

National Camera

Area Workshops Feature the **CANON** AE-1

Canon's newest SLR, the AE-1, follows the booming trend toward smaller, lighter SLR's. What's the secret for packaging a full complement of features into such a tiny, fully automatic camera? Basically, it's mechanical simplicity combined with ingenious electronic design.

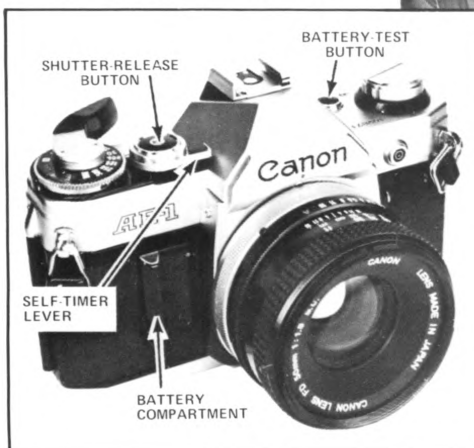
At first glance, you might think of the AE-1 as a scaled-down Canon EF. Like the EF, the AE-1 provides fully automatic diaphragm control using the FD series of lenses. You set the electronically controlled shutter speed you want—the camera sets the f/stop. And both cameras use a single silicon photocell requiring DC amplification. But that's where the similarity ends.

The innovative approaches in the AE-1 may point the way to future camera designs in several areas. For one thing, there's the unique memory circuit. Canon engineers, it seems, decided the memory-capacitor system for remembering the exposure data was old-hat—not sufficiently stable. Olympus felt that way too when they designed the OM-2. The Olympus OM-2 eliminates the memory capacitor by taking its reading after the mirror rises (from the opening curtain for fast speeds and from the film for slow speeds). But the Canon AE-1 takes a different approach—it uses a digital logic circuit to memorize the exposure data.

Since Canon also manufactures pocket calculators, perhaps it's not so surprising to find this type of circuitry in their AE-1. You may recall the first installment of our current series of *Craftsman* articles on digital electronics—there, we indicated it wouldn't be long before you'd be seeing these circuits in cameras. If you're working on an AE-1, that moment has arrived.

Pushing the release button tells the bistable flip-flop to start counting. The flip-flop counts until a comparator circuit shuts it off. The comparator sees the light conditions, film speed, and shutter speed as one input. At the other input, it sees the output of the flip-flop—a binary count which has gone through a digital-to-analog converter to become a voltage level.

Most of the AE-1's components mount to the flexible circuit board. Three ICs dominate the circuit—one on each side of the pentaprism and one above the eyepiece. Canon has literally put a computer on a chip—a microprocessing system using large-scale integration (LSI) which handles just about all the camera's functions.



A single 6-volt silver-oxide battery powers all the electronic-control circuits. The battery-test button has a dual purpose—it also serves to cancel any other function by depriving the circuits of power.

Figure 2

Most electronically controlled cameras use one electromagnet—the AE-1 has three. You can see two of the magnets after removing the bottom plate. The electromagnet on the wind-lever side controls the closing curtain. And the combination magnet (permanent magnet plus electromagnet) on the other side releases the mirror.

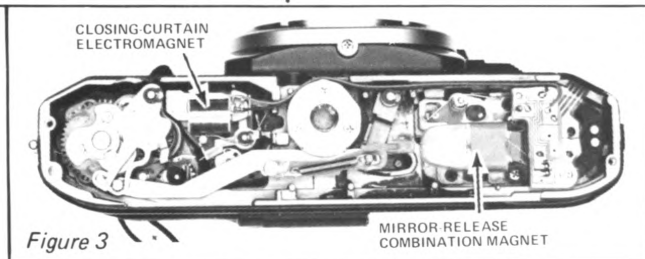


Figure 3

When these two voltage inputs are equal, the comparator shuts off the flip-flop. The flip-flop then stores—or “remembers”—the count as long as it has operating power.

Precisely 10 ms later, the mirror releases. Here again, the AE-1 takes a novel approach—an electronic circuit releases the mirror. When you cock the shutter, a lever running across the bottom of the camera pushes an armature against a permanent magnet. The permanent magnet now holds the armature, consuming no battery power.

But there's a coil of wire wound around the permanent magnet—that

makes the permanent magnet a “combination” magnet. So, 10 ms after the flip-flop starts counting, a control circuit sends a spurt of current through the coil. The coil develops a field that opposes the field of the permanent magnet. And the permanent magnet, temporarily disabled, releases the armature.

Now, the spring-loaded armature shoots toward the front of the camera and releases the mirror. As the mirror nears the taking position, it releases the opening curtain. There's nothing unusual about that part of the operation—the shutter is a conventional double-roller design. But while the mirror is

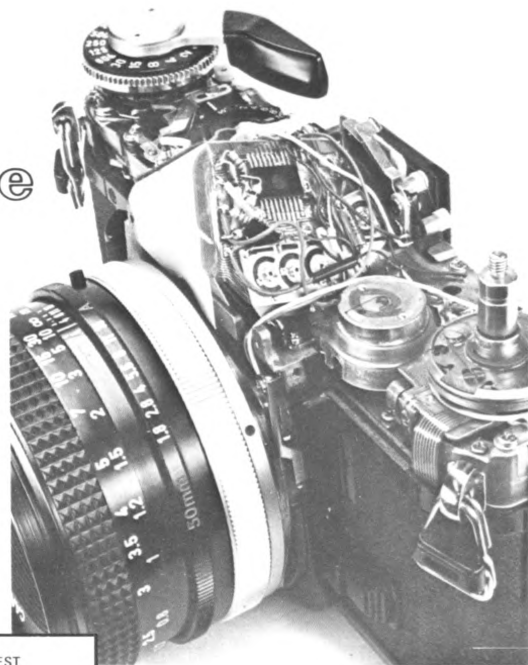


Figure 1

moving up, the AE-1 automatically sets the diaphragm opening to the f/stop decided by the memory circuit. And here the operation is unique.

In the Canon EF, a trap-needle arrangement controls the diaphragm closing.

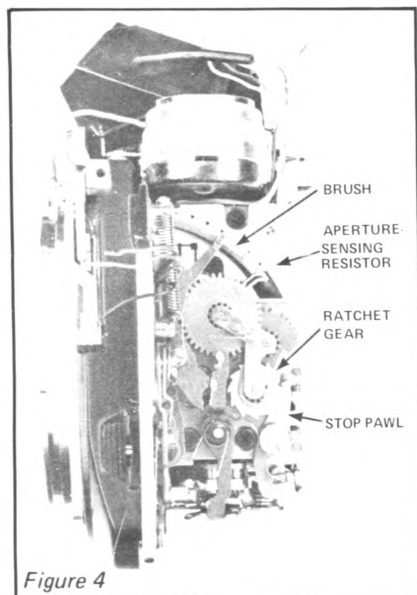


Figure 4

Diaphragm-control mechanism on the side of the mirror cage. Notice that the stop pawl is engaged with the ratchet gear—that's what stops the diaphragm at the right f/stop.



Figure 5

The Speedlite 155A may look like any other series-thyristor flash providing a choice between two f/stops. But mated to the AE-1, it does a lot more—it automatically sets the diaphragm opening and the shutter speed. And there's a not-so-obvious touch of sophistication in the way the Speedlite 155A fires the trigger capacitor—it uses another SCR. So the 300 volts stored in the trigger capacitor doesn't appear across the shutter's sync contacts.

ure. Not so in the AE-1. In the AE-1, an electronic circuit senses how far the diaphragm has closed. When the diaphragm reaches the proper aperture, the circuit shuts off the current to another magnet—an electromagnet located on the bottom of the mirror cage.

The energized diaphragm-control electromagnet holds its armature to keep a pawl disengaged from a ratchet gear (you can see the pawl and the gear in the illustration showing the side of the mirror cage). As long as the pawl clears the gear, the spring-loaded diaphragm can close. All the electronic circuit needs to know is how far the diaphragm has stopped down. When the diaphragm reaches the proper aperture, the circuit de-energizes the diaphragm-control electromagnet. And the pawl drops into engagement with the ratchet gear to stop the diaphragm action.

A resistor board mounted to the side of the mirror cage senses the diaphragm's position. The wiper for the resistor couples to the diaphragm in the lens. So, as the diaphragm closes, it moves the wiper along the resistance path. Another comparator circuit sees the resistance value at one of its inputs.

This comparator also sees the information stored by the memory circuit at the same input. So it adds these two values and compares them to a fixed reference voltage at the other input. When both inputs are equal, the comparator shuts off the current to the diaphragm-control electromagnet.

Since the AE-1 electronically governs the aperture, the galvanometer plays no role in setting the exposure. That's in contrast to the EF where the position of the galvanometer needle determines the actual f/stop. In the AE-1, the galvanometer serves strictly as an indicator—it tells you what f/stop the camera will automatically program.

You can also set manual f/stops. Here, the diaphragm-control electromagnet remains energized. And the diaphragm stops down to the aperture you've selected. When you're set to a manual f/stop, Canon makes sure you know about it—a flashing LED illuminates the letter "M" on the focusing screen as you start depressing the release button. Another flashing LED in the viewfinder warns of underexposure—not enough light for proper exposure. With all those indicators, it's pretty tough to make a mistake.

The electromagnetic release lends itself to another unique feature of the AE-1—an electronically controlled self timer. The self-timer lever sits next to the release button. Pushing the self-tim-

er lever forward closes a switch which delays the release of the mirror for 10 seconds.

So there's only one change in the circuit operation—the circuit waits 10 seconds (rather than 10 milliseconds) to send a pulse of current through the coil of the mirror-release magnet.

Since there's no familiar buzz of a gear train, how do you know when the self timer is in action? As you might expect, another flashing LED signals the self-timer operation. Moving the self-timer lever forward uncovers the LED on the top-cover plate. If you count the LED pulses, you know how much time you have before the shutter releases—the LED flashes on and off twice a second.

So far, we've mentioned two magnets in the AE-1—the one that releases the mirror and the one that controls the diaphragm. There's one more. The electromagnet visible from the bottom of the camera on the wind-lever side controls the release of the closing curtain.

Here, at least, the AE-1 sticks to conventional electronic-shutter control. Setting the shutter speed selects the resistance value in series with the timing capacitor. That determines how fast the timing capacitor can charge. When the timing capacitor reaches a sufficient charge, it shuts off the current flowing through the closing-curtain electromagnet. And the electromagnet releases the closing curtain to end the exposure.

SOPHISTICATED ACCESSORIES FOR THE AE-1

One has to marvel at the ingenuity of the Canon engineers in designing the AE-1. But Canon went even further—they introduced a new electronic-flash unit with comparable sophistication.

Used with any other camera, the Speedlite 155A provides typical thyristor control. A phototransistor sees the light reflected from the subject. So the gain of the phototransistor controls the charging time of a capacitor. When the timing capacitor reaches a sufficient charge, it fires one SCR.

Turning on the SCR connects a reverse bias across the series thyristor (the SCR in series with the flashtube). A charge stored in another capacitor reverse biases the series thyristor to shut off the flashtube's current. Nothing unusual here.

But putting the Speedlite 155A on the AE-1 takes full advantage of the flash unit's capabilities. As a team, the AE-1 and the 155A won't let you make a mistake. Forget to set the f/stop? No

problem The 155A automatically sets the diaphragm opening. You can't even set the wrong shutter speed. Regardless of your shutter-speed setting, the Speedlite 155A automatically programs a 1/60-second exposure.

What happens if you release the shutter before the flash unit has recycled? If the ready light isn't on, the Speedlite 155A won't fire. You'll get whatever shutter speed you've set on the speed-setting dial. And the diaphragm will stop down according to the available-light conditions.

The Power Winder A provides yet another sophisticated accessory for the AE-1. Unlike other motor drives, the Power Winder has no release button—you use the camera's release button. The Power Winder then automatically cocks the shutter and advances the film.

By putting part of the motor-drive control inside the AE-1, Canon made the Power Winder exceptionally compact. The switch that tells the Power

Winder when to cock the shutter is inside the camera, operated by the closing curtain. With the Power Winder attached, the AE-1 isn't much larger than conventional 35mm SLRs.

SERVICING THE AE-1

One thing about this current generation of electronically sophisticated cameras—they're here to stay. You can't overlook them. Electronically controlled cameras already dominate today's designs. And as for the future, we can expect to see the trend continue to grow.

In the case of the AE-1, the electronic sophistication also makes the camera remarkably inexpensive. The advanced IC technology eliminates around 300 of the parts you'd expect to see in a camera that does so much. As a result, Canon really saves on labor costs. And Canon passes on that savings to the consumer—the AE-1 sells for around \$300 (as low as \$250 in some places). Put such a low price-tag on a compact, talented SLR—along with Canon's full-scale promotion—and you have a camera that's selling like wildfire.

All this electronics sophistication does make us more dependent on information from manufacturers and distributors. At one time, a good technician could figure out just about any camera without relying on service manuals. But it would be pretty tough to troubleshoot a camera like the AE-1 without a schematic. Plus, it's essential to know the factory-specified voltages and currents at several points—you need that information to make the adjustments.

For example, take a look at the bank of resistors on the side of the AE-1's pentaprism. One is for the actual lens

opening—you just make the adjustment until the diaphragm stops down the proper amount for the light conditions. But to make the other adjustments, you must measure voltages at different points using a digital voltmeter (nothing else will detect these tiny signals with the precision needed). Then, you must figure out what those voltages should be by using the camera's standard reference voltage as a starting point.

So, in servicing the AE-1, a pocket calculator becomes a handy "special tool." Most of the repairs in the AE-1, we're told, involve replacing components on the flexible circuit board. It's normally too time-consuming and too expensive to replace the complete circuit module. And replacing an IC requires that you go through the adjustment sequence. Plus, you need a delicate touch with a soldering iron. Those soldering techniques you've been using for years may not be satisfactory in the AE-1.

Fortunately, there's a bright side to all this. Armed with the service information, repairing the AE-1 becomes straightforward. And, when it comes to distributing service information, Canon does a great job.

Canon started by conducting a series of four-day training sessions for their warranty people. The last of these excellent seminars concluded in February. But Canon hasn't stopped there. They want to reach the independent service technicians as well.

That's why Canon is cosponsoring this year's series of National Camera Area Workshops covering the AE-1, the Speedlite 155A, and the Power Winder A. Canon will supply the equipment—National Camera will prepare the training materials as well as present the programs. As with the factory seminars, the Workshop sessions take four days. That allows time for adjustments and troubleshooting.

Both Canon and National Camera realize that the average camera repair technician isn't an electronics expert. But you don't have to be—that's a comforting thought. Our thanks to Canon for their splendid job in disseminating service information through various channels.

Here are the dates for the 1977 National Camera Area Workshops on the AE-1 photographic system:

Detroit	May 11-14
Boston (Peabody, Mass.)	May 16-19
Albuquerque	June 15-18
Atlanta	June 20-23
San Francisco	October 11-14

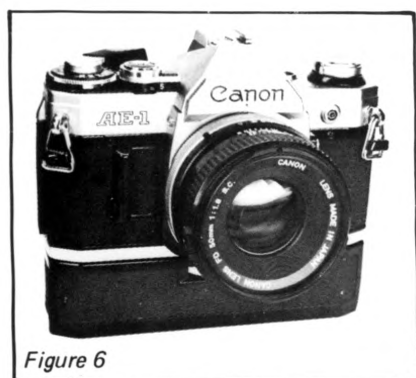


Figure 6

The Power Winder shown here can advance the film as fast as 2fps if you hold the release button depressed.

