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Harvey Libowitz and his re-creation of the first Rochester Portrait camera (right), shown actual size. All of his miniatures are workable cameras, either with optically correct lenses, as in the Portrait model, or with pinhole optics. Some of his shots are pictured far right.

ONE SMALL STOP FOR A MAN

Make no mistake, Harvey Libowitz, whose miniatures are displayed in several museums, is a man who appreciates a challenge. The reason his tiny pieces have been shown at four Ripley's Believe It Or Not museums, the Toy Museum in Kansas City, the National Geographic Museum and the International Museum of Photography at George Eastman House; the reason he's been named one of the 40 top craftsmen in the country; the reason he had the *entire* staff of this magazine entranced for the good part of a whole day, is that all his creations work.

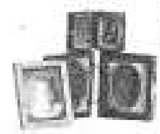
Harvey's kerosene lamps light, his firearms fire, balls roll into the pockets of his pool tables, his magic lanterns project tiny transparencies and his postage-stamp cameras take fingernail-sized photographs.

Now retired, the 61-year-old Libowitz is beginning to gain recognition for his work outside of his hobbyist field. MODERN's technical director Kenny Yamamoto saw a feature on Harvey done for a Japanese TV show. Luckily, the TV camera came in tight enough on a miniature field camera case so that Kenny was able to copy Libowitz's address, clearly readable on a tag half the size of a contact lens. After a quick look in the phone book, we set up a life-sized appointment with the master miniaturist.

We met a genial, soft-spoken man with big hands, delighted to show off his creations and workbench. A model maker since his Brooklyn, New York, boyhood, Libowitz said he began crafting miniatures 35 years ago, as soon as his first daughter was old enough to appreciate a dollhouse. "All the lamps lit," Harvey remembers with palpable pride, "and when you turned on the TV, it showed my daughter's picture."

As with most gifted people, Harvey has no real explanation for why he does what he does, only that he's been at it all his life. After graduating from New York's Metropolitan Vocational High School, Harvey was a repairman for the old Universal Camera Company. He joined the Navy in 1945 and spent a year as a motion picture camera repairman stationed at Pearl Harbor.

Back in the States and married to his childhood sweetheart, Harvey began building the world in miniature. His workshop takes up one-third of the Libowitz living room, a moving testimony to his wife's affection. "Most of the materials I use are scrap," Harvey says. He turns brass keys to tripod fittings, tenpenny nails to musket barrels, old glove leather becomes a camera bellows. His tools are modified dental equipment and a Unimat lathe.



For the miniature of the first Rochester Portrait camera commissioned by George Eastman House, Harvey matched lenses he pulled from a normal-sized viewfinder and cut the ground glass from a photographic slide; the wood was salvaged from an antique film holder sent by the museum for authenticity's sake. For Harvey it was all in a day's—or two or three days'—work.

He does not do it for money. "At this stage of my life, I enjoy the recognition," he says. Harvey is delighted to hear from people about his work, and he does take commissions "to help pay for another piece of equipment." Interested readers can contact Harvey in care of MODERN. No letters on rice grains, please.

—JOE GIOIA

Reliable INFRARED

An easy-to-build IR exposure meter can make B&W infrared photography more predictable.

THOMAS F. FULLER

I have always loved infrared photographs. They possess a mystical quality that is very special to me. Their unique tonality is similar to my dreams; they haunt me. I'll find myself staring at an infrared image, knowing I have seen it somewhere before, but not in the waking world.

Most people dream in black-and-white; I don't know how many dream in infrared black-and-white, as I seem to. But to make photographs of the real world on infrared (IR) film is quite another matter. The unusual properties of this film and of IR radiation itself have always required special handling and exposure, a lot of bracketing and other experimentation, and a goodly amount of patience. Many photographers have seen IR pictures and wanted to produce their own, but have been daunted by IR's reputation for unpredictable and frustrating results.

Traditionally, exposure of infrared films, especially by IR radiation only (as with a Wratten 87 filter), has been determined by trial and error. Because the emulsion does not have an exact infrared speed rated in ISO numbers, and because conventional light meters do not sense IR radiation, the best that photographers could do was to take a number of frames of the subject, bracketed around a guesstimated base-exposure obtained from a chart in the film's instruction sheet.

The light we see, especially artificial light, varies greatly in the amount of invisible IR radiation present: there is no direct relationship between the two. Direct sunlight is reasonably steady in IR content, but that content can still vary according to the height and angle of the sun in the sky and to the amount of water vapor present in the air. Water, even in vapor form, absorbs IR – on a cloudy day the IR content of sunlight is mostly absorbed by the vapor in the clouds. Even without clouds, two identical visible-light meter readings may result in IR film exposures that differ by several stops, making precise exposure determination ordinarily quite difficult.

Being by nature an organized sort of person who demands dependability, I thought a better way to work had to exist. Why not build an exposure meter capable of reading infrared? Although invisible to the human eye, IR radiation is part of the electromagnetic spectrum, like visible light and like the unseen wavelengths that we call radio signals and heat. Light meters read visible light; home and car radios "read" radio waves and can indicate their strength; and a thermometer tells us the level of heat. What remained, then, was to put together a device that could detect and read the strength of the invisible infrared portion of the spectrum and to learn to use this device for obtaining exposure information for IR-sensitive film.

After some research and a little experimentation, I found a way, using a $1.29 part available at Radio Shack stores, a cadmium sulfide (CdS) photocell. Using this and a few inexpensive additional parts, I designed an IR-exposure meter that most people could easily build in a couple of hours for less than $25.

The concept is very simple. Although originally intended for use with visible light, this particular photocell happens also to be sensitive to infrared. As the amount of radiant energy (either visible light or IR) falling upon it varies, so does the electrical resistance of the cell. This difference is measured by a meter connected through a simple circuit to the cell, a system identical in essential design to any conventional CdS light meter—except for one small change. When we cover the cell's sensing surface with a piece of visually opaque Wratten 87 gelatin filter, only the IR radiation is read.

Constructing The Meter

The meter will be put together from the items shown in the accompanying list of parts and materials (see page 41), according to the wiring diagram in Figure 1.

The heart of the IR meter, shown in Figure 2, is Radio Shack's #276-116/276-116A cadmium sulfide photocell (although you may substitute equivalent items made by other manufacturers for any of the other listed parts, be sure to *use only this photocell*). Begin construction by carefully soldering a flexible, insulated electrical wire to each of the stiff leads that protrude from the back of the photocell. Use only just enough heat to make a firm connection— too much may damage the cell. Insulate the two leads from each other by wrapping them with electrical tape to avoid a short circuit.

Next, bore a ⅜-inch diameter hole through the bottom of the plastic project case. From a 2x2- or 3x3-inch square Wratten 87 gelatin filter, cut a piece about an inch square. Since a gelatine filter is delicate, protect it by laminating it between two squares of clear, self-adhesive laminating plastic. With instant-bonding glue, secure this laminated sandwich over the hole in the case so the 87 filter completely blocks all visible light from entering. Now place the CdS cell face down on the plastic-covered filter, carefully centering it over the hole in the case. Lay a bead of glue around the cell to hold it in place on the back of the filter, as shown in Figure 3. Avoid getting glue between the surface of the photocell and the filter sandwich. After the glue has dried, wrap the back and edges of the cell with aluminum foil, and secure it fully light-tight with black electrical tape—be sure to tape well even around the wire leads. This will protect the photocell against the intrusion of stray IR radiation or visible light, which would cause the meter to read inaccurately.

Now attach the other parts to the lid of the project case. First, bore a hole to accommodate the casing of the microammeter (no dimensions are given here because meters may vary in size). Drill smaller holes for the meter's mounting screws, and fasten the meter in place. As shown in Figure 4, glue the battery holder onto the interior of the lid (always use an alkaline AA cell in this holder, and change it every two months whether you've used the meter or not; the battery voltage is crucial to the meter's accuracy, so it must always be fresh—never use any sort of rechargeable battery because its voltage may be less than the required 1.5V). Install the push-button switch in another hole drilled in the lid. Now connect the parts with wire, as shown in Figure 4.

Finish by installing a 22,000 (22K) ohm resistor in the wire between the plus (+) side of the microammeter and one lead of the photocell (the other photocell lead is connected directly to the on/off switch, as shown in the wiring diagram). Now close up the case, and the meter is complete.

Calibrating The Meter

Keep in mind that the meter is not measuring microammeters in this use; it is not to be considered as *anything* other than a log scale running from 0 to 50 units. I have dubbed them "IR Units," but they are not actually equal to *any* existing units of photographic measurements. You will have to calibrate your own meter, as will be explained later, to turn these so-far-meaningless units into useful exposure settings.

To do the initial calibration of my first meter, I used the following items: a 35mm camera loaded with a 36-exposure roll of black-and-white Kodak High Speed Infrared film, a 3x3-inch Wratten 87 gelatin filter, a tripod, a sunny day, and some patience. I found a stationary outdoor subject that could be photographed from the same position over a period of time, and I placed the camera on the tripod so all the test shots would include the same area of the subject.

To insure that my IR meter was aimed at the same spot for each exposure, I fitted it with an accessory foot bought at

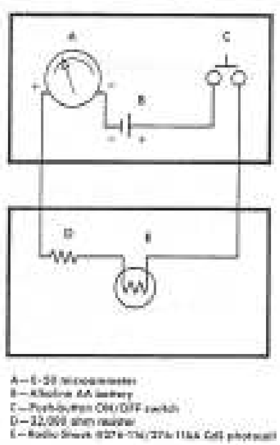


Figure 1: Wiring diagram for the IR meter.

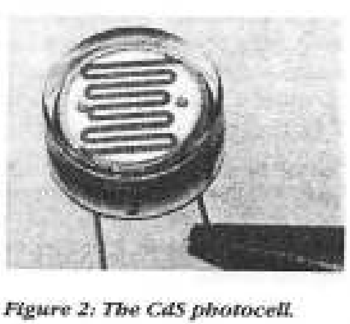


Figure 2: The CdS photocell.

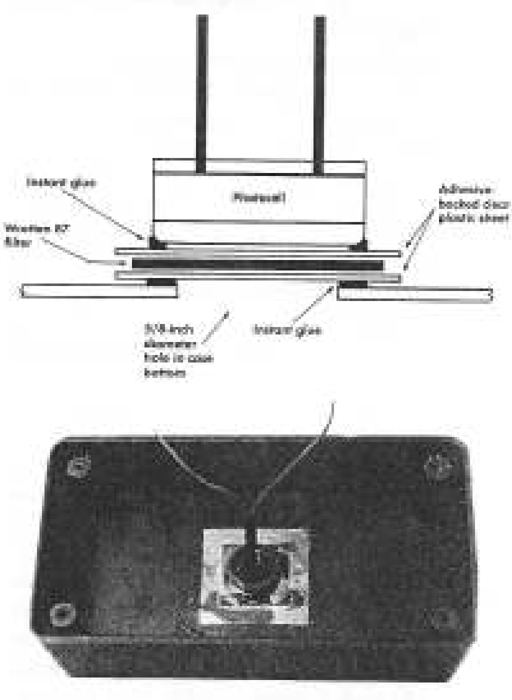


Figure 3: Photocell mounting details. *Top: Cross-sectional view of the CdS cell mounted onto the inside bottom of the plastic project case. Bottom: Photograph of the photocell glued in place face-down on the Wratten 87 filter sandwich.*

RELIABLE INFRARED

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cessing methods you use for this test, you must also use them for all future IR work with your meter; otherwise, the calibration will not remain accurate. Also, I want to caution you not to send your IR film to a commercial photofinisher for development. This film must be handled in total darkness, even when it's still in the cassette. Just taking it out of the plastic canister in room light will risk damage and possibly spoil your results. Do the processing yourself so that you'll *know* how the film has been handled.

With the film processed, I cut the negatives into five strips of five frames each; each strip representing a difference in 10 IR units on the meter scale. To avoid errors, I covered the lens after each test series and produced a blank frame to separate a particular series from the next. And I made sure to mark each negative group with its correct IR unit value before cutting the strips apart. After cutting, I examined each negative group on a light table and found the frame on each that appeared to be most properly exposed. From this procedure, I worked out basic exposure information for future use. (I will not print it here, since it would almost certainly be different with your meter, and I don't want to confuse anyone—you'll have to do your own calibration.)

I found that each 10-unit change in the meter reading gave a one-stop difference in exposure. I also found that my full sunlight exposures tended to be quite standard from day to day. Since this was so, you won't need to test as extensively as I did.

Meters made for measuring reflected visible light universally assume that the "average" scene reflects approximately 18 percent of the light that falls upon it. Use of the 18-percent gray card is a way of standardizing exposure readings in general photography. However, in IR work there is another relatively fixed value available. Broad-leaved green vegetation reflects IR very strongly in full sun—that's why such vegetation prints close to white in black-and-white IR photography. That being so, it's possible to use green vegetation as a starting point for calibration. You should assume that it is to be printed light, at about Zone VII. Therefore, once you've determined by exposure testing where a full-sun reading of green vegetation occurs on your meter scale and which of your test exposures yields a middle-gray exposure of the IR film, you can turn this into more general IR exposure information.

If, for example, a reading of 25 units on your meter on front-lit green vegetation results in a middle-gray in that area of the developed negative when the camera is set at, say, f/11 and 1/60 second, you have a starting point. Zone VII is 2 stops above Zone V. If you want that green vegetation to print as Zone VII, make your next comparable exposure 2 stops more exposed—set the camera, that is, to f/11 at 1/15th.

With this confirmed (or if need be corrected) by further testing, you can use your meter scale and the law of reciprocity to determine correct exposures when the IR readings vary later. If, on a less sunny day the meter drops, say, to 15 IR units from the previous 25, give a stop more exposure (remember, a difference of 10 units on the scale amounts to a one-stop change of IR in the reading). Or if it reads 35 IR units, give it a stop less. And if you want to use an aperture other than f/11, change the exposure time to correspond—if you close down 2 stops, to f/22, then slow the shutter by two settings also, and so on.

> *"The heart of the IR meter is a Radio Shack CdS photocell."*

To calibrate *your* meter this way, work on a sunny day: set your camera on a tripod, with the IR meter mounted in the accessory shoe of the camera. Aim it at a front-lit area of green vegetation, and press the meter's ON button to obtain a reading. After focusing the lens visually and adjusting the focus as needed for IR work, place a Wratten 87 filter over the lens, as shown in Figure 6. Set the lens aperture at f/11. Then, using the IR film and documenting each step, make an exposure series at your camera's slowest shutter speed, increasing step by step to its highest speed.

Once you've carefully processed this roll of film, you'll have a close idea of where you stand. To pinpoint matters, decide which frame best approximates a middle-gray in the metered area. Then use this information to run a second-level test. Photograph a variety of subjects, after making an exposure reading as before on green vegetation. Bracket each shot with a three- or five-shot exposure group made with one-stop increments. On this roll, make some exposures by sunlight, and then go indoors and make some by photo flood lighting, which is relatively IR-rich. After viewing your resulting negatives on a light table, you should be able to do consistently good IR-only photography with a Wratten 87 filter on your camera.

Not all IR photography is done with the 87 filter. You can also use Wratten 25 or 29 or other red filters; but with these you'll be using a combination of IR with visible light. Exposure here has always involved a degree of guesswork, since the IR radiation and the sunlight don't have set proportions.

To do such work without guessing, use a standard light meter to determine the visible-light exposure level (Kodak recommends setting the film speed at about ISO 50 for sunlight use or at ISO 125 for tungsten lighting with these filters). With your IR meter, make a similarly directed reading after calibration to determine the level of IR radiation present. If the two readings agree, you are home free. If they disagree, you have information with which to make informed exposure adjustments: you may decide to favor one reading over the other or to strike an average between them.

By using a little science to eliminate a lot of guesswork, I hope I have enticed you into this mysterious medium. Infrared is a magical world, filled with strange and wonderful vistas that you can reveal only with your camera. But it is open to exploration by anyone. Be prepared, though, because the haunting images made this way will keep you coming back again and again. The trip will be enchanting, and you'll no longer have to rely on memory when telling people about your dreams—just show them the pictures. ■

"Infrared Demystified," DARKROOM PHOTOGRAPHY, Jan./Feb. 1986, is a good, basic IR reference. For further information, see the following Kodak sources: M-28, Applied Infrared Photography, *N-1,* Medical Infrared Photography, *and N-17,* Kodak Infrared Films.

a camera store. Then I slipped it onto the camera's accessory shoe, as shown in Figure 6. To narrow the cell's angle of view, I glued onto the meter front a spare metal lens hood.

Because the meter is not a tested, factory-made product, it is probable that each one made will differ a little in its readings. Here's how I arrived at a calibration for my particular instrument:

Step 1: I waited until light conditions produced a reading of exactly 5 units on the meter scale. I found that this occurred in the very early morning hours. I pressed the ON button frequently to check the IR level. When it read the requisite 5 units, I made a series of exposures: shooting at f/11 with the Wratten 87 filter covering the lens, I made one exposure each at 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{15}$ second.

Step 2: I waited for the meter reading to rise to 15 units and then made another exposure series, this time at $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{15}$, and $\frac{1}{30}$ second.

Step 3: When the IR level hit 25 units, I did another series at $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{15}$, $\frac{1}{30}$, and $\frac{1}{60}$ second.

Step 4: At 35 units, I exposed for $\frac{1}{8}$, $\frac{1}{15}$, $\frac{1}{30}$, $\frac{1}{60}$, and $\frac{1}{125}$ second.

Step 5: Finally, when the meter read 45 IR units, I made exposures at $\frac{1}{15}$, $\frac{1}{30}$, $\frac{1}{60}$, $\frac{1}{125}$, and $\frac{1}{250}$ second.

To finish the test, I developed the film in Kodak HC-110, Dilution B, for 6 minutes at 68°F. as recommended in the film instruction sheet. If you already have a favorite developer other than HC-110, you can use that instead. However, keep in mind that standardization is important at this point. Whatever developer and pro-

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PARTS AND MATERIALS LIST

- *1 Radio Shack #270-22 Economy project case, with lid*
- *1 #276/116 cadmium sulfide photocell*
- *1 #275-1547 push button ON/OFF switch (normally open type)*
- *1 #270-401 AA size battery holder*
- *1 panel-mount DC microammeter, graduated from 0 to 50 units*
- *one 1-inch square piece of Wratten 87 gelatin filter*
- *two $1\frac{1}{2}$-inch square pieces of transparent self-adhesive plastic, used to laminate ID cards; found in stationery stores*
- *1 alkaline AA battery*
- *1 tube, instant bonding glue*
- *aluminum foil*
- *black electrical tape*
- *insulated electrical connection wire*

NOTE: The 0–50 microammeter was a regular Radio Shack item until 1986. Your local store may still have them. If not, any meter of the same type will do. You may also use parts other than Radio Shack elsewhere except for the photocell—this must be of the specified Radio Shack type because use of any other cell may result in unreliable readings.

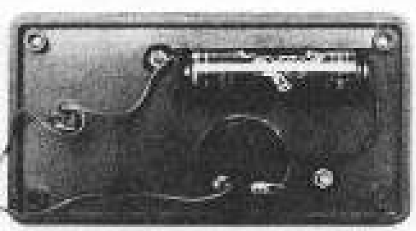

Figure 4: The inside of the project-case lid, showing the back of the microammeter, the AA battery holder with AA battery in place, and the back of the ON/OFF switch.

Figure 5: The back of the completed IR meter. You may want to relabel the meter to read "IR Units."

Figure 6: The IR meter mounted on the accessory shoe of a camera, ready for use.

The camera lens is fitted with a commercial gelatin filter holder. It is simply a hinged frame made light-tight with foam rubber and holds the thin gela[illegible] of the camera lens. [illegible] filter like the one [illegible] do, serious loss of image sharpness will result.)

MINOX ACCESSORIES JACKPOT

By some great alignment of our lucky stars every Minox accessory in the catalog is currently ON SALE. Many of the items are being sold new mainly to clear inventory. Happy hunting!

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FC 35	70	S
FC 35	35	ST
F 110	23	E
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MF 35	55	S
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