pair along with the shutter. They're already mounted to the lens standard, Fig. 57. The versatility of the Mamiyaflex makes the camera one of the most popular of the TLR's.

FIGURE 58
The Mamiya M645, a medium-format SLR on the right, compared to a 35mm Mamiya SLR. ***Photo courtesy of Bell & Howell.***

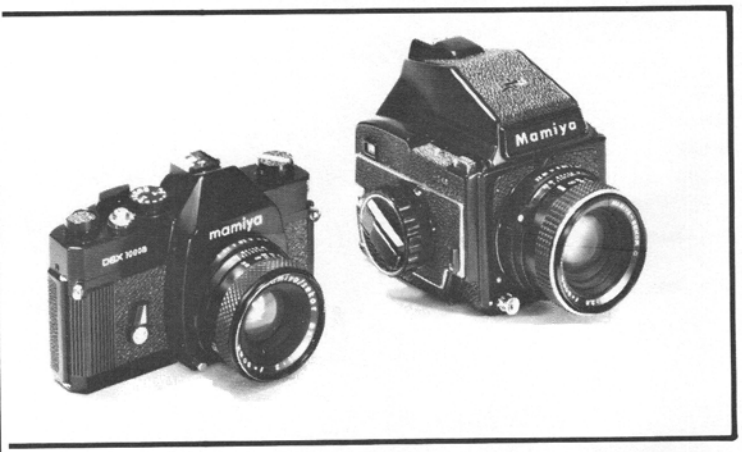


FIGURE 59
The Mamiya Press Super 23, a medium-format rangefinder-type camera. ***Photo courtesy of Bell & Howell.***

OTHER MEDIUM-FORMAT CAMERAS

Many other camera types use the medium format. Often, these cameras are just larger versions of the 35mm cameras you've already seen. The Mamiya M645, Fig. 58, is a medium-format SLR. And the Mamiya Press Super 23, Fig. 59, is a medium-format rangefinder-type camera.

Generally, the medium-format cameras cost more than do their smaller cousins in the 35mm format. And they're usually not as versatile—there may not be quite the array of interchangeable components and accessories available. So why would someone prefer the medium format?

One reason for the medium-format choice is the film itself. Using larger film, you can expect better quality—especially when making big pictures (you'll learn more about this in your assignments on film and processing). The popularity of photofinishing as a hobby has attracted many people to medium formats. It's easier for the home-processor to work with the larger film.

So you have several prime candidates for medium-format cameras—the professional photographer, the serious amateur, and the home-processor to name a few. The Hasselblad, Fig. 60, and the Bronica, Fig. 61, are two of the medium-format

SLR's that appeal strongly to the professional. Both cameras offer a large assortment of accessories and interchangeable components. Starting with the camera body, photographers can "build" a camera to suit their needs. They just install the camera back, the lens, the viewing hood, and the focusing screen of their choice.

To remove the back of the Hasselblad, just push the back latch to your right, Fig. 63. A professional photographer may own several film backs. With a 120-film back and a 220-film back, the photographer can use both types of film with the same camera.

Having several film backs offers a time-saving benefit as well. The photographer can then preload the film backs before going on assignment. After shooting a roll of film, the photographer just removes one film back and installs another. That saves a lot of time in film-loading—a real benefit in hurry-up situations, such as shooting weddings.

But cameras like the Hasselblad and the Bronica may be beyond the budget of the average hobbyist. By contrast, many TLR's are relatively inexpensive. So the TLR is a good choice for the hobbyist who wants an inexpensive medium-format camera.

Another advantage of the TLR is its quiet operation (nice for shooting events like weddings and for shooting candids). And the TLR features fast operation.

Notice that the camera shown in Fig. 59 has the word "press" in the tradename. The term **press camera** generally indicates a medium-format camera that's fast and easy to use—ideal for press photographers who need speed and convenience for newspaper shots. But these days, many press photographers use the smaller, lighter 35mm cameras.

Not all of the medium-format cameras produce 2-1/4" square formats from 120 or 220 film. Some give you rectangular formats. Or, you may be able to get interchangeable film backs for different formats.

A medium-format camera may give you a 2-1/4" x 3-1/4" format. In that case, you get 8 exposures on a roll of 120 film, 16 exposures on a roll of 220 film. Another standard format is 2-1/4" x 2-3/4". You then get 10 exposures on 120 film and 20 exposures on 220 film. Plus there's a 1-3/4" x 2-1/4" format that gives you 15 exposures on 120 and 30 exposures on 220. Notice that, in each case, you get twice as many exposures on 220 as you do on 120.

FIGURE 60
One of the most versatile of the medium-format cameras, the Hasselblad offers a full array of accessories and interchangeable components—so many that you'll see the camera referred to as "the system."

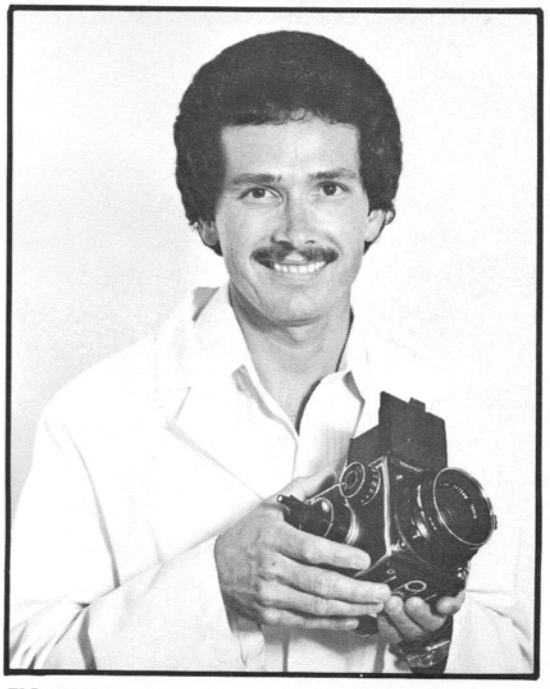
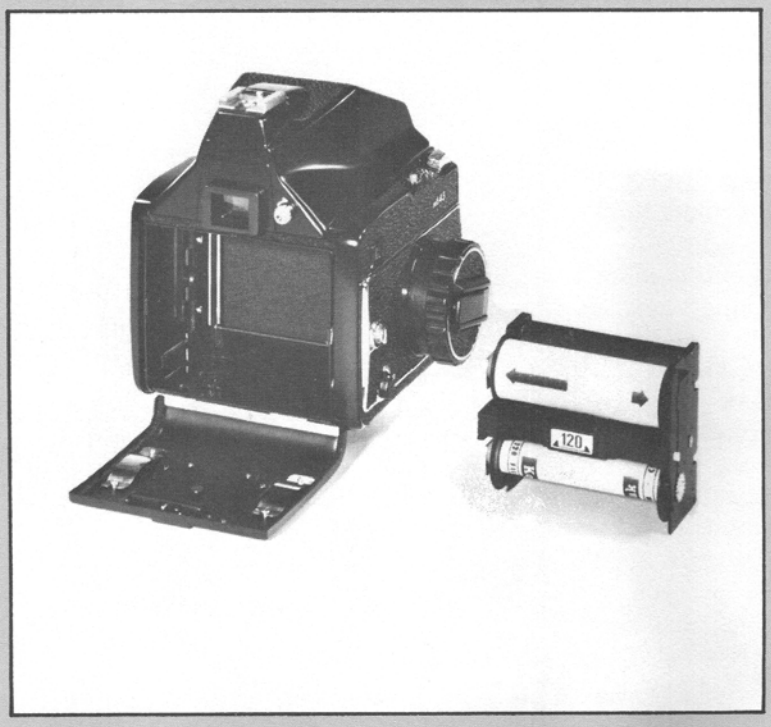


FIGURE 61
The Bronica medium-format SLR looks like a handful. But it's a versatile workhorse for advanced photographers.

FIGURE 62
The individual components of a Bronica medium-format SLR. Photographers can interchange such components to custom-fit the camera to their needs.



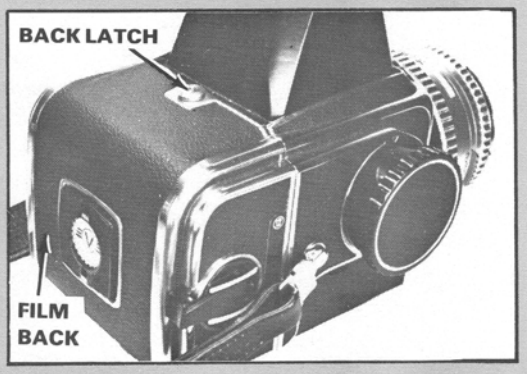


FIGURE 63

FIGURE 64
With many medium-format SLR's, you load the film in a separate module, or film insert. You then place the loaded film insert into the camera. *Photo courtesy of Bell & Howell.*

FIGURE 65
This Pentax medium-format SLR looks like a larger version of the popular Pentax 35mm SLR. It's advantages—the larger film size. "6 x 7" is the film format in centimeters (2-1/4" x 2-3/4"). *Photo courtesy of Honeywell.*

THE SELF-PROCESSING CONCEPT

One camera type challenges the cartridge-loads in snapshooter appeal—the self-processing camera. Self-processing cameras offer a benefit other types can't match—the magic of instant pictures!

For many years, there was only one type of self-processing camera—the Polaroid camera. Dr. Edwin H. Land developed the Polaroid system in the 1940's. And Polaroid cameras still bear his name— Polaroid **Land** cameras.

Things are different today. Now, Polaroid and Kodak both have instant-picture cameras that are nearly as simple to use as box cameras. Point the camera, push the release button, and the camera cranks out a picture that develops before your eyes.

FIGURE 66
A Polaroid film pack contains 8 individual sheets of film.

THE PEEL-APART POLAROID SYSTEM

Not all self-processing cameras let you watch the pictures develop. With the earlier Polaroids, including some current models, the film develops inside a package. Development starts when you pull the film package from the camera.

Rather than having a roll of film, you have a **film pack,** Fig. 66—a pack containing individual film packages (only the early, now obsolete, Polaroids use film that comes in rolls). Each individual package contains film, the print paper, and all the development chemicals.

Most Polaroid cameras automatically control the exposure. So there may be nothing on the camera to set. However, self-processing cameras do have a control you can use if your finished picture is either too light or too dark—the **lighten-darken control,** Fig. 67. Normally, there's a knob or slide on the camera. If your finished picture is too light, turn the control in the "darken" direction and take another picture.

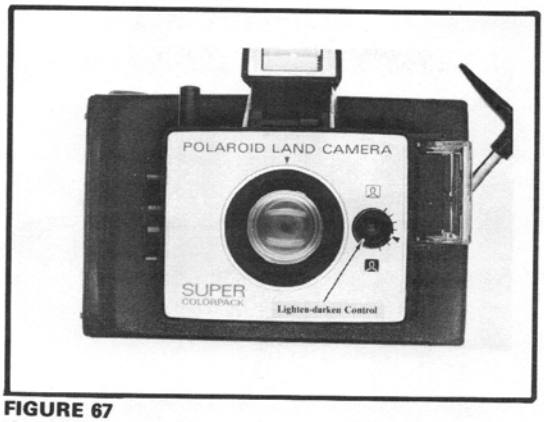


FIGURE 67
Turn the lighten-darken control clockwise for a darker print, counterclockwise for a lighter print.

There are several different films for the Polaroid models. Different formats—color or black-and-white. But not all Polaroid models will take each type of film.

Most Polaroid films give you just a finished picture—that's all. One picture—one size. If you want duplicates, the processor has to reshoot the original. And that results in a loss of quality.

Most Polaroid users probably don't care about having a negative. They just want that one picture. But for those who do care, Polaroid has an answer—the PN (positive-negative) films. PN film gives you both a negative and a finished black-and-white print.

Not many pros or advanced photographers are interested in Polaroid cameras. But they do use a lot of Polaroid film—especially the PN film. So several of the professional-caliber cameras accept special **Polaroid backs**—backs which use Polaroid film, Fig. 68.

FIGURE 68
Bronica makes this Polaroid back to fit the Bronica ETR 6 x 4.5 cm single-lens reflex. You just remove the roll-film back (120, 220, or 70mm) and install the Polaroid back. *Photo courtesy of EPOI.*

FIGURE 69
The SX-70 Alpha 1 focuses as closely as 10.4" from the subject. Aperture and shutter speed change automatically according to the light conditions. The aperture goes from f/8 to f/96.
Photo courtesy of Polaroid.

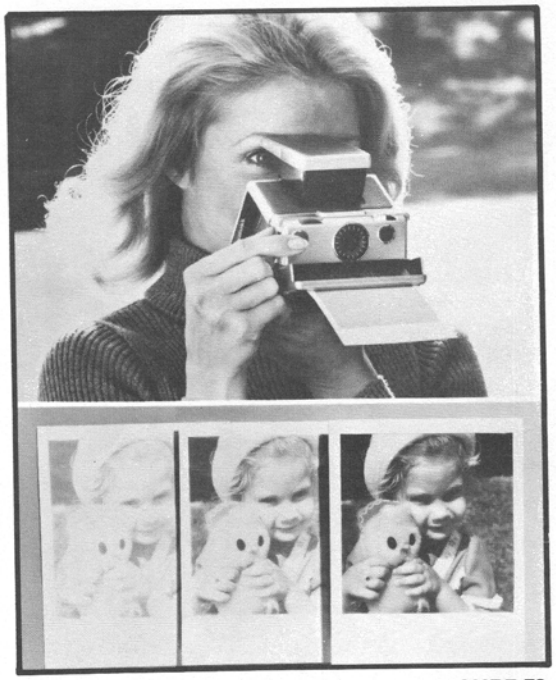


FIGURE 70
The SX-70 concept. Focus the lens through the reflex-viewing system. Then push the release button. In 1.5 seconds the camera cranks out a completely dry print which develops on its own—even in bright sunlight.
Photo courtesy of Polaroid.

Using a Polaroid back, you can shoot a picture on Polaroid film and get an instant "test" print. That print allows you to judge such things as lighting and composition. You can then make the necessary corrections in your setup. And you can reshoot the picture using whatever film you want.

Or you can use the PN negative to make your finished picture. The negative you get from the PN film is top quality. So you can use the negative to make a professional-caliber black-and-white print.

THE POLAROID SX-70

Despite all the conveniences of the peel-apart Polaroids, the cameras share a common problem. That's the mess you end up with—the chemical goo and the waste material from the film package. Polaroid eliminated this problem with the introduction of a new type of instant-camera—the SX-70, Fig. 69.

The SX-70 does all the processing work. You don't even have to peel apart a film package. After you shoot a picture, a motor inside the camera goes into action. There's the sound of the motor running and gears turning. Then, in less than two seconds, the completely dry picture comes out on its own.

At first, there's nothing on the picture—it's a blank piece of paper. The picture forms gradually, coming to life before your eyes. There's nothing for you to do but watch.

In a few seconds, you'll see a faint image. The image then becomes stronger and stronger until the picture is fully developed, Fig. 70.

The SX-70 uses its own special film pack. Each film pack contains a flat battery—the battery that drives the motor and operates the automatically controlled shutter. So each time you load the camera, you're putting in a fresh battery. You get 10 pictures, each with a 3-1/8" x 3-1/8" format, per pack.

There's only one drawback—compared to the peel-apart systems, the SX-70 is pretty expensive. That's because the SX-70 is a highly refined single-lens reflex. It folds compactly for storage and unfolds quickly when you want to take a picture.

But Polaroid followed up the success of the SX-70 with less-expensive cameras using the same film. Now, there's quite a range of models available. The less-expensive models leave out some of the refinements. For example, the original SX-70 has a chromed body with genuine leather trim. Polaroid then cut costs considerably with the Model 2, virtually the same camera but with a plastic body and simulated leather trim.

The least expensive folding model does away with the reflex viewing principle. But there's also a nonfolding version—the Pronto. The Pronto makes the SX-70 concept even more affordable. And there's still the same benefit—instant dry pictures, no fuss and no mess.

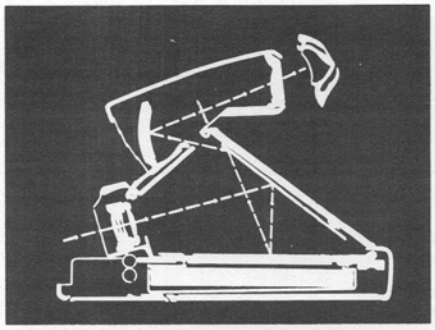


FIGURE 71
The light path through the SX-70's reflex system. Notice that the film pack sits at the bottom of the camera. Mirrors reflect the light to the film and through the reflex finder.

FIGURE 72
ITT makes this special "Magiflash" to fit the Polaroid Pronto. The Magiflash is an electronic-flash unit which eliminates the need for flashbulbs. ITT also makes electronic-flash units for other cameras designed to use flashbulbs—like the Polaroid SX-70 and the Kodak Instant cameras. *Photo courtesy of ITT.*

FIGURE 73
Kodak introduced its instant-picture system with the EK4 (left) and the EK6. ***Photo courtesy of Eastman Kodak.***

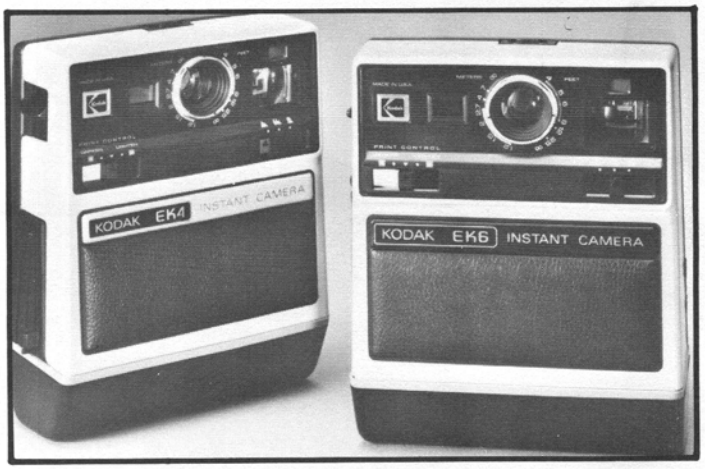


FIGURE 74
Loading the film pack in the EK6. ***Photo courtesy of Eastman Kodak.***

FIGURE 75
Turn the crank to eject the print from the EK4. The print, enclosed in protective plastic, develops before your eyes. ***Photo courtesy of Eastman Kodak.***

THE KODAK INSTANT-PICTURE SYSTEM

With Kodak's instant-picture entry in 1976, Polaroid faced genuine competition—a serious challenge to its leadership. Technically, the Kodak and Polaroid SX-70 systems are quite different. Yet the overall benefit is the same—again, instant dry pictures with no timing, peeling, or litter.

Kodak introduced its instant-picture system with two camera models—the EK4 and the EK6. As you can see in the illustrations, the Kodak cameras bear no resemblance to Polaroid's models. Even the film is completely different.

The Kodak instant-picture color film also comes in 10-exposure packs. But the image size is 2-5/8'' x 3-9/16''. And the batteries are inside the camera—not in the film pack.

Also, the Kodak picture has a different type of finish. The SX-70 picture has a glossy finish—bright and shiny. But Kodak features a satin finish—slightly textured to reduce fingerprinting and scratches.

Many people prefer the satin finish. And some feel that the Kodak film reproduces color tones with more realism. But others feel that the SX-70 color rendition is ''prettier.'' And they like the glossy finish.

The film appearance isn't the only determining factor. Some people prefer the Polaroid camera, others the Kodak. Both of the Kodak cameras shown here use 137mm f/11 lenses. And they both have automatic exposure control using electronic shutters. The shutter speeds go from 1/20 second to 1/300 second. Flash exposures are automatically programmed within the distance range of 4 feet to 10 feet.

The main difference between the EK4 and the EK6 is in how the print is ejected. The EK4 has a crank which ejects the print, Fig. 75. After you shoot the picture, just turn the crank—and out comes the print. The print develops fully in around 8 minutes. However, you can see enough of the image to judge composition in around 1 minute.

Rather than having a crank, the EK6 uses a motor. So, in this respect, the EK6 compares to Polaroid's SX-70. When you release the shutter, the camera automatically ejects the print.

OTHER CAMERA TYPES

The cameras we've discussed are the types you'll probably see most often. There are, however, many other types—-including many special-purpose cameras.

For example, the Nikonos camera shown in figure 76 really fits our 35mm category—it uses 35mm film. But it's a special type as well. It's water-resistant, like a waterproof watch. Special gaskets and seals keep out water. So the Nikonos is an **underwater camera,** used in underwater photography.

Another basic camera type is the **view camera.** And it's really a basic camera—a bare minimum of components. Large and ungainly, the view camera must be supported on a firm mount.

At first glance, the view camera must seem impractical. Yet the view camera is the studio workhorse of the professional photographer.

The beauty of the view camera is in its simplicity—and in its flexibility. There are only two basic components. A **film back** sits at one end of the camera. The lens/shutter assembly mounts in the **lens board** at the other end.

A long bellows connects the two components. As mentioned earlier, the bellows is flexible, lighttight material that opens and closes like an accordian. You can stretch the bellows to increase the distance between the lens and the film. Or you can compress the bellows to decrease the distance.

But the view camera doesn't even have a viewfinder. To see the image, you must first open the shutter. You can hold open the shutter on the "time" setting. Or, some shutters have a special lever—the **press-focus lever**—to open the shutter blades. The lens then projects the image on to the ground glass in the back assembly.

Right now, there's no film in the camera—just a straight-through path between the lens and the ground glass. So the image on the ground glass is an exact replica of the image you'll later get on film. It's even upside down and reversed from left to right.

You focus the lens by moving the complete lens board—closer to the back (compressing the bellows) or further from the back (expanding the bellows). Judge the focus by the sharpness of the image on the ground glass.

Once everything is right, you can close the shutter and load the film. The view camera uses individual sheets of film—**sheet film.** Sheet film comes in large sizes, like 4" x 5", 5" x 7", and 8" x 10". So view cameras come in corresponding sizes—a 5 x 7 view camera, an 8 x 10 view camera, etc.

Naturally, the film must be kept lighttight. That's the job of the **film holder.** The film holder accepts two sheets of film, one sheet on each side. A **dark slide** on each side of the film holder protects the film.

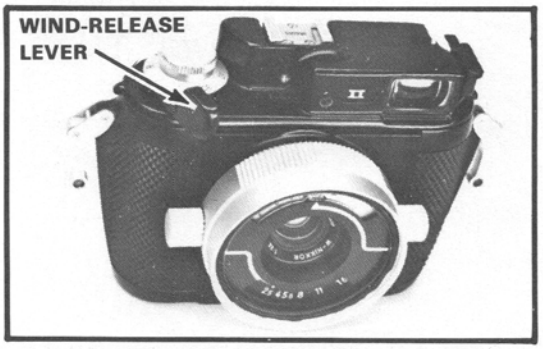
To load the camera, you replace the ground glass with the film holder. Usually, that's just a matter of slipping the film holder in front of the spring-loaded ground-glass assembly.

The dark slide still covers the film. So pull out the dark slide. You're now ready to take a picture. After shooting the picture, replace the dark slide to protect the exposed film. And pull out the film holder.

If you want to take a second picture, reinsert the film holder—this time, the other side of the film holder (the side with the fresh film sheet) faces the lens. Then, pull out the second dark slide.

The whole process may sound slow and awkward. It is. That's why the view camera is pretty much restricted to studio use. But in the studio, the view camera's the complete master. Its flexibility permits picture controls you can't get with any other camera type.

FIGURE 76
The Nikonos camera is an underwater specialist. It's also designed for simple use. One stroke of the wind-release lever advances the film. The second stroke releases the shutter.



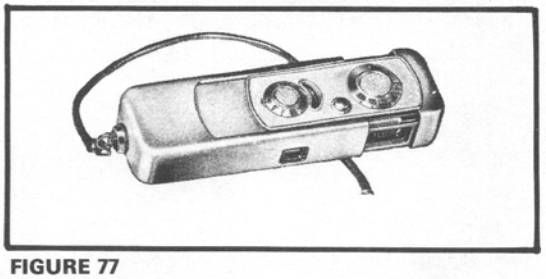


FIGURE 77
The subminiature camera may be even smaller than the 110-cartridge loads. It often uses 16mm film.

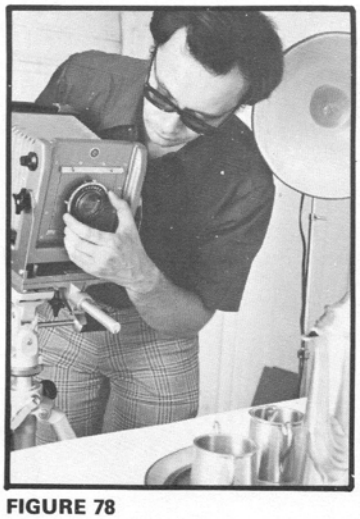


FIGURE 78
The flexibility of the view camera makes it ideal for exacting studio still lifes.

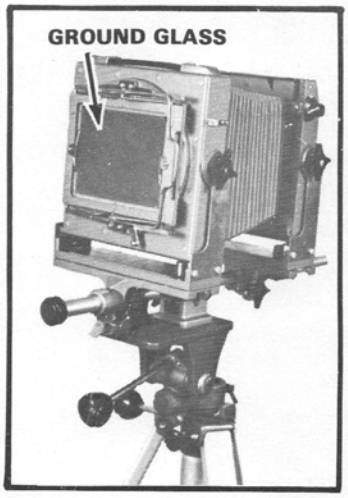
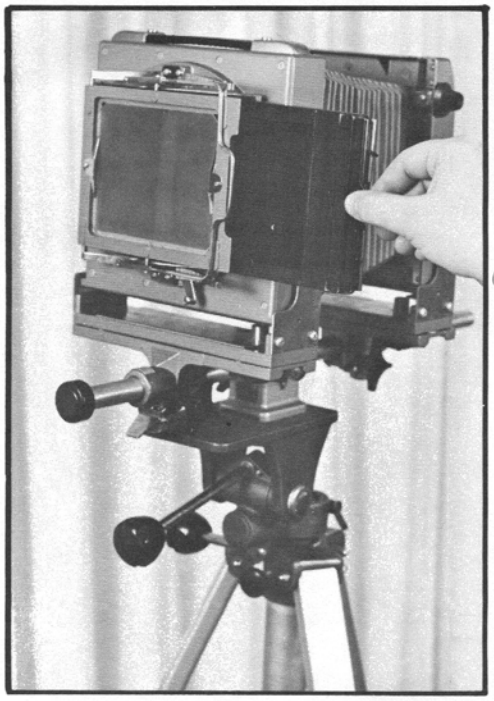


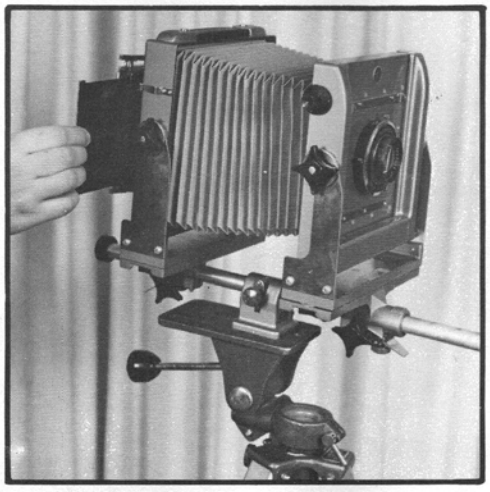
FIGURE 79
You can rotate the ground glass 90° to make either a horizontal picture or a vertical picture.



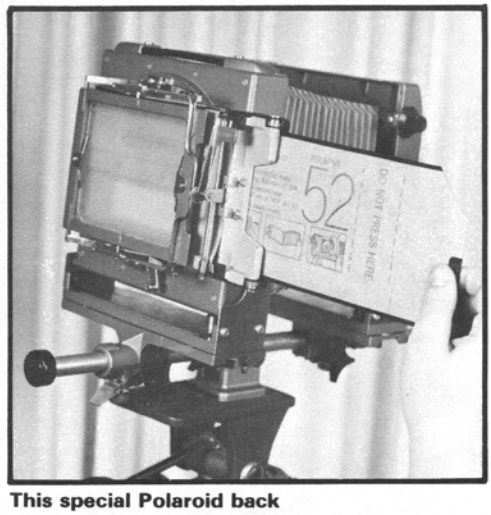
The flexibility comes from the bellows. You can raise and lower the lens mount. And the film back. Plus, you can tilt both parts. The bellows just goes along with whatever you're doing.

Such adjustments permit you to control things like depth of field, Fig. 81. Tilting the lens board puts the various elements of your picture on the same plane. And you can correct such things as tilted lines in the image, Fig. 83. That's a special type of distortion called **perspective distortion.** You'll learn more about such problems as distortion—and how view-camera adjustments can correct them—as you proceed through your course.

FIGURE 80
Sliding the film holder in front of the ground-glass assembly.



Pull out the dark slide when you're ready to take the picture. But make sure that you've first closed the shutter.



This special Polaroid back takes 4" x 5" Polaroid film. Each film package is good for one picture.

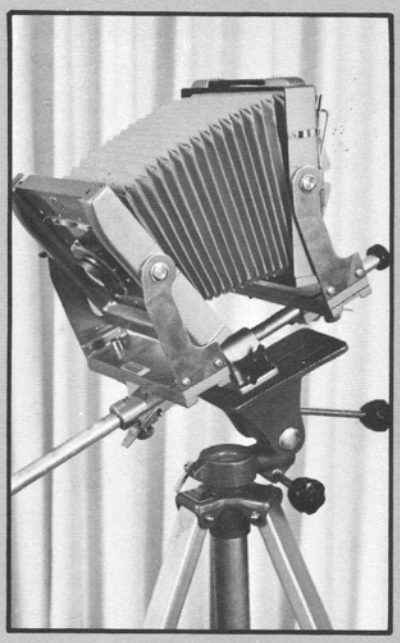


FIGURE 81
Depth of field becomes a problem when parts of the subject are different distances from the lens. With the view camera, you can tilt the lens standard. That puts all parts of the subject on the same plane. You can then tilt the film back to keep the focus sharp across the entire film area.

FIGURE 82
To take a picture of a tall building, you normally point up the camera. But that produces slanting lines in the image—rectilinear distortion. The building appears to be falling over. With the view camera, you can photograph the tall building by just raising the lens standard. Perspective then appears normal.

FIGURE 83
Notice the slanting vertical lines (the flagpole, the edge of the building) in the top shot of your National Camera school. We used the swings and tilts of a view camera to straighten the vertical lines in the bottom shot. Some lenses for 35mm cameras allow the same type of correction. Also, you can correct for such distortion in processing. You'll learn about the lenses and techniques as you proceed through your training.

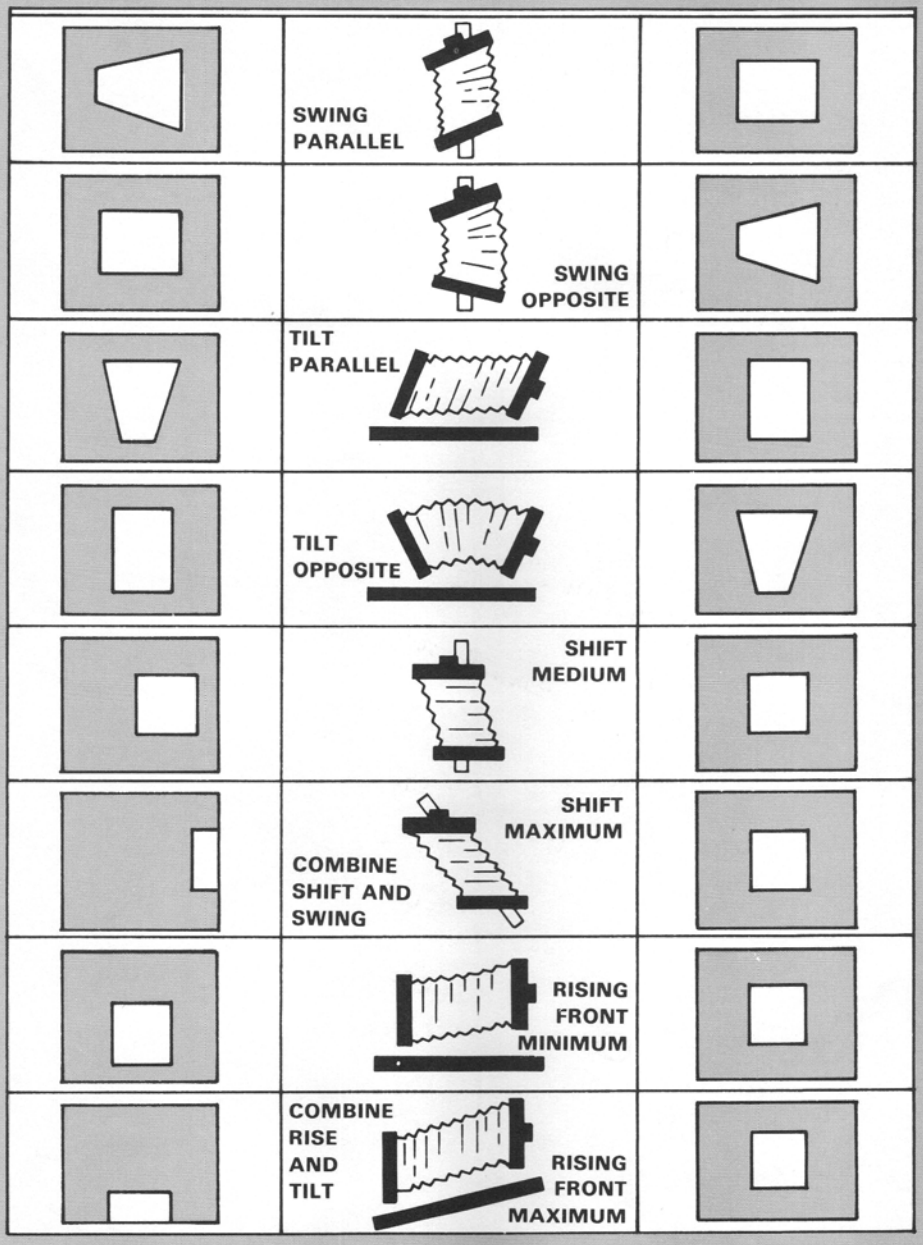


FIGURE 84
These drawings illustrate how the swings and tilts of the view camera change the image shape or position.

Another camera type that resembles the view camera is the **process camera.** But, you'll never see one brought in over the repair counter. This camera type is simply too large and heavy to be moved.

The process camera is so named because it is used in the various graphic-arts processes. The cameras function is to make copies of printed, drawn, or other original materials. Printing plates are then made from the copies using various photo-chemical processes.

Like the view camera, the process camera has a minimum of component parts. But it lacks the view cameras' flexibility. The distance between the **lens board** and **film back** can be changed. But, the two planes must remain precisely parallel to one another at all times.

The **copy board** is the third component of the process camera. It is actually a large easel which holds the copy material perfectly flat. It must also remain precisely parallel in its relationship to the planes of the lens board and film back. The copy may be illuminated by arc lights, flood lamps or large fluorescent lights.

Figure 85 shows a typical process camera. The lens board and copy board are mounted on tracks. Movement of one or the other will control the size of the image. The "process" lens is specially corrected to produce sharp images of flat subjects.

The process camera back is quite different from other cameras. The sheet film used is rarely smaller than 11" x 14". Usually it's much larger. And, special devices are needed to hold the film flat. Most common is the "vacuum" back. Air is pumped from tiny grooves in the surface of the back. This causes the film to be sucked flat against the film holder.

The copy board on some process cameras is horizontal instead of vertical. A prism—acting like a mirror—is placed in front of the lens. The image is then reflected through the lens to the film.

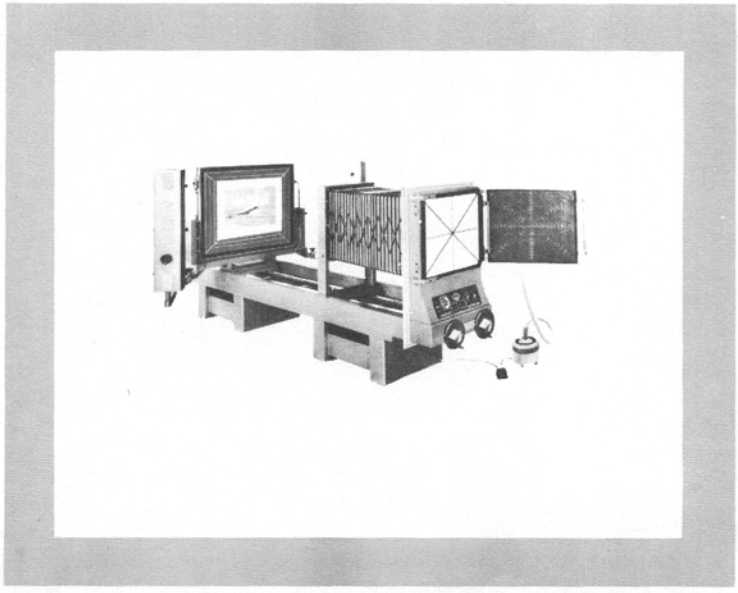


FIGURE 85
Most large process cameras are built into the sidewall of a darkroom. Once the copy board has been loaded the operator can control focus and image size (lens and copy board movement), lights and shutter from inside the darkroom. The film can also be inserted into the special back without the need for light-tight film holders.

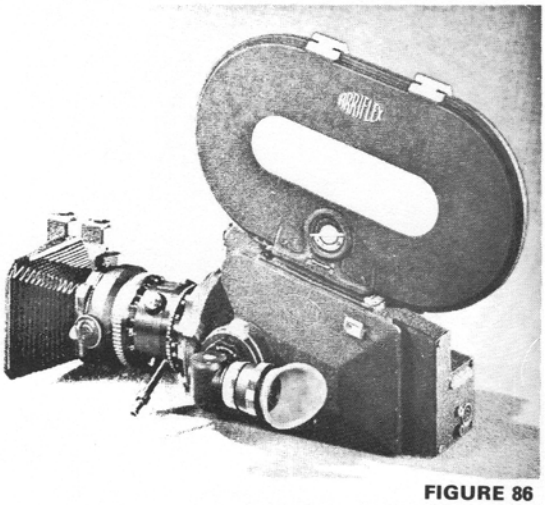


FIGURE 86
Typical professional motion picture camera.

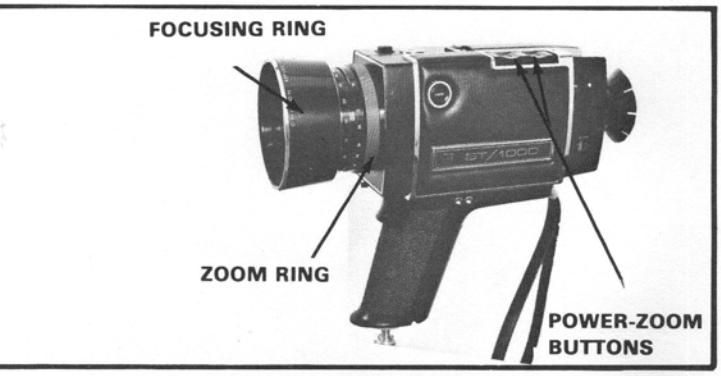


FIGURE 87 A typical super-8 camera, featuring both manual and power-zoom lens control.

FIGURE 88
A Fujica sound-movie camera

THE MOTION PICTURE CAMERA AND PROJECTOR

The motion pictures you see in a theater are usually shot on 35mm film—the same film used in the 35mm still cameras you've studied. Sometimes cameras using even larger (65mm) or smaller (16mm) film are used.

You probably won't be servicing these professional movie cameras. They're large and very expensive- highly specialized pieces of equipment for the professional motion picture industry. But the smaller versions—the ones you'll be repairing—work on the same principle.

The movie camera takes a series of still pictures. And it takes them rapidly, several in a second. A moving subject may change position only slightly between each frame.

A motion-picture projector then projects those still pictures on a screen. Normally, it projects the pictures at the same rate as they were taken—one right after another. And you get an impression of continuous movement.

The least costly amateur movie cameras have a minimum of controls. And they're quite easy to use, thanks to the drop-in, **super-8** film cartridge introduced in the mid-60's.

The more sophisticated super-8's allow some of the "professional" effects. Dissolve, fade, power zoom and complete automatic/manual exposure controls can be found on many of the "topline" models. Some even include sound.

The projector simply reverses the role of the camera. The main difference is that the projector has its own light source. It shines a powerful light through the film. A lens then enlarges the image. And it projects the enlarged image onto a screen.

Versatility and convenience features vary from projector to projector. For example, the job of threading the film through its rather complex route. In early projector designs it was quite a chore. But most modern projectors have **automatic threading.**

Some projectors use reel-to-reel projection cartridges. The projector then takes over all the film-handling functions. It even rewinds the film automatically.

Most modern projectors handle both super-8 and its European/Japanese counterpart, **single-8.** Some models also take the old, standard 8mm format. These are called **all-8** or **dual-8** projectors—they'll handle any 8mm film.

Another variation in projectors is the lens. Some come with fixed-focal-length lenses. They give you just one image size for a given projector-to-screen distance. The only way to make the image larger is to increase the distance between the projector and the screen.

Other projectors have zoom lenses. Here, you can control the image size without changing the projector-to-screen distance.

Top quality projectors feature a wide range of running speeds—from 5 frames per second (for a slow-motion effect) to as high as 54 fps. And some permit reverse projection.

Sound film requires a sound projector. These projectors play back the films made with sound cameras. Or, they allow you to add sound to silent films that have been sound-striped.

FIGURE 89
This Kodak Moviedeck projector projects super-8 sound and silent films as well as 8mm silent films. Threading is automatic—just place the film leader into a slot on top of the projector as shown here. The projector also rewinds the film automatically in around 70 seconds for a 400-foot reel. ***Photo courtesy Eastman Kodak.***

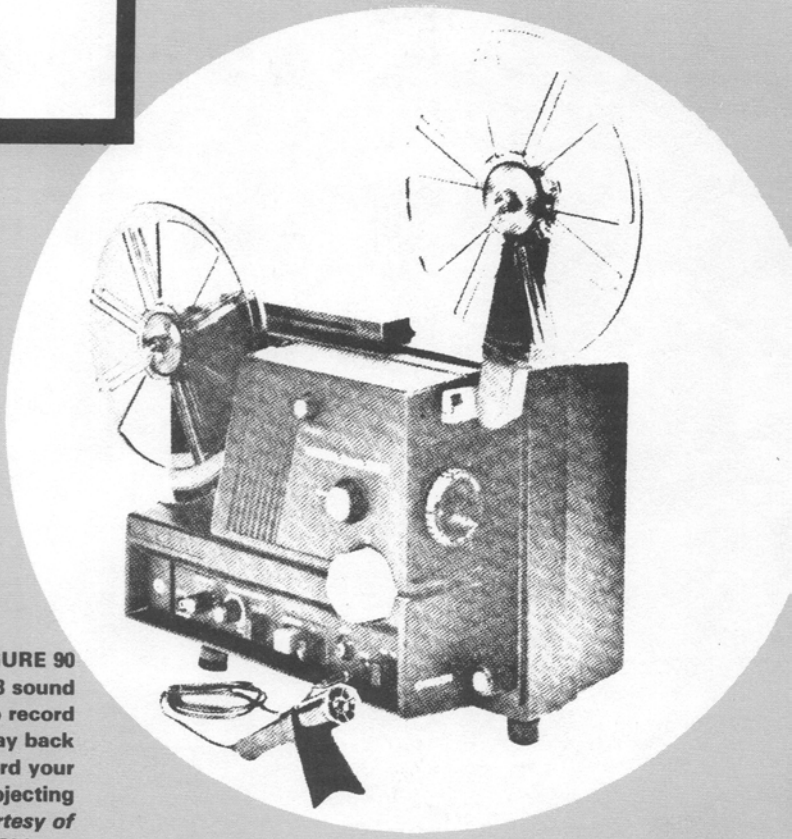


FIGURE 90
The Chinon 7000 super-8 sound projector allows you to record sound as well as play back sound. So you can record your narration while you're projecting the film. ***Photo courtesy of Chinon.***