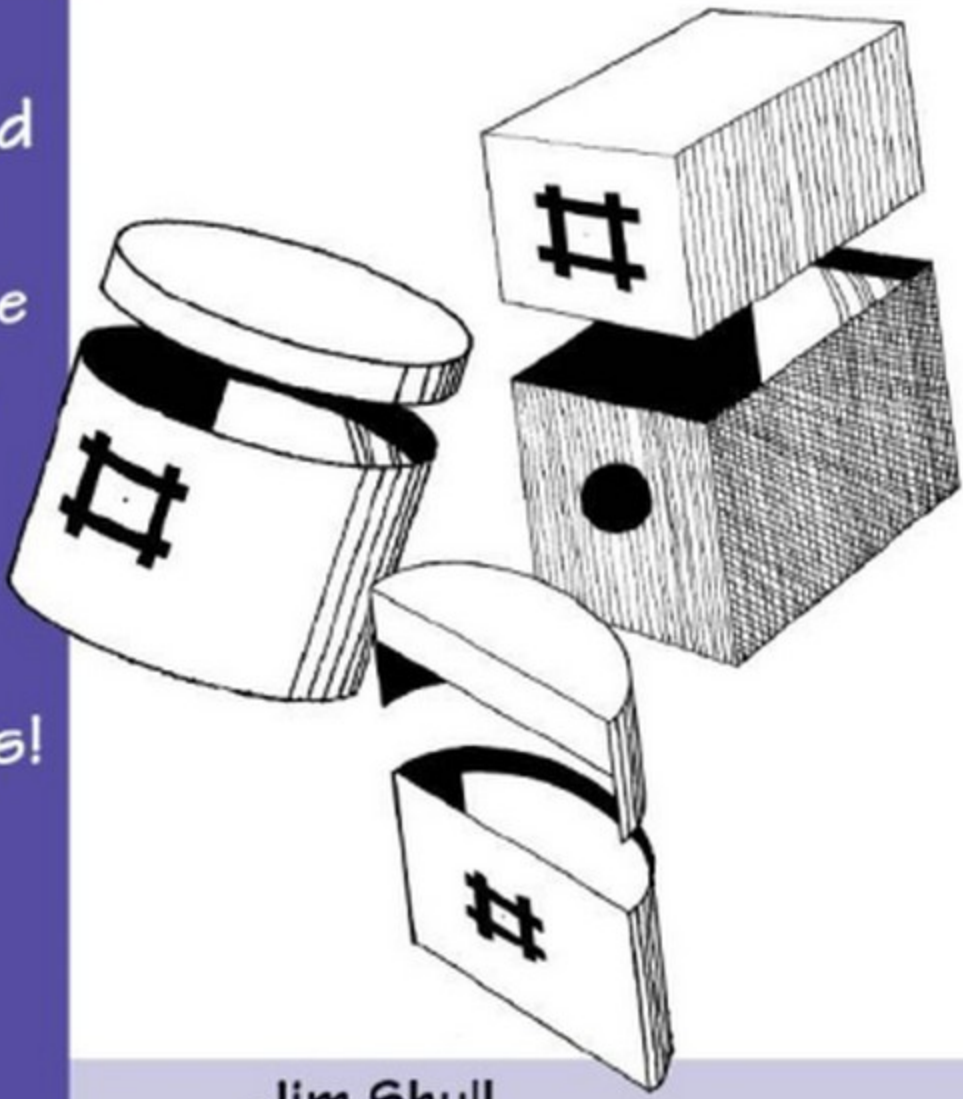
The Beginner's Guide to Pinhole Photography

Kids and adults can take photos with home-made cameras!



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Amherst Media, Inc.
Photography Books for the Professional & Amateur

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Published by:
Amherst Media, Inc.
P.O. Box 586
Buffalo, N.Y. 14226
Fax: 716-874-4508

Publisher: Craig Alesse
Senior Editor/Project Manager: Richard Lynch
Associate Editor: Michelle Perkins

ISBN: 0-936262-70-2
Library of Congress Card Catalog Number: 98-71750

Printed in the United States of America.
10 9 8 7 6 5 4 3 2 1

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INTRODUCTION

You can do pinhole fotografy without knowing anything about pinhole fotografy, or Orthodox Photography.

This manual has the basic information about the way of pinhole for uncommitted amateurs, artists who are allergic to technical information, elementary and high school teachers, and anyone baffled by f-stops, TL's, SLR's, RF's, and GTO's who wants to learn photography without the confusion of the immense amount of jargon that abounds in photography.

✔ Pinhole Fotografy and Orthodox Photography

The most important difference between pinhole fotografy and the more conventional "orthodox photography" is that a pinhole camera does not use a lens and an orthodox camera does. A pinhole camera uses instead a very small, round hole, the pinhole, which makes an image that can be captured by standard light-sensitive materials to make a photograph.

More important than the differences between pinhole and orthodox photography is the question; why pinhole? There are some good reasons for the way of pinhole.

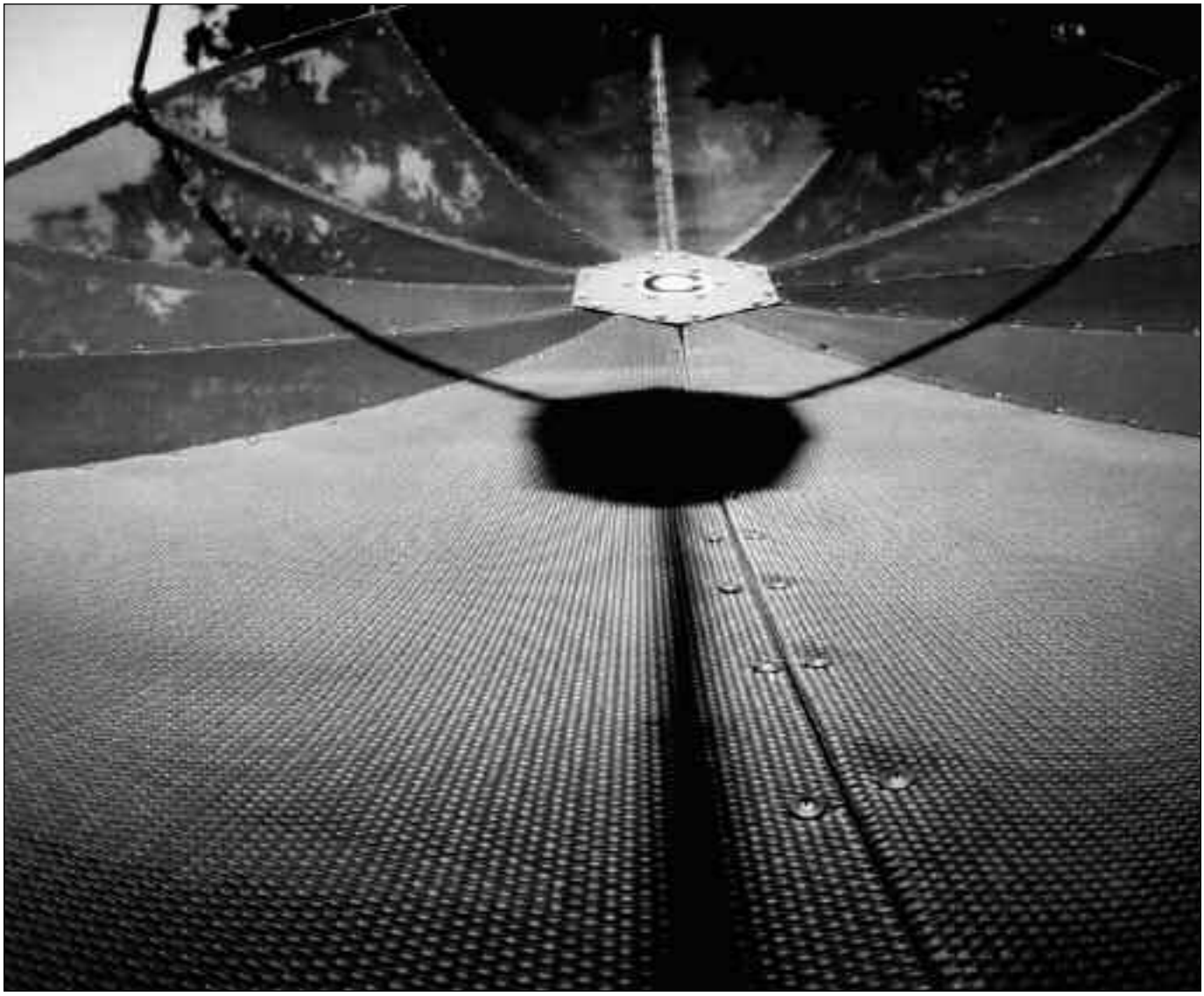
The way of pinhole brings new perspectives to the ordinary stuff of our lives...

Pinhole is a relatively inexpensive, fast and very educational way to make photographs. There is nothing "automatic" and there is no dependence upon proprietary film packs, batteries or equipment. People who go thru a pinhole fotografy experience gain a much more comprehensive understanding about photography in general, and in less time, than any other method of learning about photography. The resulting fotografs are usually interesting, often unique and occasionally amazing. It is also a lot of fun. To summarize, Pinhole Fotografy is:

✔ **Cheap.** The camera can be made of cardboard or from various easily available containers. The "film" can be printing paper and the darkroom doesn't necessarily need running water, electricity or the usual darkroom apparatus beyond trays, tongs and safe-light.

✔ **Fast.** Almost as fast as the instant film route, much less mysterious and much more satisfying. With some practice (but not the first time), a pinhole negative can be in your hands in 5 minutes, and the positive of the negative can be produced in another 5 minutes.

✔ **Educational.** Since you have to do it all yourself, the procedures and effects can be observed as they happen (you won't be in the dark).



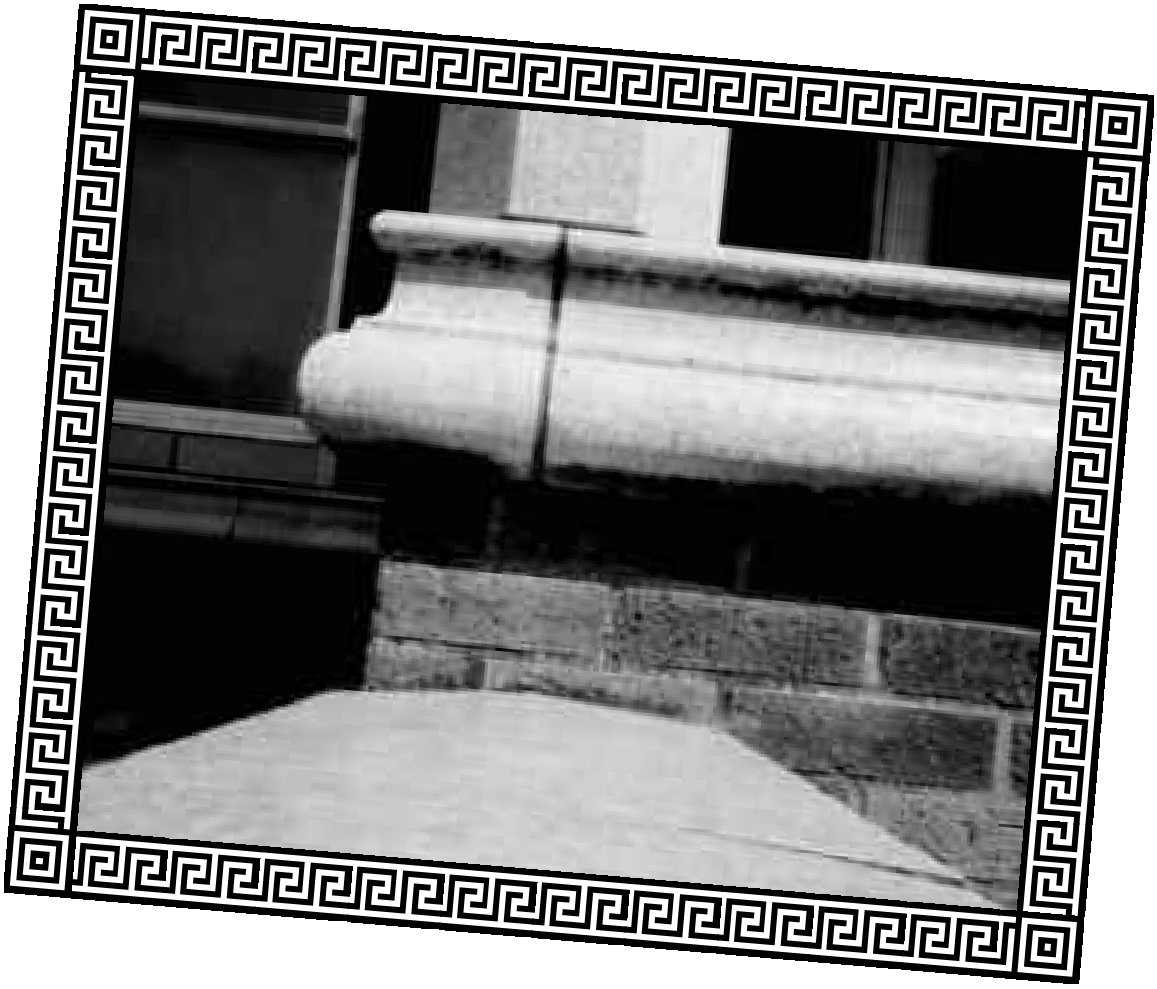
Another ordinary, and for some folks indispensible, item in our lives: a satellite television dish.

✔ Background

The image-making ability of a very small, more or less round hole is not easily noticed but has been known for some time. There is evidence that the ancient Greeks were aware of the phenomenon. You can see the phenomenon for yourself by going into a darkened room and making a small round hole in a wall (such as a window shade), that looks upon the bright outside world.

By holding a more-or-less translucent piece of paper 6 to 12 inches from the hole, you will see an (upside down) image of whatever is outside.

If the hole is made large enough to fit a simple lens into it, a much brighter image results and new considerations are added; having to focus the image, and contending with lens aberrations. This contraption, either with or without a lens, was called a "camera obscura" (which is Italian for "room dark"), by Italians of the Renaissance. They seem to have done the earliest explorations on the subject.



(left and above) Two not so normal views taken with a "normal" focal length pinhole camera.

By the sixteenth century, specially constructed portable darkrooms were in common use by artists who would take their "camera obscuras" out to a select view of the local scenery and trace the projected image on paper. This device was also used to help work out understandings and uses of central perspective, which was a prime concern of most artists of the Renaissance. The seventeenth century Dutch painter Vermeer is thought to have used a camera obscura for many of his paintings.

The use of a lens was preferred at first because of the brighter image projected, even though the lens aberrations and the necessity of focusing the image were somewhat a disadvantage. In the nineteenth century, when light-sensitive materials were invented that made photography possible, a lens had to be used because these earliest materials were very slow to react to light. As a result, the possibilities of pinhole were generally neglected, and many people now think that the main value of the pinhole phenomenon is to demonstrate optical principles in fifth-grade science.

A major advantage of a pinhole over a simple (or not so simple) lens is "infinite depth of field." To see this for yourself poke a pinhole into a thin sheet of opaque material and hold the pinhole close to your eye (if you wear glasses, take them off). Hold one of your fingers a few inches in front of the pinhole and notice that your finger is about the same clarity as everything else beyond. That's infinite depth of field. A more or less scientific explanation for depth of field is that an optical image is made up of very tiny "circles of confusion." When the circles of confusion are small enough, they are called "points" and the optical image is considered to be in focus. Therefore, points of focus. A pinhole camera has infinite depth of field because the pinhole creates circles of confusion the same size as the pinhole all over the inside of the camera, and the little circles of confusion are small enough to be regarded as points of focus.

"A major advantage of a pinhole over a simple (or not so simple) lens is 'infinite depth of field.'"

If you were taking this picture with a regular camera, you would have to choose whether to focus on the building in the background, or the car in the foreground. You'd probably end up with something like the top image.

Because pinhole cameras have an infinite depth of field, both the building and the car are in focus, despite the distance between them! The bottom image shows the results of shooting the same scene with a pinhole camera.

These have a high enough resolution to be acceptable as a coherent image, and maybe even a work of art! Orthodox photographers can use a small aperture to increase the depth of field, but except for rather uncommon lenses, the depth of field is not very extensive compared to a pinhole image.

Doing Your Own Pinhole Fotografy

✔ Building the Camera

Over years of teaching the way of pinhole I've evolved a distillation of ideas and techniques which can be useful for others, including teachers, and for workshop situations.

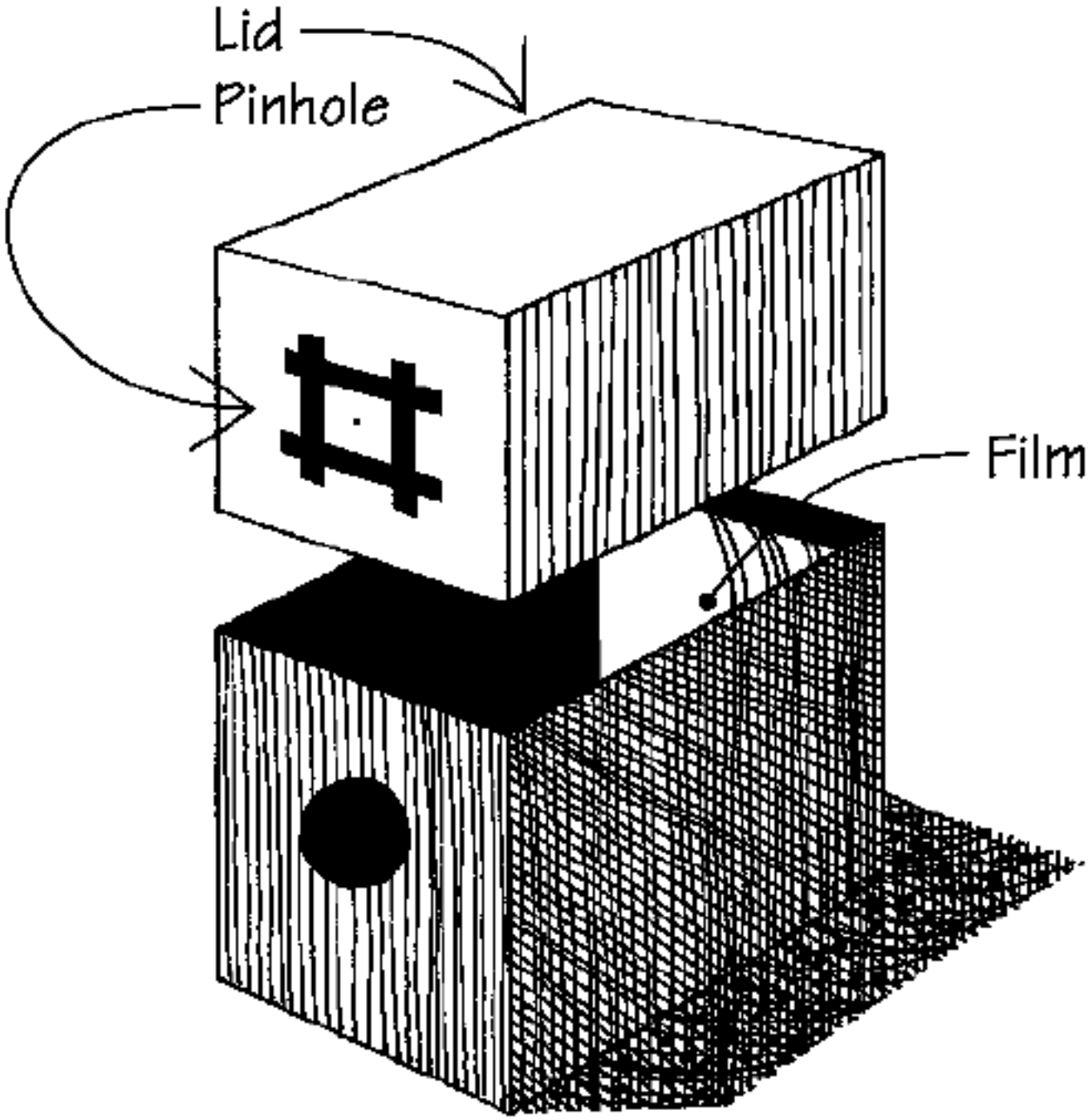
There are lots of ways to make pinhole cameras, all the way from total scratch to using a ready made container needing a little modification, or modifying an existing orthodox camera. Try to avoid flimsy con-

tainers for modification into pinhole cameras; shoe boxes are a prime bad example. Some of the Kodak boxes for films and chemicals are quite good. A light-tight lid and the film holding method inside the camera are the most important details to build. Appropriate tools include scissors, X-Acto knives, model glue, ruler, black vinyl electrician's tape, etc. The use of artist's black acrylic paint is highly recommended to plug light leaks.

A mundane tool (a stapler) becomes an interesting foto.

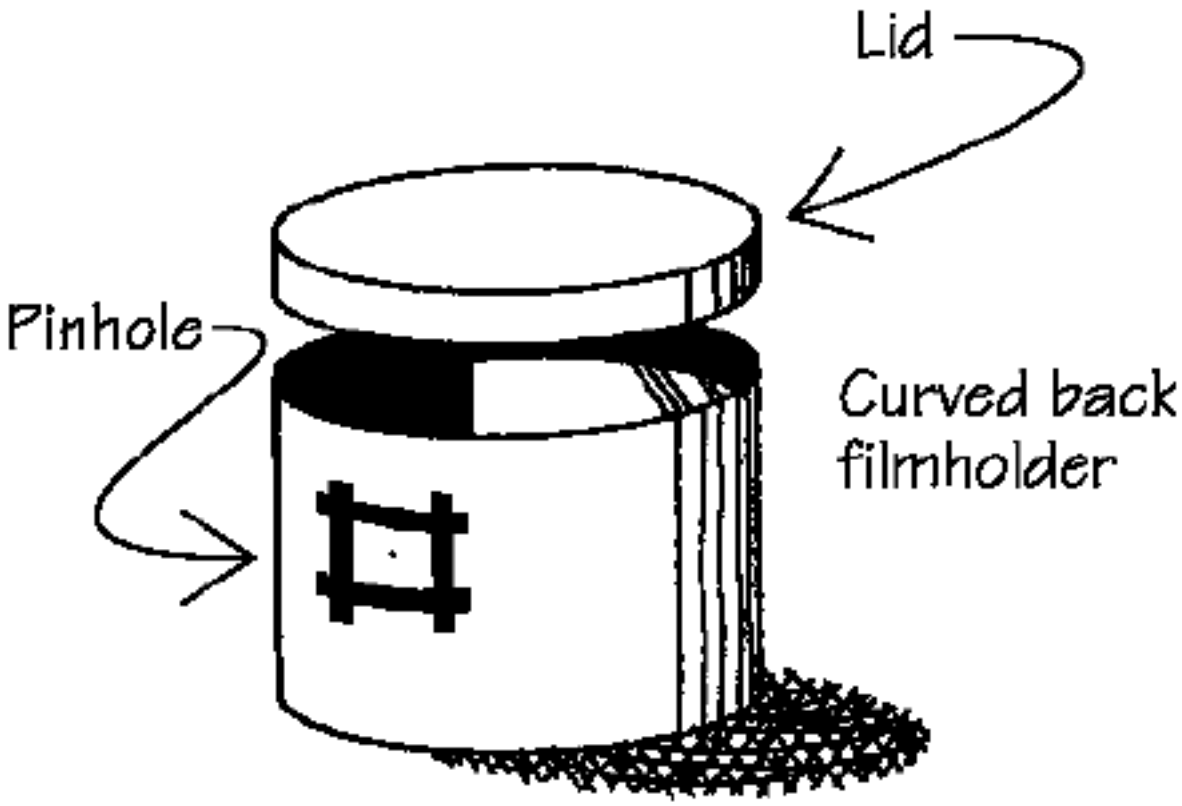
Supplies for Pinhole Camera-Making:

- ☐ sturdy box with a light-tight lid
- ☐ scissors
- ☐ X-Acto knife
- ☐ model glue
- ☐ ruler
- ☐ black vinyl electrician's tape
- ☐ artist's black acrylic paint
- ☐ needle
- ☐ pencil
- ☐ spare cardboard for film/paper holder
- ☐ white paint (if using a dark box)



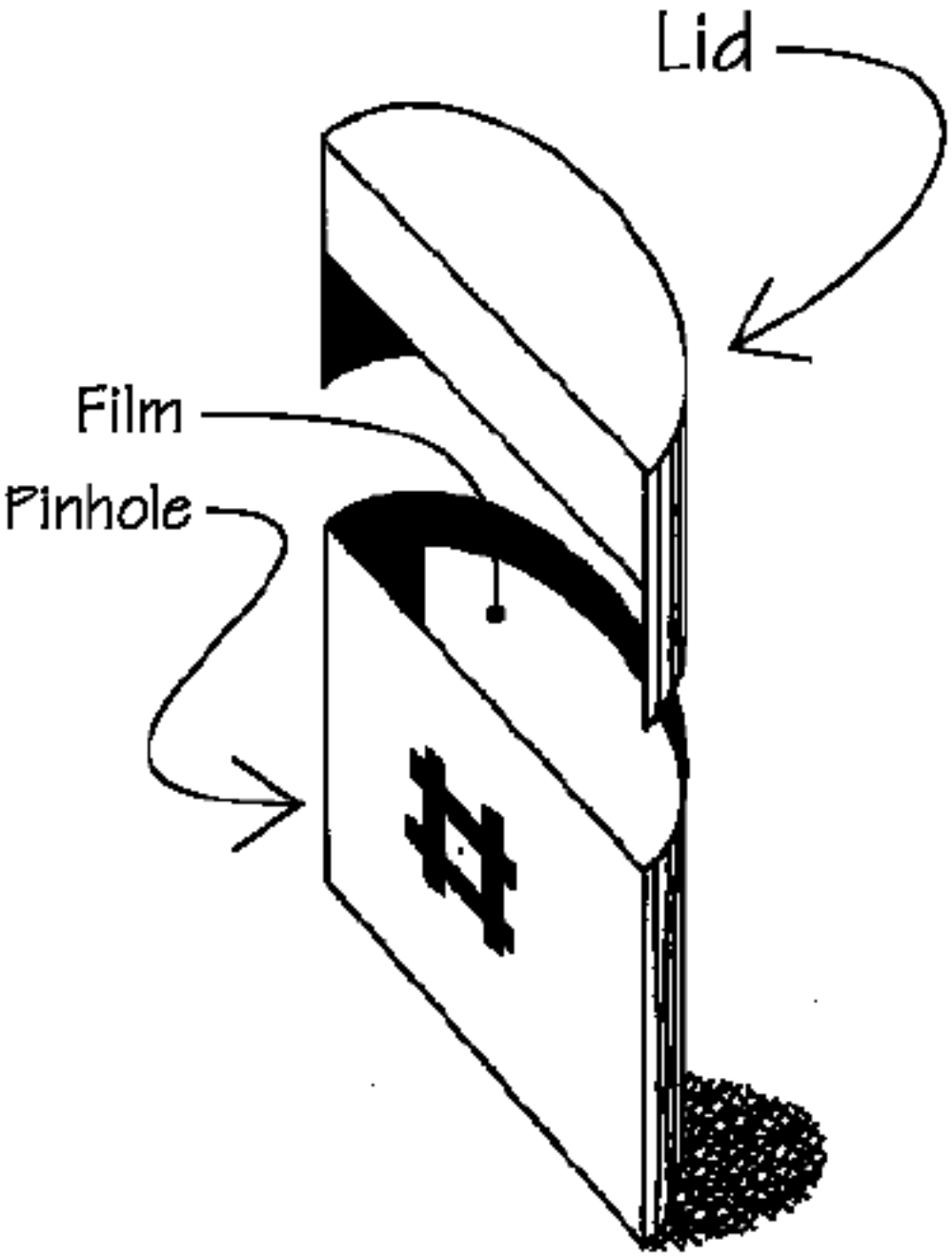
Basic box
"Normal" focal length

A "normal" focal length pinhole foto, taken with a basic box camera placed on the deck next to a driveway.



Basic cylinder pinhole camera "Wide angle" focal length

Foto of a horse skull made with a "wide angle" curved back camera.



Half-cylinder camera
Very wide angle focal length

A foto of bleachers taken with a wide angle, curved back camera.

The largest pinhole camera I've built was from a refrigerator packing crate that was originally made into a portable darkroom. The fotografer could go inside to make an exposure and then develop the negative. Instant fotografy!

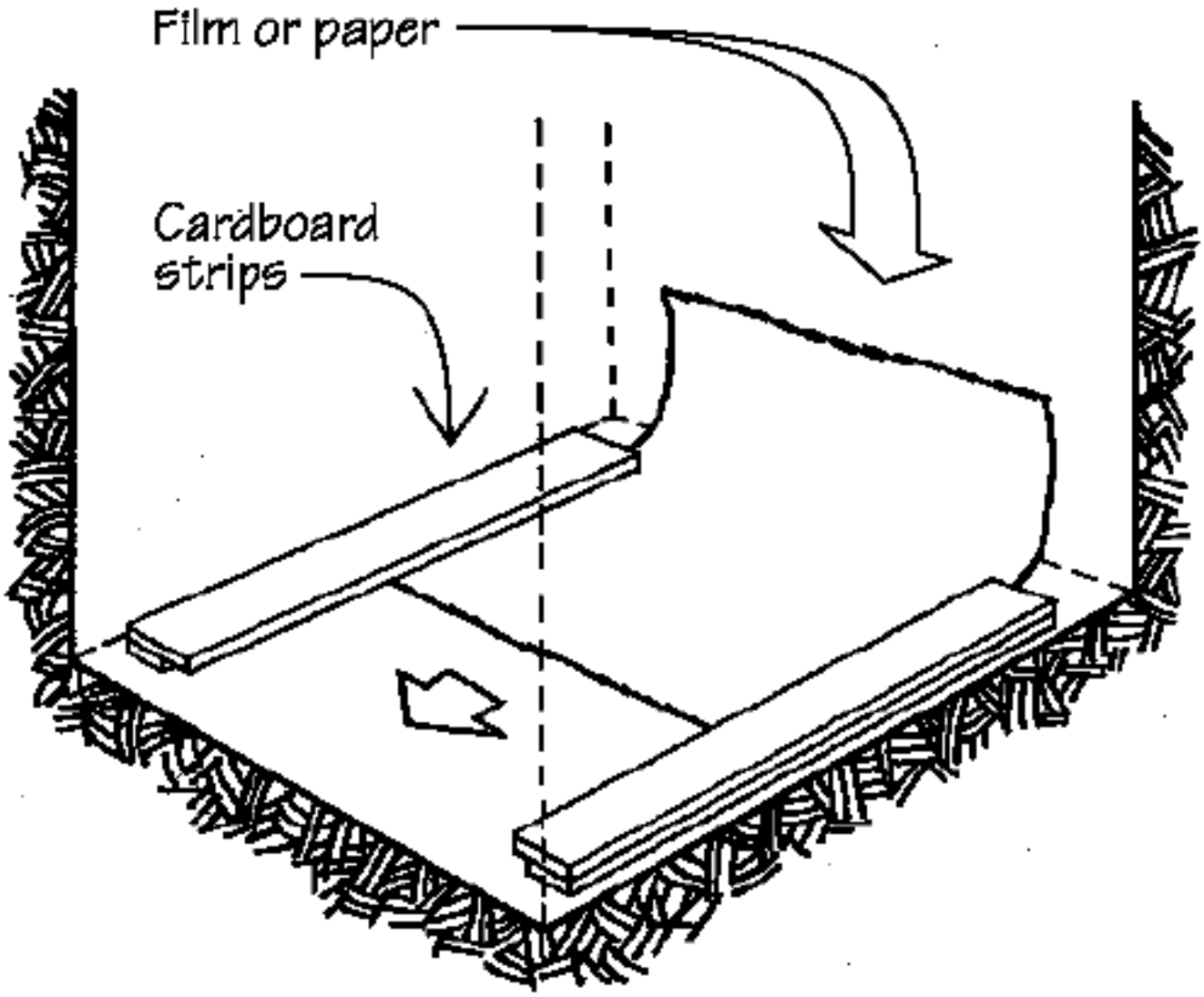
"The largest pinhole camera I've built was from a refrigerator packing crate..."

• Format Size

It is important to decide on a size of fotograf (format size) that is convenient to handle, such as 4 inches by 5 inches. The other important dimension is the focal length, which is the distance from the pin-hole to the "film" inside the camera. For the 4 inch by 5 inch format, the focal length should not be longer than 10 inches. A focal length of 2 to 4 inches produces a sharper, "wide angle" image.

• Inside the Camera

The inside of the camera should be flat black in order to prevent light from bouncing around during an exposure and fogging the film. Black acrylic artist's paint is excellent for plugging light leaks in corners and joints on the inside of the camera. The outside of the camera should be white, or at least not too dark, to help prevent heat buildup inside the camera during an outdoor exposure. A method to hold the "film" in place is quite important, partly for easy loading in the darkroom and partly to hold the "film" securely while you are out with the camera scouting around for the perfect pinhole shot.



One darn good way to build a pinhole camera filmholder

—X-ray view inside camera

• The Pinhole

The most important detail to a pinhole camera is the pinhole, and while it can be a hole made by a pin, it is usually a hole made by a needle. Any hole of about the right dimension in relation to a focal length will form an image, but a perfectly round hole in a very thin material will make the best image. So while it's possible to produce an image by stabbing a hole in the lid of a coffee can with a slightly used shingle nail, a nicely drilled needle hole in thin brass or aluminum (or gold foil for a little more class) will produce a superior image, as will high-tech holes produced by laser.

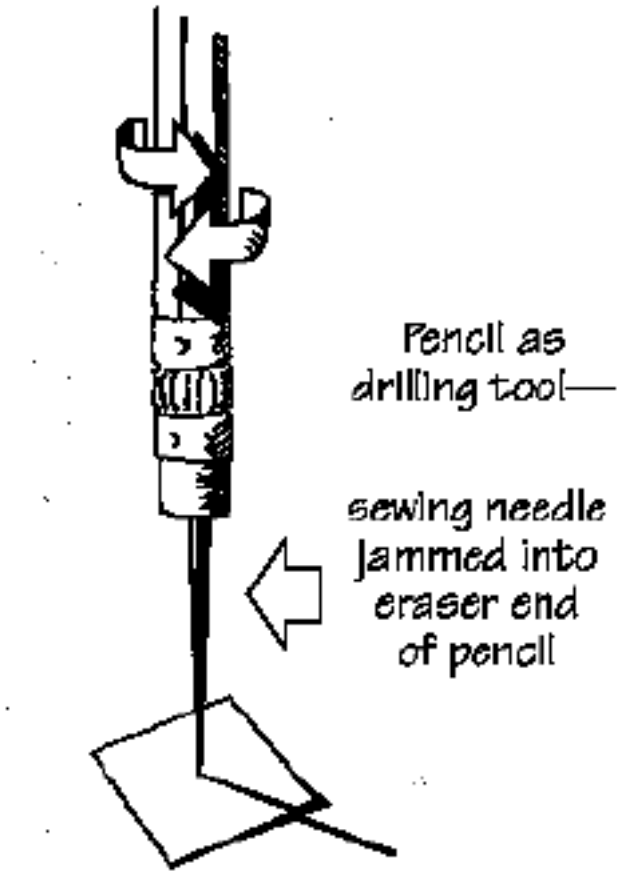
There are several ways the ideal size of hole can be calculated for any particular focal length, however it's my experience (with all due respect and admiration to those who have made the calculations) that about any size of hole will produce an image. The chart can be used as a rough guide. In general, the smaller the hole, the sharper the image and the longer it takes to make the exposure.

SIZE NUMBER OF NEEDLE	DIA. INCHES
4	.036
5	.031
6	.029
7	.026
8	.023
9	.020
10	.018
12	.016
13	.013

A fairly simple and reliable method of making a perfectly round hole is to drill thru brass shim stock of .001 or .002 inch thickness (obtainable from automobile parts stores) with a number 10 hand sewing needle, which is presumed to be a diameter of .018 inch. Shove the eye end of the needle into the eraser of a pencil to provide a convenient way to hold the needle. Twirl the point of the needle on the brass in

"With some practice a perfect 'pinhole' can be made in 5 minutes."

order to form a dimple in the brass. Turn the brass over and sand it with very fine (600) sandpaper or crocus cloth to remove the dimple. Then drill with the needle on that side to open up the hole a little. Turn the brass over and sand the other side and then drill to increase the size of the hole. After 4 or 5 alternate sandings and drillings of both sides, the hole will be expanded to the full shank diameter of the needle, and it should be perfectly round. With some practice a perfect "pinhole" can be made in 5 minutes.

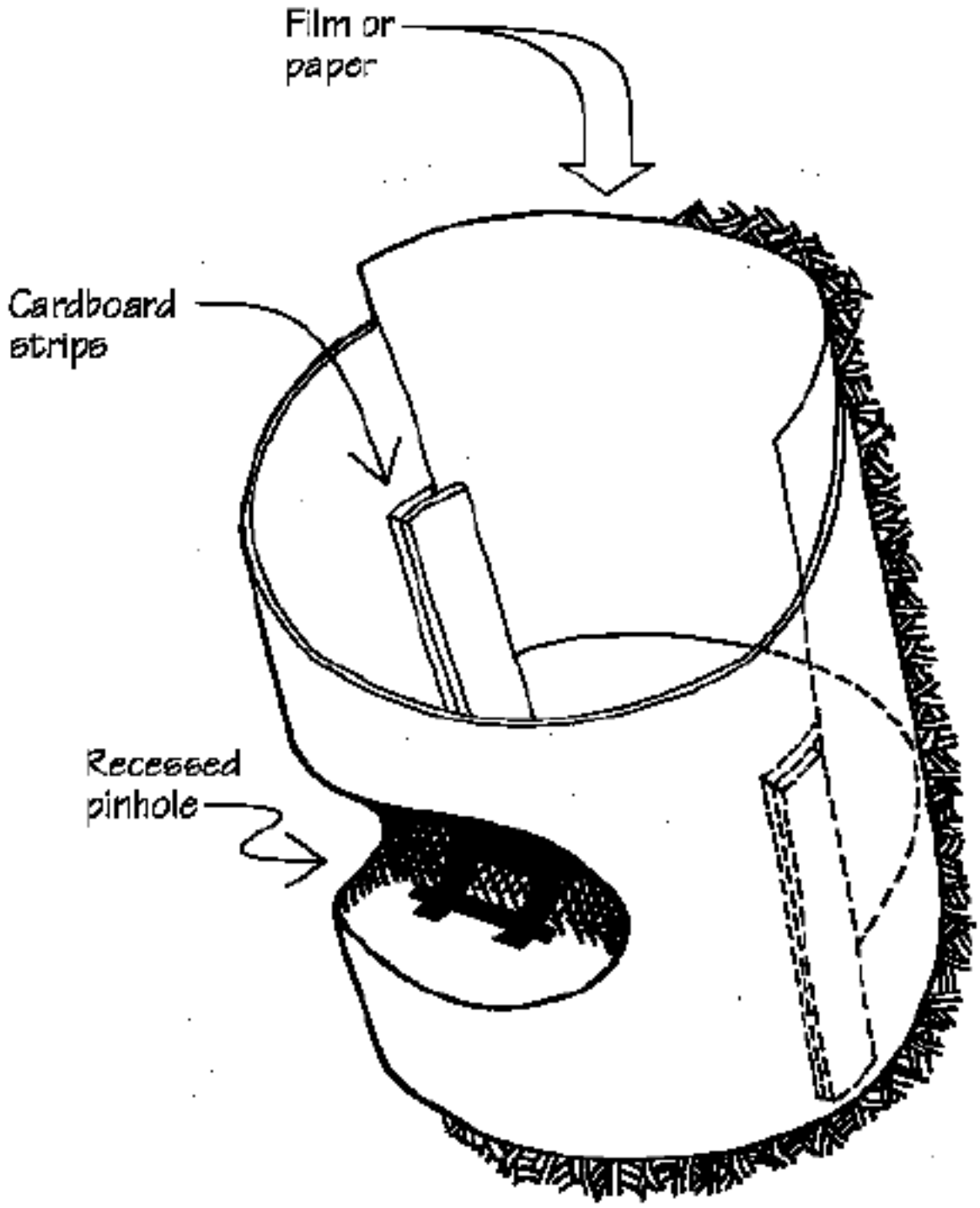


Drilling the Brass Shim-stock

• General "Types" of Cameras

Books on photography often state that the "normal" focal length of a given format is the diagonal measurement of the format size. Therefore, the "normal" focal length of the 4"x 5" format is about 6 inches, which amounts to about a 40° to 50° angle of view. With pinhole the results from cameras that have a shorter than normal focal length, or "wide angle," are usually finer in resolution, have more contrast and require less time to make an exposure. A 4" focal length will produce a wide-angle effect of about a 60° angle of view. A 3" focal length results in an 80° angle of view. Even greater wide-angle effects result from curving the "film" holder in the camera, which also somewhat equalizes the exposure over the "film" plane. This camera can be made from a tube or cylinder, such as a Quaker Oats cereal box.

"Even greater wide-angle effects result from curving the 'film' holder in the camera..."



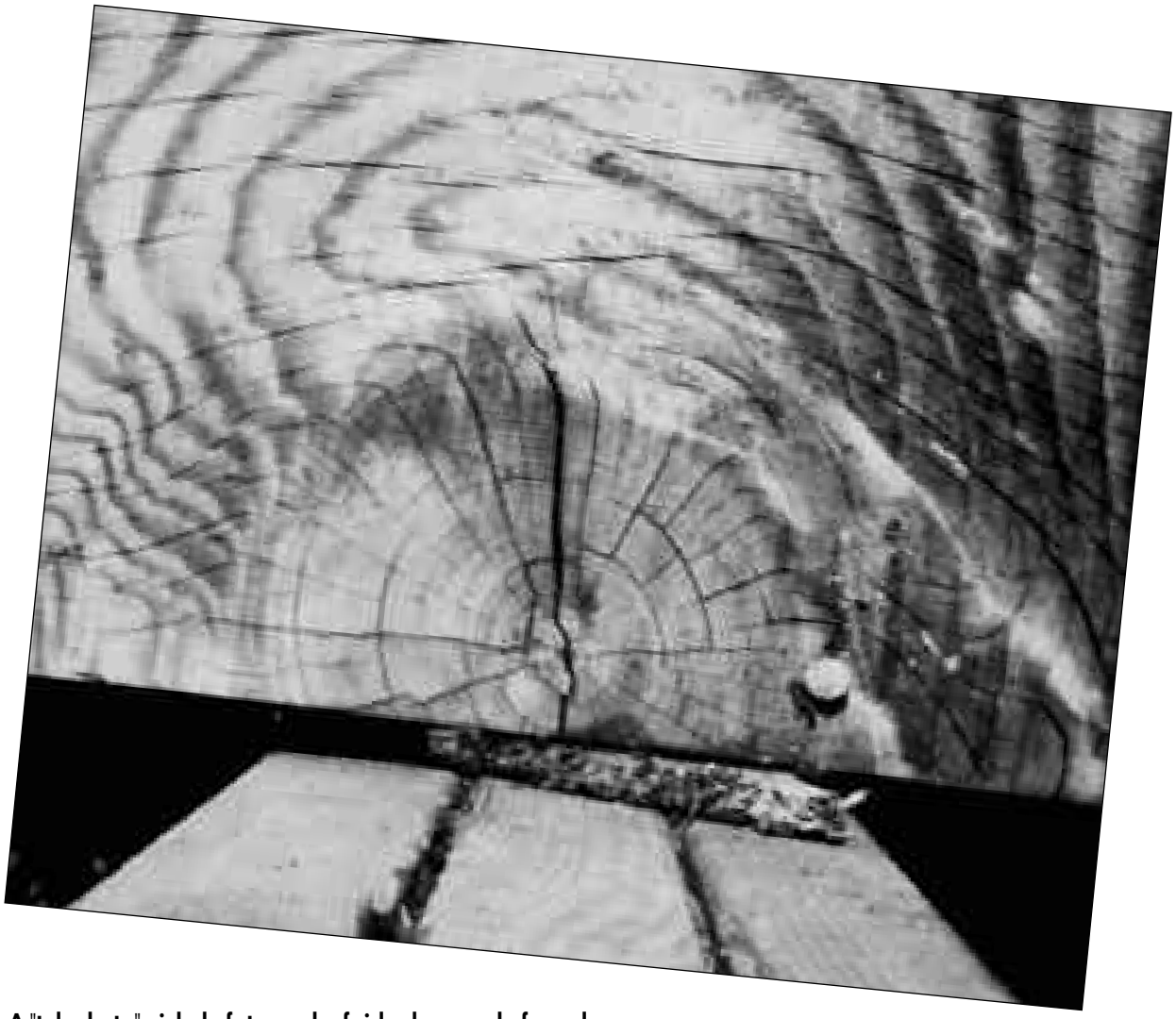
Curved back filmholder for cylinder camera

A wide angle foto of farm equipment made using a camera with a shorter than normal focal length and a curved "film" plane.

A wide angle, frog's eye view pinhole foto.

The "telephoto" camera, which has a focal length that is longer than "normal," is quite easy to make, but extreme telephoto (which for the 4" X 5" format is a focal length longer than 10 inches) is not especially satisfactory. Factors of diffraction and "circles of confusion" enter in that make low contrast (gray) and low resolution (fuzzy) images.

A "telephoto" view is made by using a longer than normal focal length. For this image, the camera was placed on a nearby ledge, about 5 feet from the subject.



A "telephoto" pinhole foto can be fairly sharp and of good contrast. The camera was placed on the beam in front.

Stereo pinhole is another simple thing. A camera made from a long box that will take a 5" x 8" piece of paper is a convenient size. Make a divider in the center, put in two pinholes 2" to 3" apart, and expose both sides at the same time.

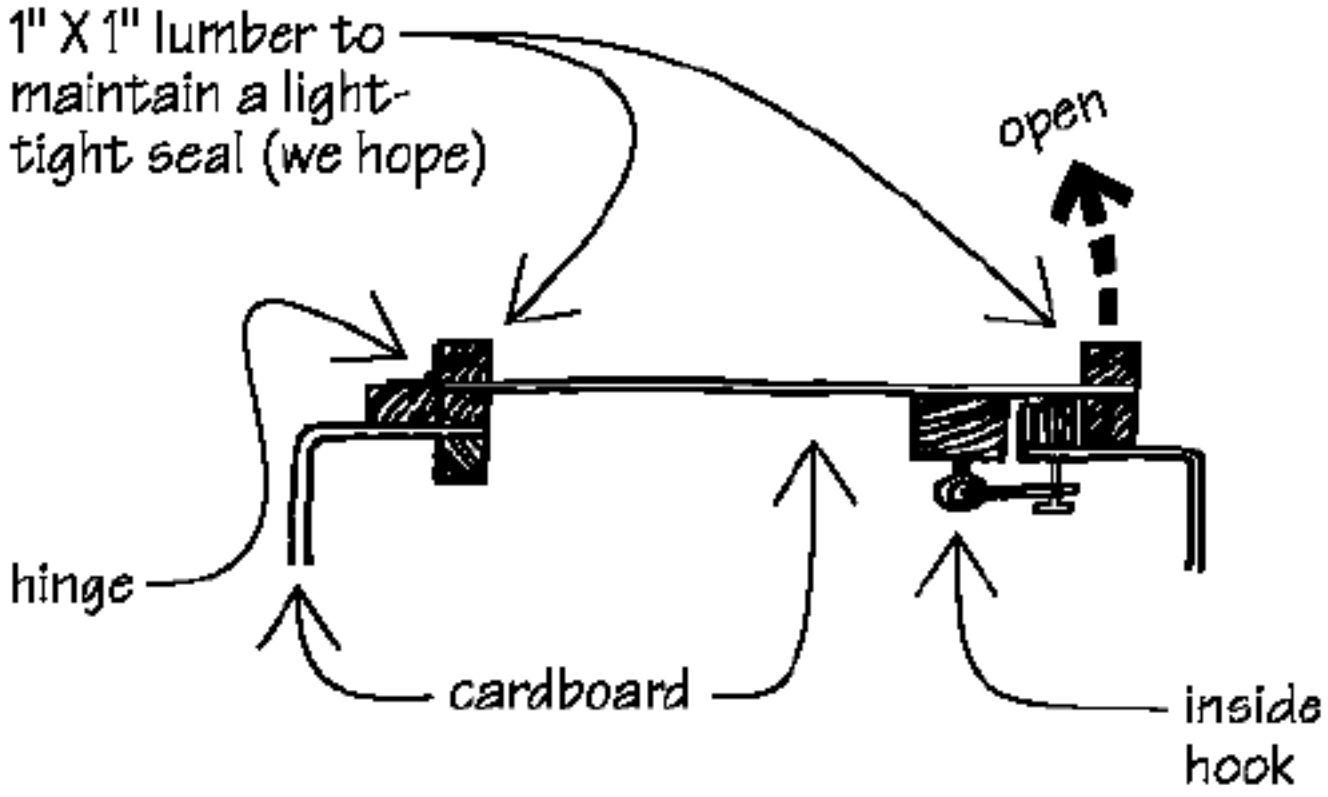
✔ The Darkroom

With the pinhole installed, the camera is ready to be loaded for an exposure, which requires some sort of darkroom for the loading, unloading and processing of the "film." A darkroom for pinhole use can be quite simple and inexpensive. I've made darkrooms out of cardboard, black sheet plastic and appliance crates, and darkrooms for camp or workshop situations where there was no water or electricity. The most difficult detail is the way in and out. A door that goes directly into the darkroom means that every time the door is opened a blast of white light gets in and all the darkness goes out. For a small scale situation with people that stop and think about it before going in or out, this is OK altho inconvenient. A much better method is to construct some sort of zig-zag, walk thru light baffle. This can be done with cardboard, black sheet plastic, packing cases and the like, along with lots of duct tape.

"The most difficult detail is the way in and out."

Portable Darkroom Door

Section View From Above



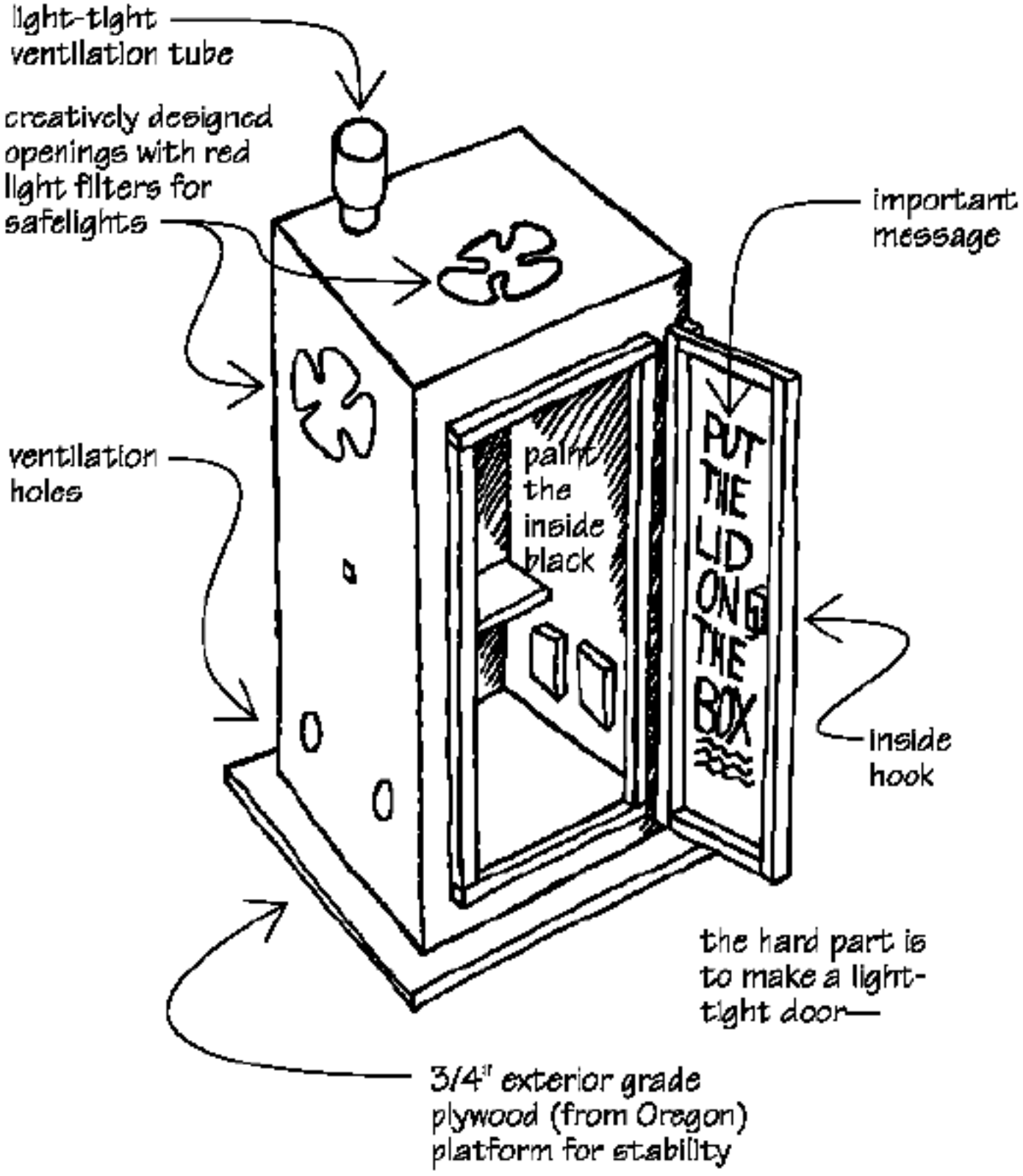
It is advantageous if the wash part of processing can go on outside the darkroom, like in a convenient sink, or pond, or river, or the ocean. This means that people can look at their stuff in white light with out having to suspend darkroom activities. If there is a shortage of water, the use of a washing aid after the fix can cut done the amount of water needed for the wash, or the fotos can be washed later when and/or where water is available. Most photographic papers can survive unwashed for a few days.

• Safelight

Essentially, a darkroom is a place where white light is excluded but red to orange "safelight" is present. For situations where there is no electricity, the safelight can be a hole to the outside covered with red cellophane or red blockout film (used for graphic design purposes). A flashlight with red material over the bulb can also be used. Where there is electricity any red to orange safelight is OK including homemade arrangements such as a 1958 ford tail light lens with a 7 watt bulb inside. A word of caution; no safelight is totally safe for light sensitive materials and some safelights are safe for only a few minutes. All photographic paper should be kept in a light tight place at all times. Most people learn that basic rule when they turn on the white light and then notice the box of paper with the lid off.

"A word of caution; no safelight is totally safe for light sensitive materials..."

Portable Darkroom and Camera
Built from Refrigerator Box



• Equipment

Other equipment for the darkroom would include 4 trays big enough for 4" x 5" paper. Inexpensive office or household plastic containers usually work well. 2 or 3 pairs of tongs are quite desirable but not absolutely necessary. Other darkroom items that are more or less nice to have but not essential would include a timepiece, such as a wristwatch that indicates seconds, a thermometer, various measuring containers of the kitchen variety, contact printer, paper cutter, and such really non-essential things like air conditioning, stereo and refridge for refreshments...

✔ Darkroom Events

• The Light-Sensitive Stuff

When a more or less workable darkroom has been set up, the loading, unloading and processing of the "film" can commence, which brings up a point to ponder, namely, what to load. While any light sensitive material can be used to make a pinhole image, such as film and enlarging print papers, I recommend enlarging print paper for the following reasons:

1. Most papers are Orthochromatic, meaning they are not very sensitive to red light and are used in safelight conditions. This means the entire cycle of loading, unloading and processing can be observed. Regular Panchromatic films are sensitive to all light and require total darkness during processing.

"This means the entire cycle of loading, unloading and processing can be observed."

2. With papers the same chemicals can be used for positives and negatives.

3. The developer for paper takes less time to do its job than developer for film.

4. Paper is cheaper than film, which is in keeping with the low cost way of pinhole. My usual method is to buy 8" x 10" print paper and cut it down to 4" x 5" (in the darkroom).

So now that the camera has been loaded and an exposure made, what's next?

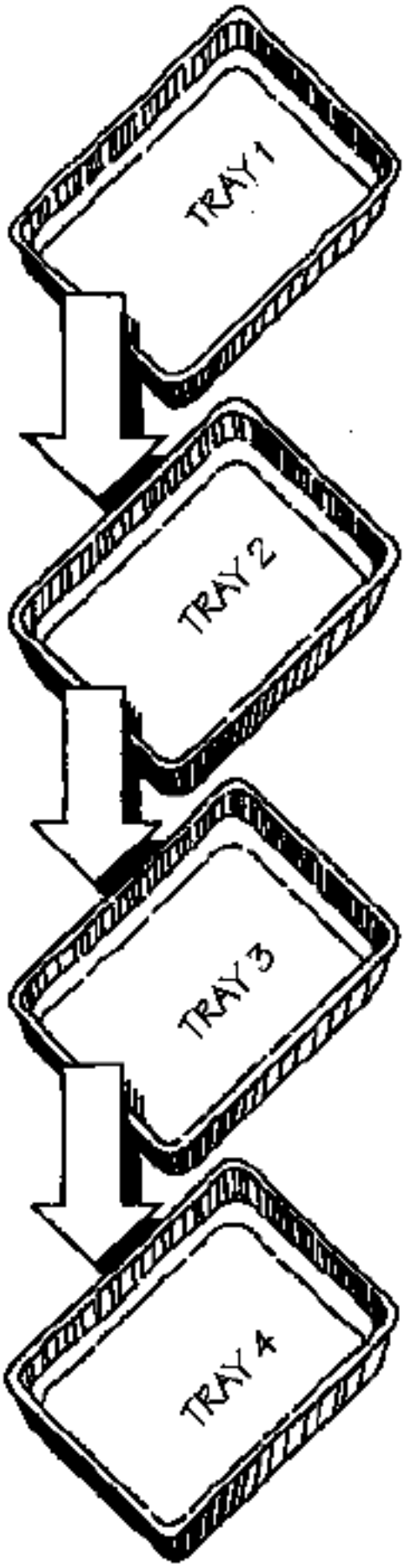
• Chemicals

The standard chemicals are in readiness in the trays; developer, stop bath, fix and water wash. They will function at temperatures between 50° to 100°. The ideal temperature is 68°, give or take 10°. The exposed paper is first placed in the tray of DEVELOPER for about 2 minutes, then dunked in the tray of STOPBATH for 10 to15 seconds, then into the FIXER tray for 5 to 8 minutes, then to the water WASH for awhile (usually the longer the better).

Once again, the DEVELOPER is any brand of paper developer. The development time of 2 minutes is sort of typical, with 1 to 4 minutes being the usual range.

The STOP BATH can be plain water, but a snort of Acetic Acid will make it much more effective. Acetic Acid is a standard photographic chemical, just follow the formula on the bottle. Indicator Stop Bath, another standard photographic chemical, is even better, it makes the stop bath look yellow. When it becomes exhausted, it turns purple, a clear indication that the stop bath is pooped. The stop bath will stop the developer from developing the image, which for a good exposure is not of much concern. More importantly, the stop bath will neutralize the paper. The developer is alkaline and the fixer is acid and would soon be rendered worthless by the developer if there were no stop bath. It works the other way around as well.

"When it becomes exhausted, it turns purple, a clear indication that the stop bath is pooped."



Developer

Two minutes, give or take 20 seconds—
use tongs to drain foto and drop into stop bath

Stop Bath

Half minute, at least—
return developer tongs to developer tray

Fix

Five to ten minutes—
same tongs can be used for stop & fix

Wash

One hour of running water—
the fotos can be parked here until running water is available; a sink, hose, creek, ocean, etc.

The FIXER eschews obfuscation (a 1970's bumper sticker comment). It will fix the image so that white light will not turn the image black.

The WASH gets the fixer out of the paper so the image won't turn brown and ultimately fade. An optional product known as Hypo Clearing Agent will speed up the wash time and reduce the amount of water that is needed.

In keeping with the inexpensive way of pinhole, your well-washed but still wet negatives and/or positives can be dried between the pages of a telephone book, a volume of art history, or simply allowed to dry on a convenient surface.

To rehash a bit more elaborately; the developer stage is the moment of truth. If a good exposure was made the image will begin to appear in 20 to 30 seconds and not turn black all over. This makes the exposure a "keeper," at least for technical reasons; aesthetic reasons are another concern. If the exposure is obviously not a keeper there is no reason to go thru the rest of the trays. Reload the camera and try another exposure. "Bad" exposures and their causes are discussed in the table on the next page.

"...the developer stage is the moment of truth."

Two Symptoms of "Bad" Exposures...

A.—The paper remains blank white, or the image is very faint. There are 3 reasons for this.

Causes:

1. The paper was loaded in the camera backwards, hence very little light got thru the paper to the light sensitive side.
2. The shutter was not open during the presumed exposure time.
3. The exposure was not long enough by a whole lot.

B.—The paper image is very dark, or completely black. There are 3 reasons for this.

Causes:

1. The camera has a big light leak
2. The paper was exposed to white light by mistake.
3. The exposure was too long by a whole lot.

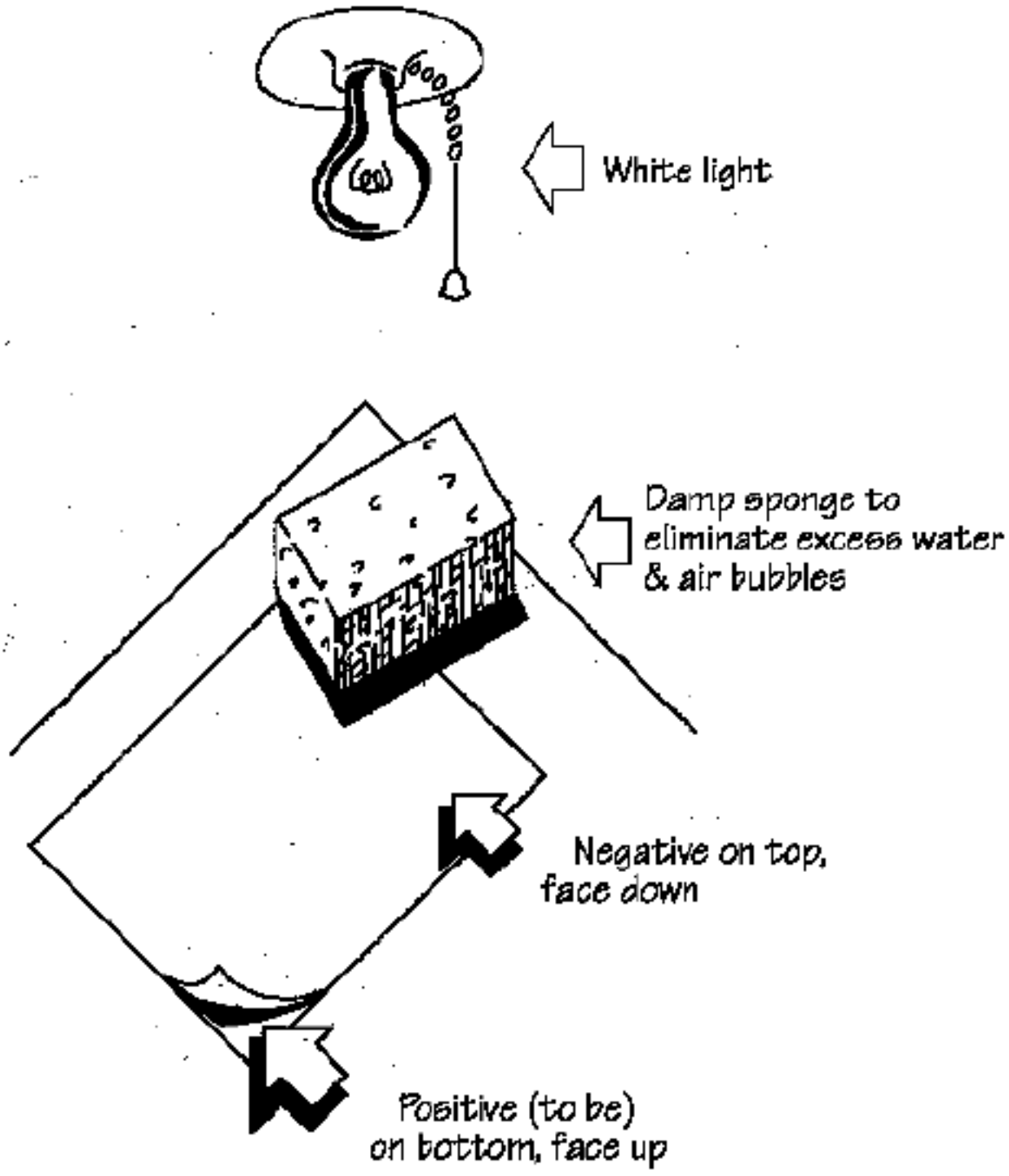
✔ Making Positive Prints

After a few exposures have been made that turn out OK, you will have a good idea of what works with the particular paper you are using along with the general light conditions of the moment. The next trick is to make a positive print from a negative. The positive is what people ordinarily call a photograph (fotograf). The basic method is known as contact printing and it can be done either wet or dry. The dry method generally results in better prints but the wet method can be done as soon as the negative gets to the wash.

"The basic method is known as contact printing and it can be done either wet or dry."

• Wet

When the negative is in the wash, an unexposed piece of paper is also placed in the wash for a minute or two. Then the negative and the positive-to-be are placed together face to face (emulsion surface to emulsion surface) on some sort of support and the excess water and air bubbles are skooshed out. Make sure the negative is between the source of white light and the unexposed paper, which usually means the negative is on top. Turn on the white light for about one second, then put the positive to be in the developer and put the negative back in the wash. With a few exposures a fairly good idea of the proper exposure time can be determined.

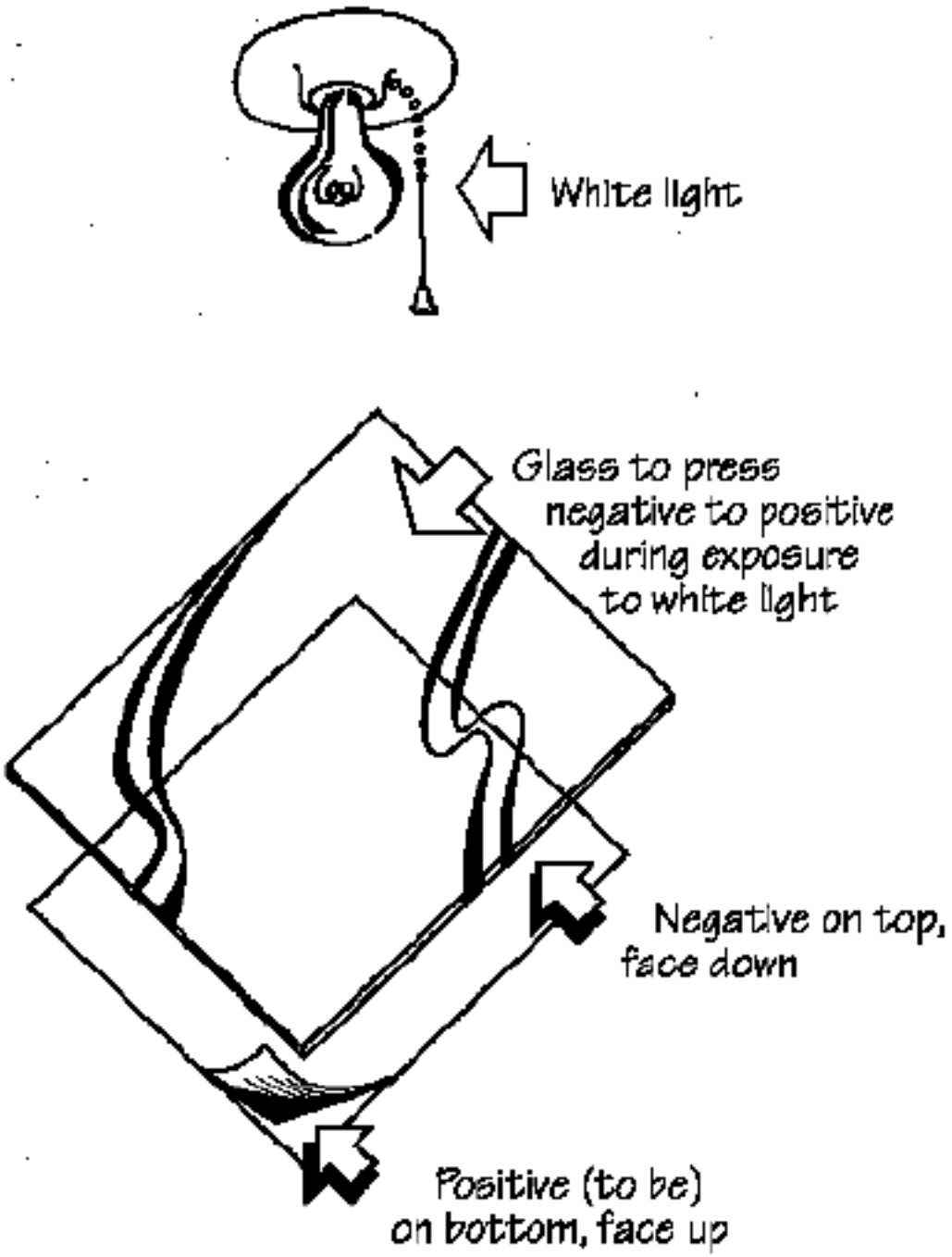


Wet contact printing

• Dry

If you can wait for the negative to dry, the dry method is simpler and can make better results. A piece of glass is needed to maintain close contact between the negative and unexposed paper during exposure. The construction (or purchase) of a contact printing frame or printing box with its own white light source is usually worthwhile if there are lots of negatives to print.

"If you can wait for the negative to dry, the dry method is simpler..."



Dry contact printing

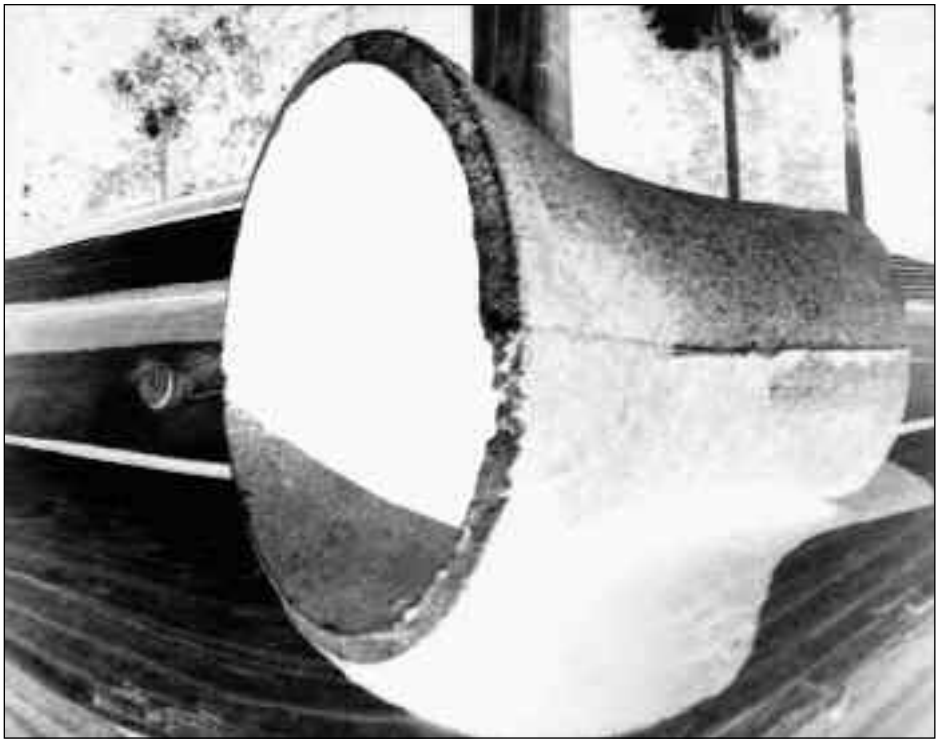
The following few pages will help you begin to get an idea of what kind of negative will produce what kind of print. Closely examining your negative will determine which pictures you decide to print.

NEGATIVE

PRINT

A negative that is too dark, produces a print that is too light.

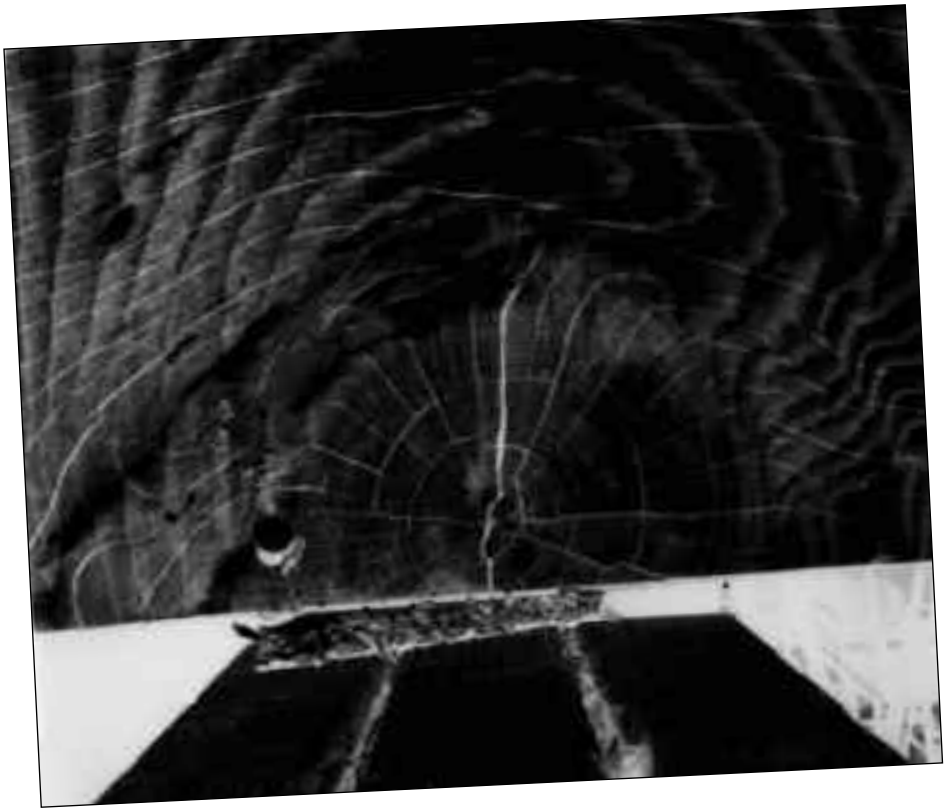
A negative that is too light, produces a print that is too dark.



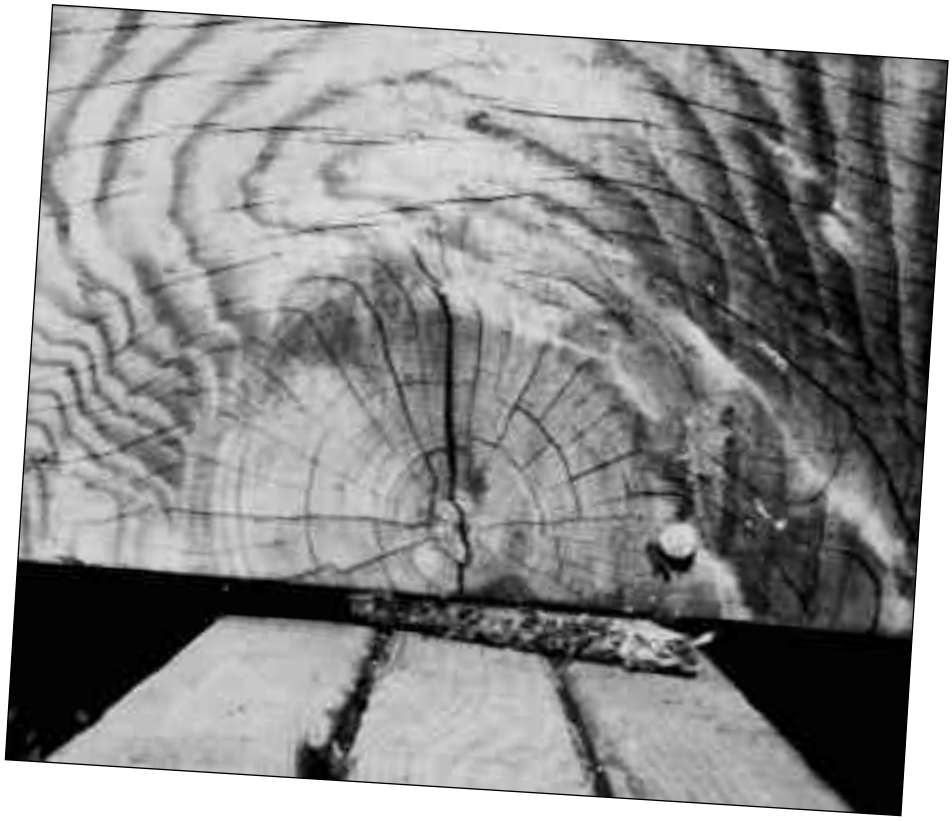
NEGATIVE

PRINT

A well exposed negative is one that has well defined areas of light and dark (i.e. it's not overwhelmingly dark or light).



NEGATIVE



PRINT

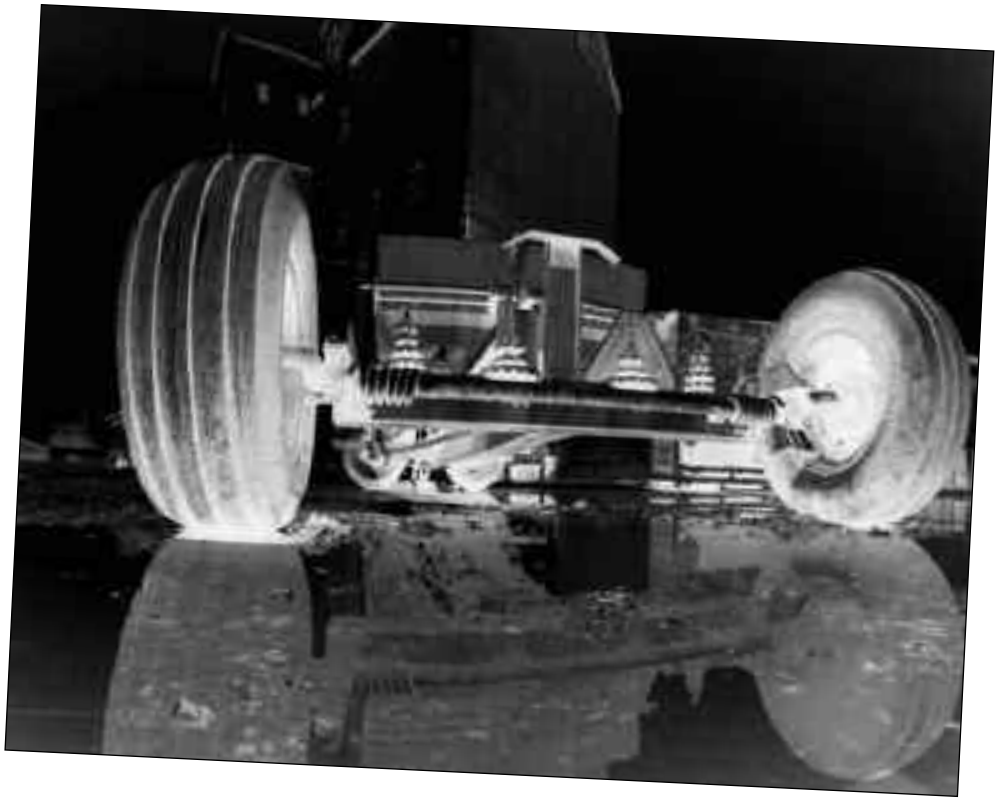
NEGATIVE

PRINT

NEGATIVE

PRINT

NEGATIVE



PRINT

Exposure Info

Returning to the business of making an exposure, otherwise known as "taking a picture." There are factors about making an exposure that require a lot of study and testing (as a lifetime project) in order to understand all the relationships and possibilities. Regardless of that, it is not difficult to make a successful exposure with our rudimentary pinhole cameras, and for a lot of simple cameras that have been around since the Kodak appeared in the 19th century. For the way of pinhole, making the exposure mostly consists of loading the camera, going to a likely place to take a picture, parking the camera where it can't

move for a long exposure (like one minute), going back to the darkroom and processing the exposure. An ability to produce a well exposed negative is learned thru experience, and the way of pinhole is a fast way of getting the experience. This is the way most people acquire and improve their ability to photograph.

✔ The Four Factors

Regardless of our casual approach, there are certain factors that are in effect every time a photograph of any kind is made. Having some information about those factors can help in understanding what happens and why, or what doesn't happen and why not. Knowing the factors will also make it possible to calculate an exposure for various conditions, or to relate the way of pinhole to the photographic methods like the zone system, or maybe even to the way of Zen. These can be conveniently regarded as the Four Factors. They are fundamental to photography because if any one of them is missing, a photograph cannot be made.

"Knowing the factors will also make it possible to calculate an exposure..."

The factors are listed on the opposite page, and treated in more detail in the rest of this chapter.

The Four Factors for Exposure

1. **Light.**

   How much and what kind. Measured in foot candles.

2. **Sensitivity of "film."**

   Measured with ASA, ISO, DIN or ANSI numbers.

3. **Interval.**

   The amount of time the light is allowed to go thru the hole. Measured by shutter speeds.

4. **Aperture.**

   How big the hole is that the light goes thru to get to where the "film" is. Measured by "F" stops. This is where the needle comes in. The f-stop is a simple ratio expressing the relation of the size of the hole to the distance from hole to film plane. Therefore, a 1" hole and a 6" focal length creates a ratio of 1:6, or f/6.

For orthodox photography the usual technique is to take a light reading with a light meter that has been set to a particular ASA, ISO or DIN number, which is the film "speed". The reading will show a range of possible "F" stop and shutter "speed" combinations, one combination is selected, and the exposure is made. On the surface, it looks very simple, but there are a lot of interesting, sometimes peculiar and often complex elements to each factor and their relations to each other. The subjective judgment for each factor that the photographer has is also part of the equation. This is an art part of photography, as well as being philosophical territory (filosofical for pinhole). For pinhole the factors work thusly:

"This is an art part of photography, as well as being philosophical territory..."

• Light

The more the better, especially if the "film" is enlarging paper. Paper is much more sensitive to the blue end of the spectrum so daylight is about the best light usually available. Also, paper is slow stuff compared to film.

• Sensitivity of the "film"

Manufacturers of enlarging papers don't rate papers with ISO numbers, but often use ANSI numbers. A 200 to 300 rating is fairly slow and 750 to 1000 is relatively fast. Also the contrast grade of the paper usually affects "speed." Most papers of grade 0, 1 or 2 (soft papers) are faster

"It is my experience that the lower, soft grades of paper generally give better results..."

than higher grades of the same paper. Variable contrast papers can be used and their rating will be for no filter. It is my experience that the lower, soft grades of paper generally give better results, at least for the kind of pinhole fotos that I like. Single weight paper is easier to use, and cheaper, than double weight.

I usually use a medium speed, single weight, contrast 2 semigloss paper. I use an ISO of 4 which I learned by trial and error. Most papers are about the same. You can take your particular brand and at least start with ISO 4, then adjust accordingly. If you use ortho film, there will be an ISO rating in the instructions, sometimes two or three. If so, use the one for white flame arc.

• Aperture

This is the ratio of the size of the aperture (pinhole) to the focal length. The focal length is the distance from the hole to where the film is. So if the hole is one inch in diameter and the focal length is 6 inches (distance from hole to film plane), the ratio is 1:6, or F/6. For example, a number 10 needle is .018" and if used with a 5" focal length, then:

$$\frac{.018}{5.00} = \text{f/277}$$ (f/280 is close enough)

This is another reason for not using a light meter; even the best seldom chart beyond f/45.

To save you from tiresome calculations, here's a table:

Needle no.	Diameter	Best Focal Length	f-Stop
4	.036"	20"	f/550
5	.031"	15"	f/490
6	.029"	13"	f/450
7	.026"	10"	f/390
8	.023"	8"	f/350
9	.020"	6.5"	f/300
10	.018"	5"	f/280
12	.016"	4"	f/250
13	.013"	2.5"	f/190

The table below shows the resulting f-stops for varying focal lengths with a .018" pin-hole.

Focal Length	f-Stop
4"	f/220
5"	f/280
6"	f/330
7"	f/390
8"	f/440

"In other words, to heck with it; wait until the sun is out. "

• Interval

Generally known as shutter "speed." With pinhole the shutter speed is usually more than 15 seconds and can even be hours. In my opinion, if the exposure takes more than 10 minutes then the conditions for the way of pinhole are not sufficiently auspicious. In other words, to heck with it; wait until the sun is out. Such slow shutter speeds mean that the shutter can be quite rudimentary. I use black vinyl electrician's tape to cover the pinhole. A finger over the pinhole will suffice for a quick trip out and back into the darkroom.

To calculate shutter speed, a basic law is used: at f/16 on a bright sunny day, the proper shutter speed in the reciprocal of the ISO number. Therefore at f/16, on a bright, sunny day, with ISO 4 paper, the shutter speed should be 1/4 second.

However, pinhole cameras often have much higher f-stops (see the chart on the opposite page!). The following key shows the shutter speeds for different f-stops (still on a bright, sunny day with ISO 4 paper).

F-Stops

4	5.6	8	11	16	22	32	45	64	90	128	180	256	360	512
1/60	1/30	1/15	1/8	1/4	1/2	1	2	4	6	16	32	64	128	256

Shutter Speeds (in seconds)

Advanced exposure info is provided on pages 73 and following.

This mostly takes care of the basic business of the way of pinhole fotografy. I recommend using this information and making some exposures for a while. You will probably get some ideas for pinholy possibilities, which will increase your interest, magnify your joy, and generally demonstrate why pinhole fotografy has significance beyond being a funny way to take pictures. Also, questions may begin to form which are usually a variation on "what am I going to take a picture of?" The next chapter suggests a few possibilities.

"This mostly takes care of the basic business of the way of pinhole fotografy."

Nifty Pinholy Ideas

• Try high-contrast paper, or "litho" films, such as Kodalith. It's not necessary to use the specified developer. Dektol will develop anything. However, the best high-contrast or tonal range possibilities will result with specified developers.

• Try panchromatic stuff, otherwise known as regular film. It's more of a hassle in the darkroom but it sure is fast exposing, and you can modify orthodox cameras in order to use roll film.

• Try X–Ray film. Orthochromatic and fast (but not cheap).

• Make your own light-sensitive emulsions, such as the gum bichromate process, and apply to different shapes or surfaces, like the inside of a rubber ball. Info about this can be found in books on alternate photographic methods.

• Distorted images such as the image off a Christmas tree ball or convex mirror, or windows with water drops on them.

• Modify a Polaroid camera and expose color film.

• Multiple images by using several pinholes in different kinds of patterns.

• Use unround-pinholes, such as a narrow slit or a square hole.

• Try infrared film.

"Modify a Polaroid camera and expose color film."

The image to the right was created using an array of three pinholes in a "normal" flat-back camera.

When shooting this image, three of the five pinholes in the "normal" flat-back camera were used.

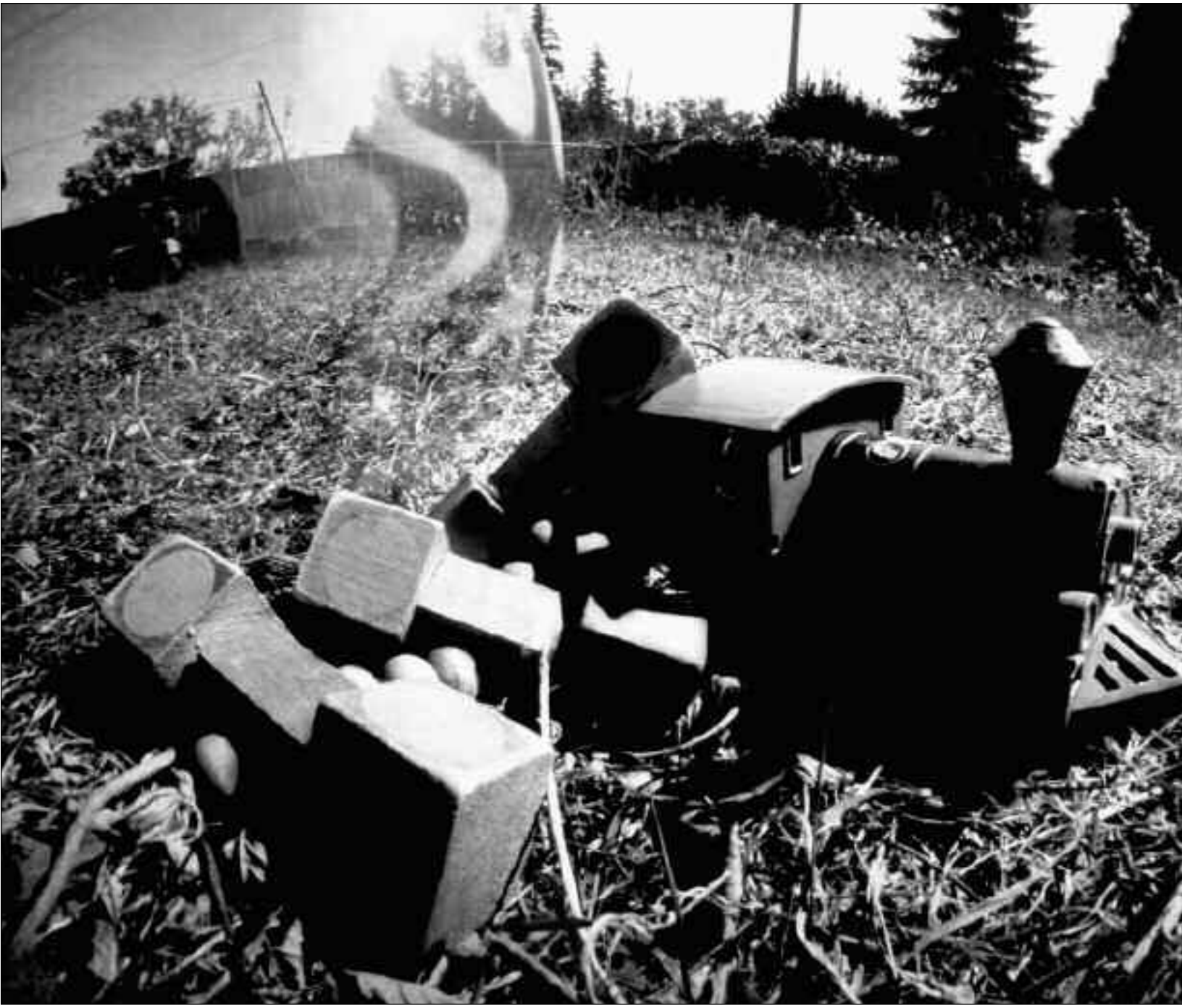
The negative of the same image shown on the previous page.

This pinhole foto of some old farm equipment was shot with a "normal" flat-back camera, using three pinholes.

Foto of an ear (with surrounding head).

• Lie down next to your camera and take a picture of your ear (or some other view of your anatomy).

• Halfway thru an exposure, put an object in front of your camera, or move some of the objects that are in view of the camera. This will result in transparent "ghost" objects. Also, anything moving about during an exposure will not show up in the fotograf. A view of a busy downtown will appear to be deserted.



Shot with a "wide-angle" curved-back camera, a child's ball was removed from the foto mid-exposure to create the ghostly image you see in the upper left-hand corner.

• Take a picture of an object and process the negative. Place the negative in another situation and fotograf that. The negative will be a positive in the next negative.

A negative looks like a positive on a negative fotografed of it. If you print the second negative, the original negative will once again look like a negative.

Perfection: Advanced Exposure Tips

While the info in the manual is adequate for the more casual pinholer, experienced photographers will notice the omission of information about reciprocity failure during the typically long exposures for the way of pinhole. For those of you who must know everything and have good light meters and want to pinhole according to the Zone System, here is some additional info to carry you on to the perfect pinhole fotograf.

Reciprocity means that when shutter and aperture values are changed step-by-step, say, from f/16 at 1/125 second to f/11 at 1/250 second, the two exposures would be identical as far as the film is concerned.

However, this reciprocity conks out when exposures are extremely short or (as we are concerned about in pinhole) extremely long. Since the phenomenon has been known for quite some time, fairly accurate (and lengthy and complicated) compensating factors have been worked out. They look like this:

Indicated Exposure	x Reciprocity-Failure Compensation	= Actual Exposure Time
1 second	x 1.25	= 1.25 seconds
5 seconds	x 1.5	= 7.5 seconds
15 seconds	x 2	= 30 seconds
45 seconds	x 2.5	= 1 minute, 52 seconds
2 minutes	x 3	= 6 minutes
5 minutes	x 4	= 20 minutes
10 minutes	x 5	= 50 minutes
20 minutes	x 6	= 2 hours
40 minutes	x 8	= 5.5 hours

However, not all photographic emulsions respond the same way and some papers are much more sensitive than the compensating table indicates. Testing and complete notes of test results are in order here. Prayers and incantations may also be of some help.

When making precise calculations for exposure, you may also find it helpful to augment the shutter speed key on page 59 by adding two intermediate slots between the major slots of aperture and shutter speed. The resulting table would look something like this:

F-Stops

11	12.5	14	**16**	18	20	**22**	25	28	**32**	35	40	**45**	50	56	**64**
1/15	1/12	1/10	**1/8**	1/6	1/5	**1/4**	1/3	2/5	**1/2**	3/5	4/5	**1**	1 1/3	1 2/3	**2**

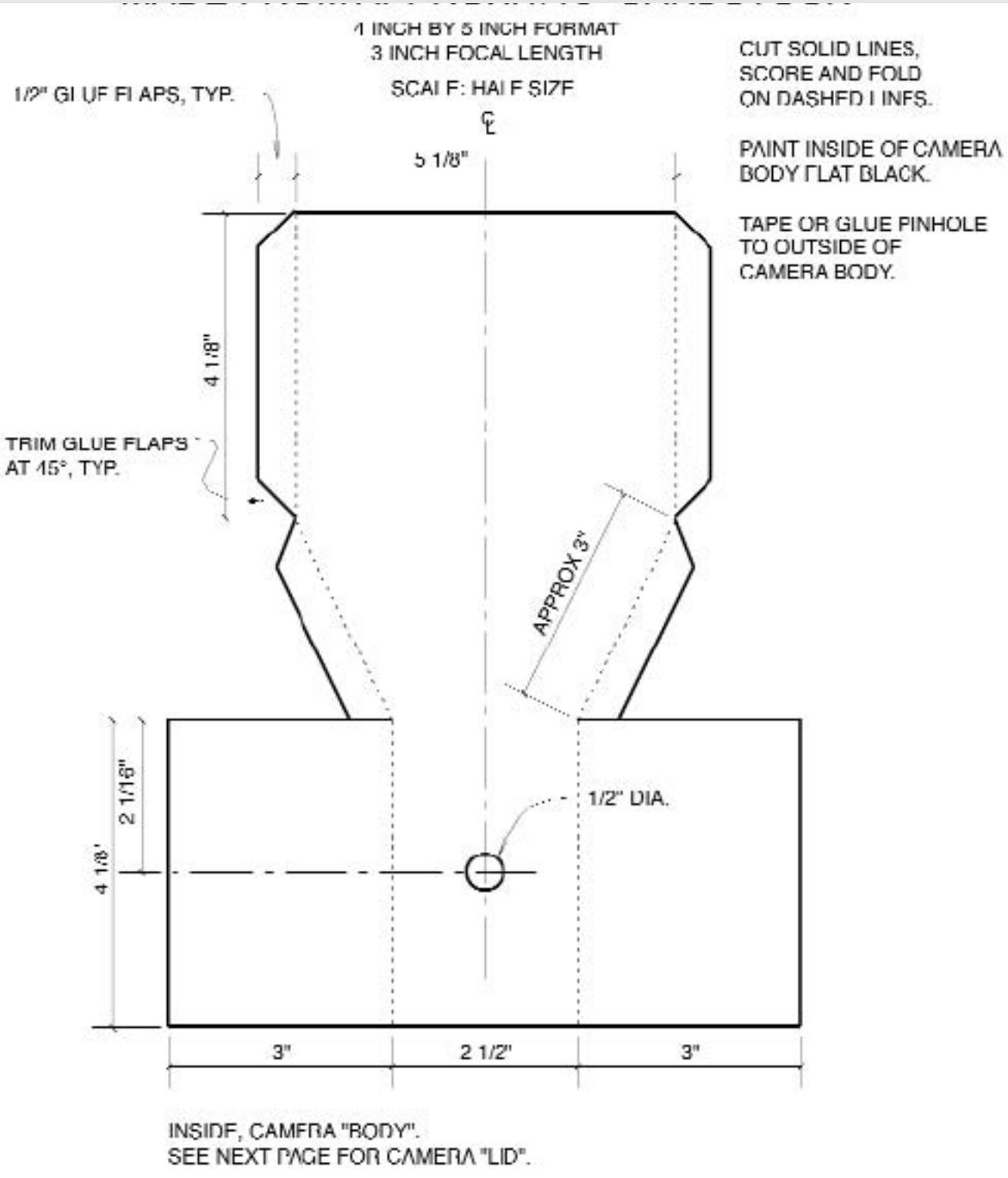
Shutter Speeds (in seconds)

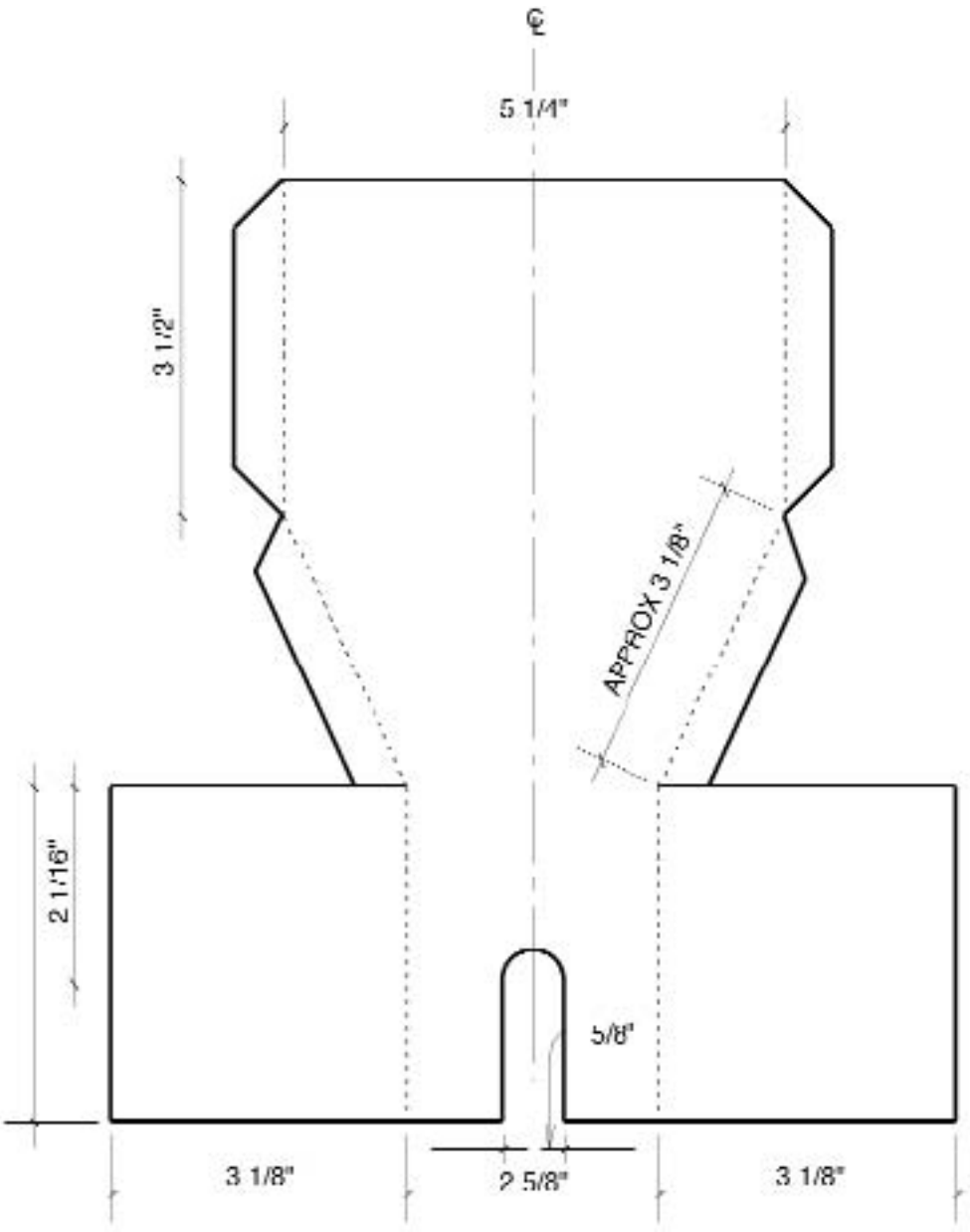
This kind of key works the best with pinhole, since the f-stop of the individual camera in invariably something odd like f/290 which does not fit the standard progression. Extra intervals on the key will make things a little more precise.

For pinhole fotografers who want to master every little detail, a handy guide for calculating exposure is the *Black Cat Extended Range Exposure Guide* (see the back pages of this book for ordering info).

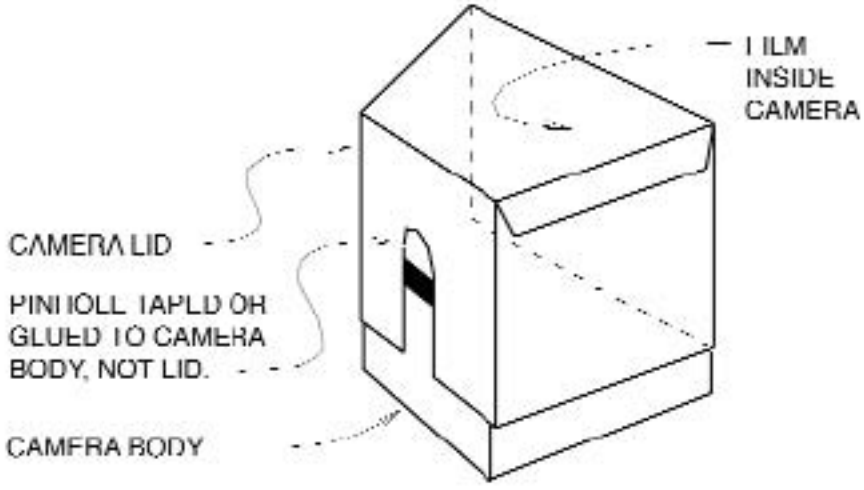
Pinhole Camera Plans

For those pinholers industrious enough to start from scratch (or for those who find themselves lacking a suitable box to modify), the plans below will make an excellent pinhole camera. The plans are designed for use with approximately 1/16" cardstock. Using a photocopier (or scanner and printer, if you have access to these), the plans can easily be scaled up to a 100% pattern (or you can just draw them out the old fashioned way!).





OUTSIDE, CAMERA "LID"



PERSPECTIVE VIEW

Glossary

Acetic Acid
Can be used with water to create an effective stop bath.

Aperture
How big the hole is that the light goes through to get to where the film is. This is measured in f-stops (see **F-Stop**).

Circles of Confusion
The constituent components of an image, when these are close enough together they are called points and the image is considered to be in focus.

Contrast
Refers to the light and dark areas in an image. High contrast images have strong areas of dark and light, low contrast images have few areas of dark and light but lots of gray.

Developer
An alkaline chemical used to develop images in the darkroom.

Enlarging Paper
This is the "film" of pinhole. Compared to standard film, its reaction to light is quite slow. Since it is much more sensitive to the blue end of the light spectrum, it is best used in daylight. Generally rated with ANSI numbers for "speed" (rate of reaction to light.)

Exposure
Refers to the exposure of the film to light. The four important factors to consider are the kind of light, the sensitivity of the "film," the amount of time the shutter is open, and the aperture of the camera (see **Film, Interval and Aperture**).

Film
A material (for pinholers generally paper) which reacts to light. The degree of its reaction is measure using ASA, ISO, DIN or ANSI numbers (see also **Enlarging Paper**).

Film Holder
Hold the "film" in place in the camera. May be either flat, or curved (for "wide-angle" effects).

Fixer
An acidic chemical which fixes the image so that white light will not turn the image black.

Focal Length
The distance between the film plane and the pinhole. The "normal" focal length is is the diagonal measurement of the format size (see **Format Size**).

Format Size
Refers to the dimensions of the "film" that is used in the camera.

F-Stop
Expresses the ratio between the size of the pinhole to the distance from the hole to the film plane.

Infinite Depth of Field
Objects are in focus no matter how close to or far from the camera they are.

Interval
The amount of time the light is allowed to go through the hole. It is measured by shutter speeds.

Orthochromatic Papers
Papers which are not very sensitive to red light and are used in safelight conditions (see **Safelight**).

Panchromatic Film

Otherwise known as "regular" film, can also be used for pinhole. It is more of a hassle in the darkroom, but is very fast to expose, You can also modify an orthodox camera in order to use roll film.

Printing, Wet or Dry

Involves the making of a positive print from a negative.

Safelight

A red to orange light used in a darkroom to which lightsafe materials do not react strongly.

Shutter

Since shutter speed are very slow with pinhole, a piece of electrical tape (or even a finger) will suffice as a shutter.

Stereo Pinhole

Accomplished by placing a divider in the center of the camera with a pinhole on either side. Both halves of the film are exposed simultaneously.

Stop Bath

Used to stop the developer from developing the image. Also neutralizes the paper. This bath can be plain water, or you can use Indicator Stop Bath, a yellow solution that turns purple when it is exhausted.

Telephoto Camera

Telephoto cameras are those with a focal length that is longer than normal (see **Focal Length**).

Wash

Gets the fixer out of the paper so the image won't turn brown. An optional product known as Hypo Clearing Agent will speed up the wash time and reduce the amount of water needed.

Index

Other Books from Amherst Media, Inc.

Black Cat Extended Range Exposure Guide ★

Jim Lehman

All the exposure information you need for pinhole or 35mm photography in one comprehensive, easy-to-use tool! Features lighting conditions, film speed settings that extend beyond your camera's ISO/ASA built-in range, Zone System readouts, and more! $19.95 list, 4x8, order no. 1271

Basic 35mm Photo Guide

Craig Alesse

Great for beginning photographers! Designed to teach 35mm basics step-by-step — completely illustrated. Features the latest cameras. Includes: 35mm automatic and semi-automatic cameras, camera handling, *f*-stops, shutter speeds, and more! $12.95 list, 9x8, 112p, 178 photos, order no. 1051.

Don't Take My Picture

Craig Alesse

This is the second edition of the fun-to-read guide to taking fantastic photos of family and friends. Best selling author, Craig Alesse, shows you in clear, simple language how to shoot pictures, work with light, and capture the moment. Make everyone in your pictures look their best! $9.95 list, 6x9, 104p, 100+ photos, order no. 1099.

Build Your Own Home Darkroom

Lista Duren & Will McDonald

This classic book shows how to build a high quality, inexpensive darkroom in your basement, spare room, or almost anywhere. Information on: darkroom design, woodworking, tools, and more! $17.95 list, 8½x11, 160p, order no. 1092.

Into Your Darkroom Step-by-Step

Dennis P. Curtin

The ideal beginning darkroom guide. Easy to follow and fully illustrated each step of the way. Information on: equipment you'll need, set-up, making proof sheets and much more! $17.95 list, 8½x11, 90p, hundreds of photos, order no. 1093.

Camera Maintenance & Repair

Thomas Tomosy

A step-by-step, fully illustrated guide by a master camera repair technician. Sections include: testing camera functions, general maintenance, basic tools needed, basic repairs for accessories, camera electronics, plus "quick tips" for maintenance and more! $24.95 list, 8½x11, 176p, order no. 1158.

Camera Maintenance & Repair **Book 2**

Thomas Tomosy

Advanced troubleshooting and repair building on the basics covered in the first book. Includes; mechanical and electronic SLRs, zoom lenses, medium format, troubleshooting, repairing plastic and metal parts, and more. $29.95 list, 8½x11, 176p, 150+ photos, charts, tables, appendices, index, glossary, order no. 1558.

Restoring Classic & Collectible Cameras

Thomas Tomosy

A must for camera buffs and collectors! Clear, step-by-step instructions show how to restore a classic or vintage camera. Work on leather, brass and wood to restore your valuable collectibles. $34.95 list, 8½x11, 128p, b&w photos and illustrations, glossary, index, order no. 1613.