

# PINHOLE

## CAMERA DESIGN DOCUMENT

### 1) Facts

- a. A pinhole camera, also known as camera obscura, or "dark chamber".
- b. Leonardo da Vinci gave a detailed description of the pinhole camera in his manuscript *Codex Atlanticus* (c. 1485).
- c. The first photograph taken with a pinhole camera was the work of Scottish scientist Sir David Brewster in 1850.
- d. Depth of field is of no concern everything in front of the camera is in focus.
- e. Distortion can be created or controlled to some extent by the perpendicular relationship of the film plane to the pinhole.
- f. A pinhole photograph is slightly out of focus because the beams that pass through the pinhole to form the image are not points of light but small discs.
- g. The pinhole has a finite diameter that has a relation to the wave length of the light. When the size of the pinhole is nearly the same as the wavelength of the light diffraction occurs disrupting the light beam to the film.
- h. Because the light at the outer edges of the exposure have traveled a longer distance than the center beams the center is more exposed than the edges this causes the outer edges to look a little darker.
- i. The pinhole camera is not ideal for moving subjects.
- j. The image on the inside of the camera body will be upside down and reversed like it is in our eye. (the brain flips it over)

### 2) Definition

- a. aperture – diameter of the pinhole
- b. focal length – distance from pinhole to film
- c. f-number – relationship to pinhole diameter and focal length
- d. exposure – amount of time the film is exposed to a light source
- e. angle of view – the width of the view, a function of the focal length

### 3) Design

- a. The Camera Body (box)
  - i> Must be light proof
  - ii> Paint inside flat black
  - iii> You can employ a film camera body and a lens cap with a pinhole to make pictures
- b. The Pinhole:
  - i> The diameter of the pinhole for sharpness of the image
  - ii> The distance from the pinhole to the film
  - iii> The thinness of the pinhole material
  - iv> The accuracy of the diameter of the hole

### 4) Materials

- a. A box or tube for the body
- b. Flat black paint
- c. Black photographic tape (Scotch #235)
- d. Thin metal material for the pinhole (shim stock)
- e. Lens cover method (magnet if the box has a metal front)

### 5) Pinhole People

- a. Ansel Adams
- b. NASA

### 6) Tools

- a. Pinhole designer program -> <http://www.pinhole.cz/en/pinholedesigner/>
- b. Info -> <http://www.pinholerresource.com/shop/home>

## Pinhole Parts List

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Camera Body – one can of mixed nuts 6” dia x 4 high with black plastic top – Wal-Mart.

Mat Board – heavy black mat board about 24”x36” enough to make seven 6” circles. It needs to be black to the center (not a white core). – Aaron Brothers Hurst

3M photo mount spray can – used to glue the circles to each other – Aaron Brothers Hurst

Heavy steel washer – used to mount the magnet lens cover. – Lowes

¼” 20 nut – used to create the tripod mount on the bottom of the camera. – Lowes

JB Weld 2 part Epoxy – used to mount the washer and nut to the camera body – Lowes

Flat black spray paint – used to paint the inside of the camera body – Lowes

Black electrical tape – used to seal light leaks and make a film release tab in the camera body – Lowes

Round magnet – used for a lens cover – Lowes

Krazy Glue – used to glue the wood stick inside the camera body – Lowes

Brass sheet .005 thick max – used to make the pinhole lens – Roy’s Hobby Shop Hurst

.020 drill bit – used to make the pinhole in the brass – Roy’s Hobby Shop Hurst

#600 sand paper – used to smooth the brass after making the pinhole – Roy’s Hobby Shop Hurst

Wood pop sickle stick – used to create a film stop inside the camera – any place

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6035 Precinct Line Rd  
N Richland Hills, TX 76180

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Hurst, TX 76053

# Pinhole Camera Design Calculations

Pinhole Diameter and Focal Length | Exposure | Angle of View | Magnification | Zone Plate

Camera design

Pinhole diameter:  in

Focal length:  in

Light wavelength:  mm

f number:

Exposure factor for f 22:

Optimal focal length for given pinhole diameter:  in

Optimal pinhole diameter for given focal length:  in

Formula

$$d = c \sqrt{f \cdot l}$$

Select constant:

d | pinhole diameter    f | focal length  
c | constant            l | light wavelength

Pinhole Diameter and Focal Length | Exposure | Angle of View | Magnification | Zone Plate

f number of the pinhole camera

f number:

Exposure factor for f 22:

Calculate ▶

Save...

Time for f 22	Resulting time
1/125	1 s
1/60	2 s
1/30	5 s
1/15	9 s
1/8	17 s
1/4	34 s
1/2	1 m
1 s	2 m
2 s	5 m
4 s	9 m
8 s	18 m
15 s	34 m
30 s	1 h
1 m	2 h
2 m	5 h

Reciprocity failure

include rec. failure for film:

Note: for more information about reciprocity failure, see Help.

Pinhole Diameter and Focal Length | Exposure | Angle of View | Magnification | Zone Plate

Format of light-sensitive material:  x  in

Focal length:  in

Angle of view:

Diagram

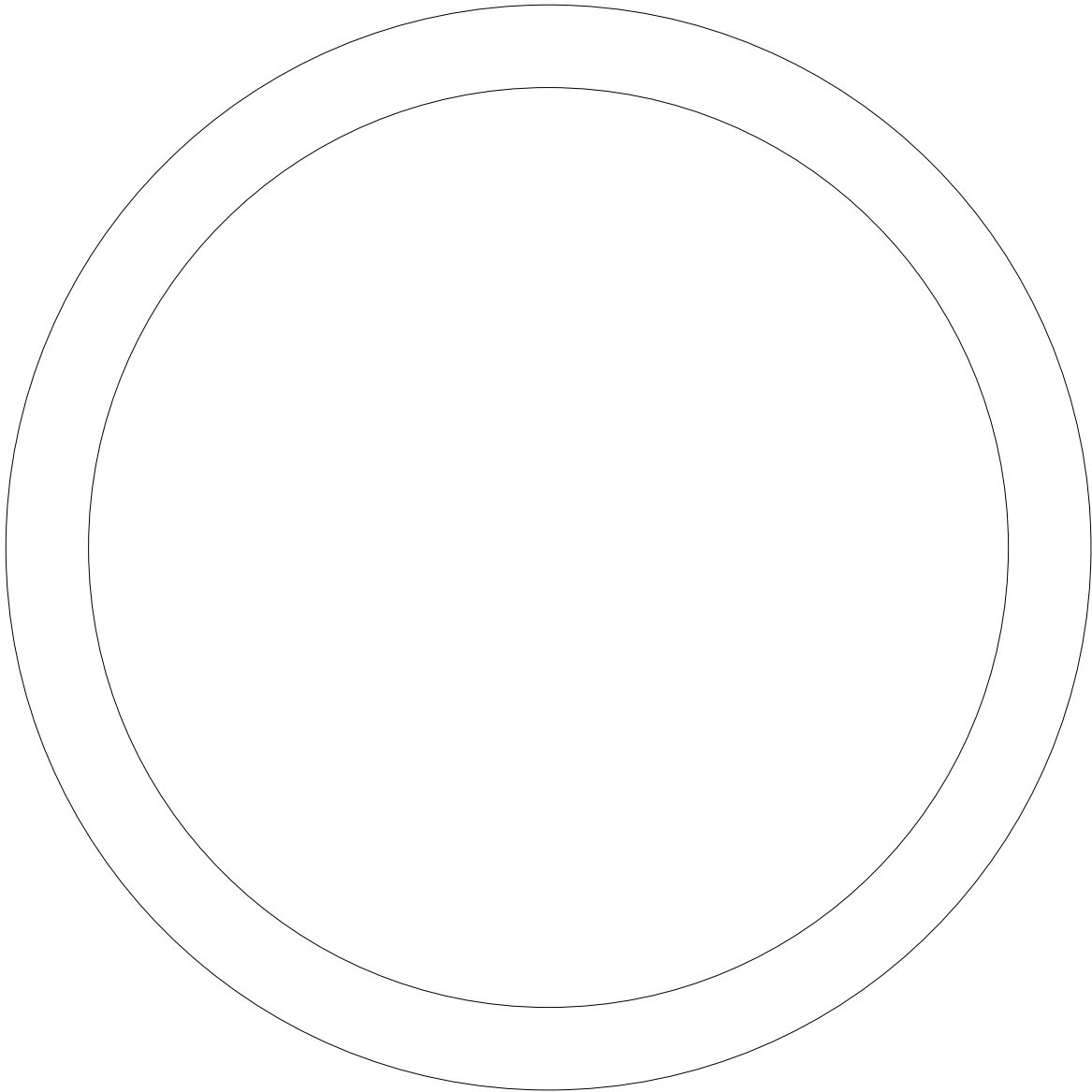
— Chosen angle of view  
- - - Angle of normal focal length

# Pinhole Camera Plan Layout

## 6" Dia x 4" Height Canister



# Pinhole Camera Top Layout



Inside template  
to locate pinhole

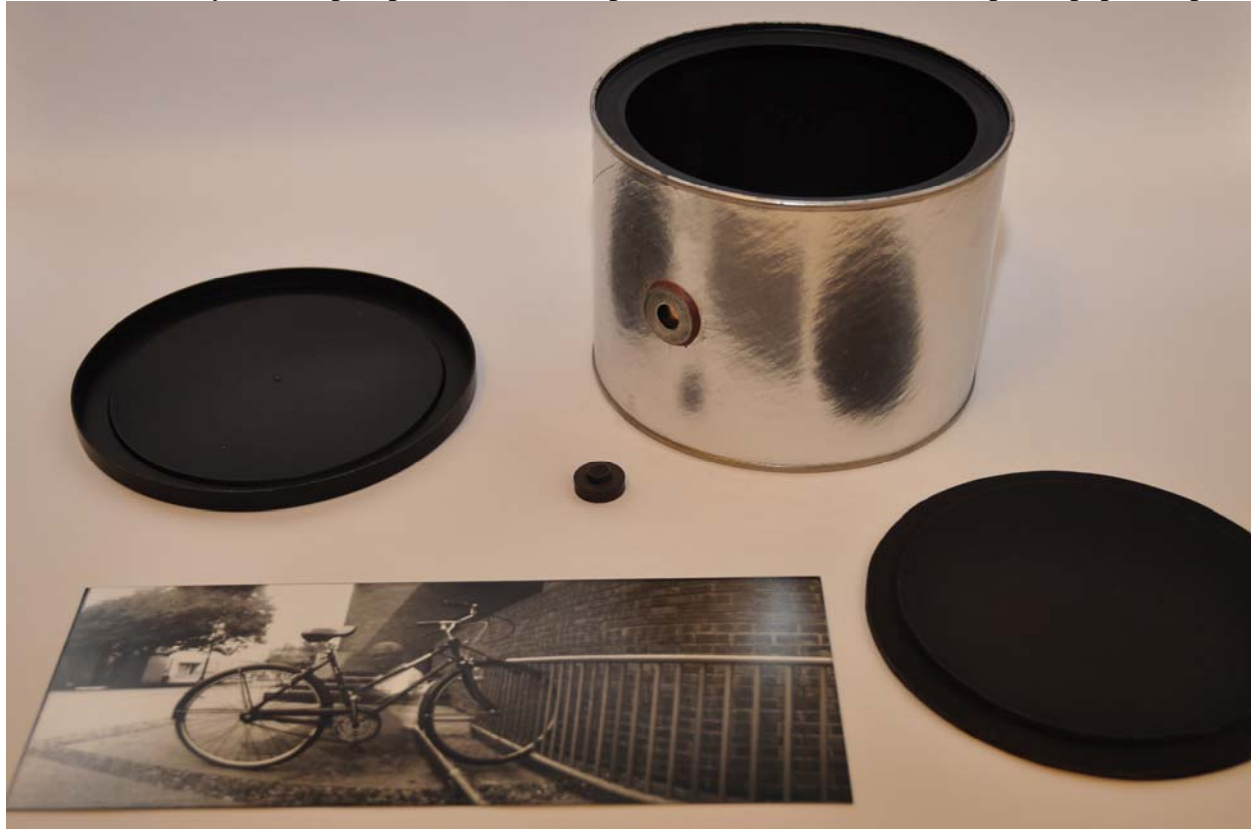
## Pinhole Assembly and Operation

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Remember you can take any container; make it light tight; put a pinhole in a surface and light sensitive material on the opposite side; find a subject and capture it with infinite depth of field. This design is for one of many and can produce a 4"x10" panoramic image.

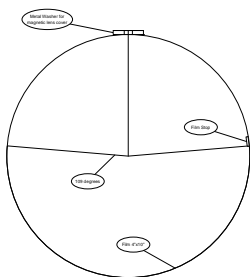
The final product has five parts:

The camera body, lens cap, top inside cover, top outside cover and a 4"x10" photo paper strip.



The camera body is made from the mixed nut can. Empty and clean the can.

Measure the can and find the center from top to bottom and cut a hole the size of the inside hole in the washer through the side of the can.



A pop sickle stick is used to help locate the photographic paper when loading the camera. Cut the pop sickle stick so that it fits in the can from top to bottom. Cut out the full scale diagram like the one on the left and lay it in the bottom of the can so that you can locate the wood strip at the film stop position as shown on the diagram to the pinhole. Glue the stick on the inside of the can with Crazy glue.

Paint the inside of the can with flat black paint.

## Pinhole Assembly and Operation

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Cut a 1" x 1" square of .005" brass sheet for the pinhole. Use the .020" drill and with very little pressure drill a hole in the center of the brass. This operation has a great deal to do with the kind of picture the camera will produce. Make it very round and as near to .020" as you can. Use the 600# sand paper to smooth any rough edges on both sides of the brass. Inspect the hole at each operation.



On the inside of the can centered over the hole secure the brass sheet with the .020" hole with black electrical tape so that it can see the outside world through the hole in the can.



A washer is secured on the outside of the can over this lens assembly with epoxy resin to allow a magnet to be used as a lens cover.

Note that the magnet has a small circle of black matt glued to it to help center it on the washer and make it harder for the magnet to slide off by accident.



The top inside cover is constructed of 4 circles of black mat. Two of them are 6" and fit inside the rim of the top cover. The other two are smaller and just fit inside the opening and protrude into the can. This eliminates a light leak from the edge of the opening. The plastic cover is not modified and simply keeps the assembly together.

## Pinhole Assembly and Operation

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Take the black mat stock and cut five 6" circles and two 5" circles. Make sure that each of the 6" circles can lay in the top of the can and that both of the 5" circles just fit into the can opening.

Assemble the top inside cover from two 6" and two 5" black mat circles. Use 3M spray to bond the assembly together. Confirm that it fits flush with the top of the can and allows the plastic top to fit in place.

The bottom of the can is thin metal and if we bond the 1/4 " 20 thread nut in the center without making the bottom stiff, the can will vibrate like a leaf in the wind when we mount it on a tripod. Use the three other 6" mat circles to solve this problem. Cut a smaller 2" hole in each of these three 6" circles so that the epoxy will have enough area to bond to the bottom of the can. Use the 3M spray and bond the three into a single unit that is now as thick as the nut. You should be able to place this on the inside edge of the bottom of the can. Spray 3M glue on the bottom of the can and the mat assembly and secure it to the bottom of the can.



Mix enough epoxy to fill the 2" opening in the bottom mat assembly. Place the nut in the center of the 2" opening and fill the balance of the opening with epoxy. This will bond the nut and the edges of the mat assembly to the can for the tripod mount. Make sure you do not get epoxy in the threads of the nut.



## Pinhole Assembly and Operation

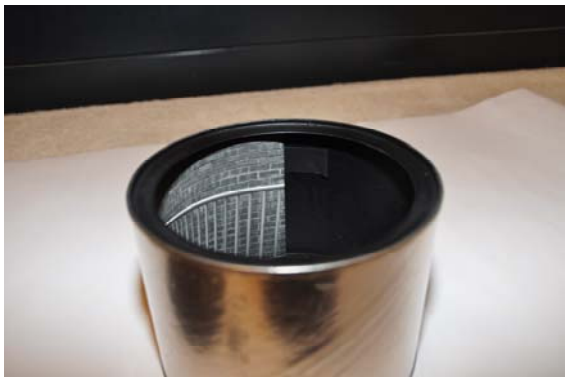
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This camera is designed to use 4"x10" photographic paper. The paper is placed on the inside of the container on the opposite side from the pinhole.



A small wood strip is placed to stop the paper on one side so that it is in the correct position each time the camera is loaded.



A black piece of tape on the opposite side from the wood strip helps in the removal of the paper.

## Pinhole Assembly and Operation

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You are ready to capture a picture. Load unexposed paper in a dark room place the lens cover and two tops in place and find your picture. The picture in this document was shot with this camera on a bright sunny day and the bike was exposed for 120 seconds and the person sat in position for 40 seconds.

Pinhole Camera Sample Images

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“Play Ground” – 6” peanut can pinhole camera – 2/9/2009  
Negative produced @ 120 sec in shadow lower sun – held on top of fence at 48”  
Final contact print - f 2.8, #0, 17s with burn 5s on left side ground



Bike – 6” peanut can pinhole camera – 2/11/2009  
Negative produced @ 55 sec in bright sun – ground shot with ½” tilt up – 3 ½ feet from subject.  
Final contact print - f 2.8, #0, 30s with burn 20s on left in front of bike.



Bike Ghost – 6” peanut can pinhole camera – 2/12/2009  
Negative produced @ 120 sec in shadow of bright sun – ground shot with ½” tilt up – 6 feet from subject – produce ghost by moving in frame for 40 sec.  
Final contact print - f 2.8, #0, 27s with burn 20s on left half and 25s burn to tree top upper left.