The Zone 8 Photographic Society

PINHOLE PHOTOGRAPHY - Charles Hart, AZPS

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PART 1. ABOUT PINHOLE IMAGES

Most people probably think of them as being soft and fuzzy. Well, this is often the case, but not necessarily so. Apart from their artistic use in photography, pinholes have scientific applications in situations where lenses cannot be used. For these, pinholes have to produce reasonably sharp images. To do so, they must satisfy two important criteria. The first is quality of construction. The ideal is a perfectly circular hole in a thin sheet of metal whose thickness tapers down to virtually nothing at the perimeter of the hole, and is uniform all the way round. Home-made pinholes are unlikely to come close to this and so tend to produce soft images.

Manufactured pinholes are usually much closer to the ideal and, subject to the second criterion, produce much crisper images. The second criterion is the relationship of the pinhole diameter to the focal length. Pinholes do not actually focus light, so, strictly speaking, it is incorrect to refer to their focal lengths. However, the correct term - distance of the pinhole from the image plane - is rather a mouthful, so focal length is more often used. There is broad agreement that, for any focal length, there is an optimum diameter which will give the sharpest images. However, different authorities give different values, although the variations are not huge. What is not in doubt is that a diameter well away from optimum gives a much softer image.

Of course, the quality of the pinhole and its optimum placing from the image plane only matter if you want your pinhole images to be as sharp as possible. If you attend to these points and enlarge no more than x2 or x3, your pinhole images may be almost as sharp as lens images. But if you want prints that sharp, why use a pinhole anyway? The answer is that it is entirely up to you. Pinhole photography is all about experiment, throwing away therulebook and doing whatever interests you. Whether your images are sharp or soft, they will have massive depth of field, from a few inches in front of the camera to infinity. This is not characteristic of pinholes as such, but of their very small apertures.

For example, a 25mm lens used at f16 on a Leica screw camera gives depth of field from about ¾ metre to infinity. The 24mm f120 pinhole for this camera could hardly do much better. What is a characteristic of pinholes is correct geometry. A 6mm glass lens on 35mm film would be fish-eye. The equivalent 25mm pinhole on a 5x4 camera renders straight lines at subject edges absolutely straight in the image.

The corners of pinhole images are often very dark. This happens because the cone of light diverges from the back of a pinhole with an angle of over 160 degrees. So the image plane can be put much closer to the pinhole than would be possible with a lens, while still covering the format. For example, a 5 x 4 inch sheet could be as close as 14 to 15 mm. However, although the circle of light covers the format, at such close distances the pinhole to corner light path is much longer than the pinhole to centre path. So there is dramatic light fall-off at shorter focal lengths. For the 25mm on 5 x 4 it is about 4 stops centre to corner. As with glass lenses, the fall-off is less at longer focal lengths. You can either accept this darkening as a feature of wide-angle pinholes, or try to reduce it - entirely a matter of taste.

PART 2. CAMERA CHOICE

There are three options. 1) Put a pinhole on an existing camera in place of the lens. 2) Buy a factory-made pinhole camera. 3) Make your own camera.

With the first, removing the lens from a fixed-lens camera can be difficult. Interchangeable-lens cameras are easier, and being able to go from pinhole to lens at will is an advantage with roll films (35mm, 120 and 220) - you may not want to use a whole roll for pinhole work. To choose, it's best to start by deciding whether you want to use roll film, sheets (film or paper) or a digital sensor. Unless your DIY skills are up to making a winding mechanism and frame counter, the roll film options are an existing lens camera or a factory-made pinhole camera. For digital, using an existing camera is the only realistic way, unless you are able to afford a digital medium or larger format back, of course.. Sheet materials can be used with any of the camera types and are the easy way for DIY.

As already mentioned, existing cameras allow changing between pinhole and glass. They also allow reasonably accurate framing of the subject. Finally, if they have focal plane shutters, they provide timed speeds, useful if you use high ISO speeds or some of the pinhole variations mentioned in Part 3. Purpose-made cameras offer different benefits. Apart from very low cost, home-made cameras allow any size and shape of image plane you want. Both they and factory-made cameras can be very small and light compared with existing cameras of the same format. However, the greatest advantage is the possibility of very wide angles. On existing cameras, the shortest possible focal length is the flange to image-plane distance in a fixed-body camera, or the minimum compression in a bellows camera. Recessed lens boards won't do, because the acceptance angle of over 160 degrees means that pinholes would see their fronts. The 25mm for 5x4

previously mentioned is an example - the limited bellows compression on a normal 5x4 wouldn't allow anywhere near as short a focal length to be used.

PART 3. PRACTICALITIES.

a) PINHOLES

For buying, there are supplier contacts in the Appendix. For DIY you can buy blanks from the same sources, or just use thin scrap metal. The bottoms of foil pie dishes work well. Avoid aluminium cooking foil - it tears too easily.

Decide what diameter and focal length you want (see Appendix). Place the metal on a hard surface, hold a pin of the required diameter so that it is vertical and its point firmly touches the metal, and spin the metal around the pin until you have made a hole all the way through. Turn the metal over and carefully smooth off any burr from the reverse side. If you have used scrap, cut out a piece about 1 cm in diameter around the hole to allow for mounting.

To mount the pinhole,make a hole a few mm diameter in a body cap or lensboard and stick the pinhole behind it. Lensboards can be made from mountboard or other stiff card. For body caps, preferably use proper screw or bayonet caps. The white plastic ones that come with new cameras have to be painted to make them opaque and they easily fall off.

For a home-made camera, either stick the pinhole over a small hole on the front of the camera, or design it to accept a lensboard, so that you can easily change pinholes. Use the table in the appendix to find the aperture of the pinhole from its diameter and its focal length. It is a good idea to bracket exposures for your first few subjects and use results to confirm or amend the aperture. If you buy a pinhole, the maker will tell you its diameter and the f-number for its intended focal length.

b) MAKING CAMERAS

You can either build from scratch, or use an existing container. If you want to be able to shoot more than one sheet per outing, you will need to use a changing bag, or design the camera to accept film holders. It is usual to paint the inside matt black, but I painted one white, and it worked well. A shutter of some kind is essential. Black sticky tape is simple, but hard to open without jerking the camera. A hinged or sliding shutter is better.

A tripod socket is useful, but not absolutely necessary. Hand-holding is possible if the shutter action is reasonably smooth, because the pinhole blur will mask the hand-holding blur. Instead of a single pinhole, you could use two or three pinholes, multiple pinholes in various patterns, slits and crosses. I haven't tried any of these (yet) because I'm too interested in the images produced by a related device, the zone plate. Essentially, this is very small circular piece of film, with alternate black and clear concentric rings. Unlike pinholes they do focus, but this isn't evident because they throw light from bright areas into the shadows and give a very diffused image. This, and their larger apertures (f45 is typical), suit them to hand-holding.

If you use infra-red film, you will need filters and with simple on-off shutters, neutral density filters can be useful for extending the exposure to 1 second or more to enable timing with a watch or by counting. The best place is inside the camera, held against the pinhole with Blu-Tak. If the filter has to be in front, because of the camera type or because you don't want to be stuck with it for a whole roll, the easiest way is just to hold it, taking care not to get your fingers in the field of view. This is where a cable release is handy or, on a homemade camera, a long handle for the shutter.

c) VIEWFINDING

The simplest way is to point and hope. The next step up is to use a viewing frame. However, with very wide angles, this method isn't at all accurate. Pinhole work does not have to be about accuracy but if that's what you want, a suitable focal length accessory finder, such as you would use with a rangefinder camera, works better for wide angles. . The most accurate method is to compose with a lens of the same focal length and then replace it by the pinhole.

d) METERING

Pinhole apertures may be outside the range of your meter, as may be the ISO from 1 to 12, typical of paper and infra-red films. If so, make a table which enables you to find the exposure at your aperture and ISO from the time for an aperture and ISO which are in range. With simple pinholes, exposures are often long enough to lead to reciprocity failure, so get to know the reciprocity characteristics of your material. With long exposures in fading light, it is often necessary to extend the original time, sometimes more than once. It makes for an interesting life. This is less likely with multi-pinholes and zone plates, which have larger apertures.

e)PHOTO PAPER

Remember that this will give you a paper negative, which you will have to contact if you want a positive print. With Ilford's latest paper product - Direct Positive Paper - you simply expose in camera, process as usual and you have a positive image. I find it works well.

APPENDIX

1) Diameters D and Focal Lengths F, both in mm, and Apertures A. NOTE: Apertures are only for the given focal lengths. To use the same diameter for a different focal length, divide the new focal length by the diameter.

D..... F..... A
0.2..... 25..... f 125
0.25..... 50.....f 200
0.30..... 75..... f 250
0.35..... 100..... f 286
0.40..... 125..... f 312
0.45..... 150..... f 333
0.50..... 200..... f 400
0.55..... 250..... f 455
0.60..... 300..... f 500

2) BOOK

Pinhole Photography. Eric Renner. Focal Press.

3) WEBSITES

a) Information, books, cameras, pinholes: **http://www.pinholeresource.com**

b) DPP paper - info/buy: **http://www.ilfordphoto.com**

c) Info: on processes: **http://www.alternativephotography.com**

d) CAMERA MAKERS: http://www.pinholesolutions.co.uk http://www.zeroimage.com

On ebay, the seller http://stores.ebay.com/good2rely?_rdc=1 - interchangeable pinholes in very well-made metal mounts for Canon, Leica, Nikon, etc.

e) MATERIALS

(ZPS Members) **Refer to TIL 49**, but note that Retro Photographic are no longer trading. Most of what they supplied is available from Silverprint: http://www.silverprint.com or http://www.ag-photographic.co.uk

4) ADDITIONAL IMAGES: Because this TIL contains larger B+W images, I have put some illustrative colour images in my ZPS pbase gallery, in the sub-gallery entitled Pinzone: **http://www.pbase.com/zps/pinzone** but please note this is work in progress, so do remember to return to this gallery regularly to view more images as they are processed and uploaded

PINHOLE EXPOSURE GUIDE

PART 1 - BASIC GUIDE

This covers from about ISO 200 in good light to about ISO 25 in dull light, based on metered exposures at F16 from 1/250s to 1s.

TO USE THE TABLE: Meter to find the exposure for f16, then read down to find the exposure for the aperture of your pinhole. For example, if the exposure at f16 is 1/8s, at f180 the basic exposure will be 16s - but a reciprocity correction may be needed. See Below.

Pinholes often have intermediate apertures, eg, f138 or f155. If the aperture is close to one in the table, use the time for that-the time for f128 will be valid for f138. If it is roughly mid-way, estimate between adjacent times. Eg: if the time is 1/15s at f16, use 6s for f155.

RECIPROCITY FAILURE

If you use film, you MAY need to compensate for this by giving extra exposure. The extra has NOT been included in the table because it depends on both the particular film and the basic exposure. For example, Adox CHS 25 needs about ½ stop extra at 2 seconds, and at least 2 stops at 2 minutes, whereas Fuji Provia 100F does not need any extra at all before 2 minutes.

NOTE: The times are in seconds until they are more than 1 minute, when they are given, eg:, as 1min 4 seconds. They are precise relative to those for f16, but in practice they can be rounded off. You would not see any difference between exposures of 32s and 30s, or between 4min 16 and 4 minutes.

PART 2 - SUPPLEMENTARY GUIDE

a) FOR METERED TIME AT f16 SHORTER THAN 1/250s

In the basic table, find the time for your pinhole aperture which corresponds to 1/250s at f16. Then DIVIDE it as follows for your metered time at f16

FOR METERED TIME AT f16: 1/500 - 1/1000 - 1/2000 - 1/4000
DIVIDE 1/250s TIME BY: 2 - 4 - 8 - 16 respectively

For example, if metered time is 1/1000s and pinhole aperture is f128. The 1/250s column in the basic table gives 1/4s for f128. Dividing by 4 gives 1/16s as the actual exposure. On a timed shutter, 1/15s would easily be near enough. With a simple on/off shutter you couldn't have so short a time - see d) below - Camera Design

b) FOR METERED TIME AT f16 LONGER THAN 1s

In the basic table, find the time for your pinhole or zone plate aperture which corresponds to 1s at f16. Then MULTIPLY it by your metered time at f16
For example, if metered time is 4s and zone plate aperture is f45. The 1s column in the table gives 8s for f45, so the basic exposure would be 32s. However, remember that for times over 1s, you may need to correct for reciprocity failure.

c) ISO FOR SLOW MATERIALS

If the ISO is too low for your meter, set ISO 100, find the exposure for f16 and then for your actual aperture from the basic guide. Then MULTIPLY that as below

REQUIRED ISO:	25	20	16	12	10	8	6	5	4	3	2	1	½
MULTIPLY ISO 100 TIME BY:	4	5	6	8	10	12	16	20	25	32	50	100	200

Finally, make a reciprocity failure correction, if needed. For example, pinhole aperture is f138, film is ISO 12 and needs ½ stop extra for reciprocity failure between 2s and 30s.

First, set ISO 100 on your meter and find the time for f16. Suppose it is 1/30s. Next, read down from 1/30s in the basic table. This gives 2s for f128, which is close enough to the actual f138. Then, for ISO 12, MULTPLY by 8, to get 16s.

Finally, add the 1/2 stop for reciprocity failure, to get the required exposure of 24s

d) USING THE GUIDE FOR CAMERA DESIGN/MATERIAL CHOICE.

For cameras with simple on/off shutters, whether home-made or bought, the essential consideration is to have an exposure of at least 1s, to allow timing with a watch or by counting. The example below shows how to achieve this, using the tables and the guide REQUIRED ISO = 1/EXPOSURE IN GOOD SUNLIGHT AT f16

Example: For a pinhole aperture f128. The basic table shows that, for 1s at f128, the corresponding f16 time is 1/60s. So the fastest material practicable for use in good light would be ISO 60 = effectively, on the usual scale, ISO 64.

To design a camera, start with the focal length you want and a pinhole diameter (which may or may not be optimum-your choice). Work out: Aperture = Focal Length/Diameter. Now follow the above example to find the highest ISO which allows a minimum exposure in good sunlight of 1s. If you wanted to use something faster than this, you'll need to think again about the focal length and diameter.

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If you would like more information about The Zone 8 Photographic Society please check our website online at: http://www.photosnowdonia.co.uk/ZPS, where you will find details of membership benefits and the full Technical Information Leaflet on Pinhole Photography by Charles Hart, AZPS.