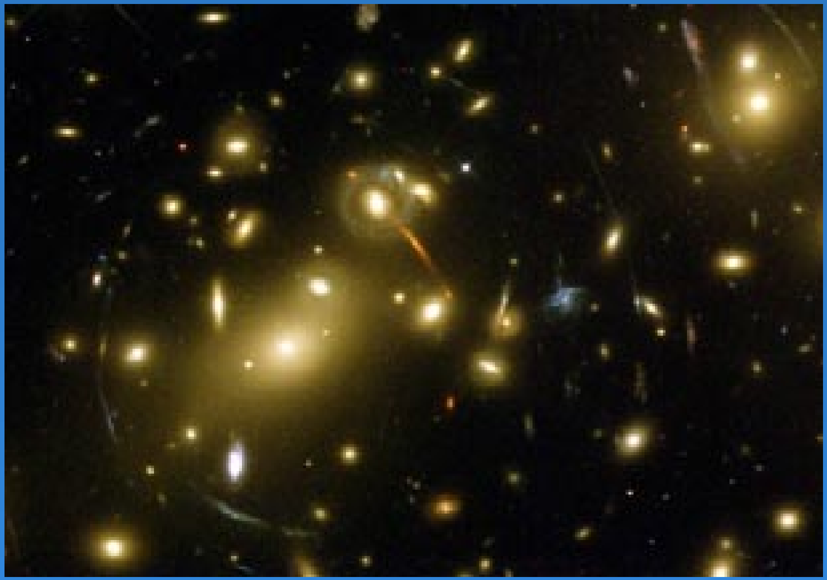


Astronomy 80 B: Light

Lecture 12: review quiz, photography, vision

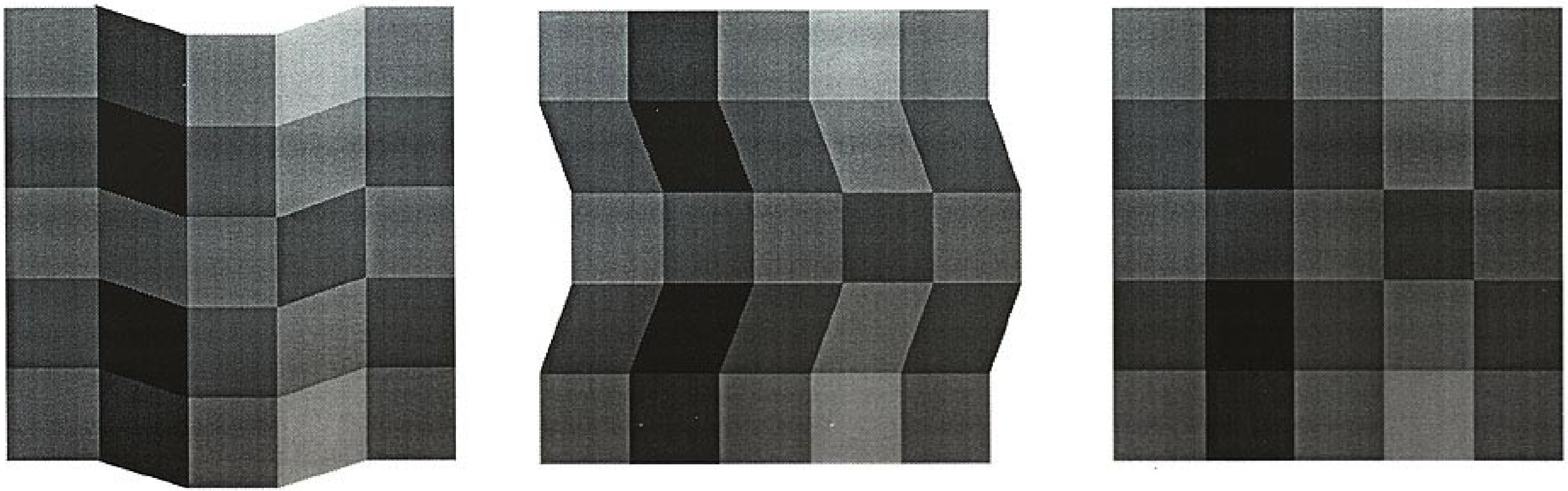
8 May 2003

Jerry Nelson

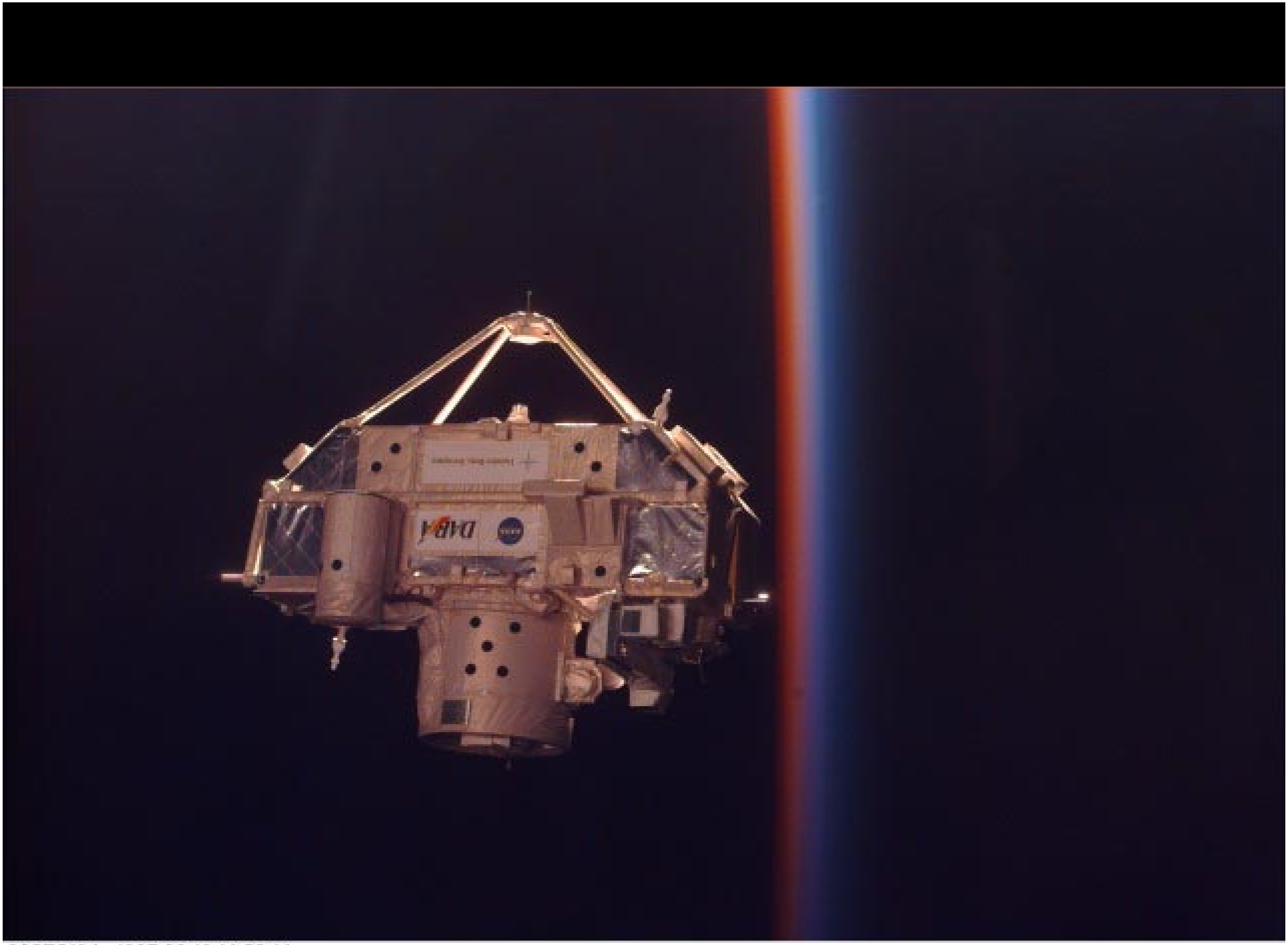
Topics for Today

- Total eclipse of the moon 15 May 2003!!!
- Status of field trip
- Status of research/term papers
- Optical illusion
- Pretty picture
- Review Quiz 2
- Camera principles

[redacted]



[redacted]



S85E5104 1997:08:16 14:52:14

Review of Quiz 2

Single lens reflex camera

- **Key components of an SLR**

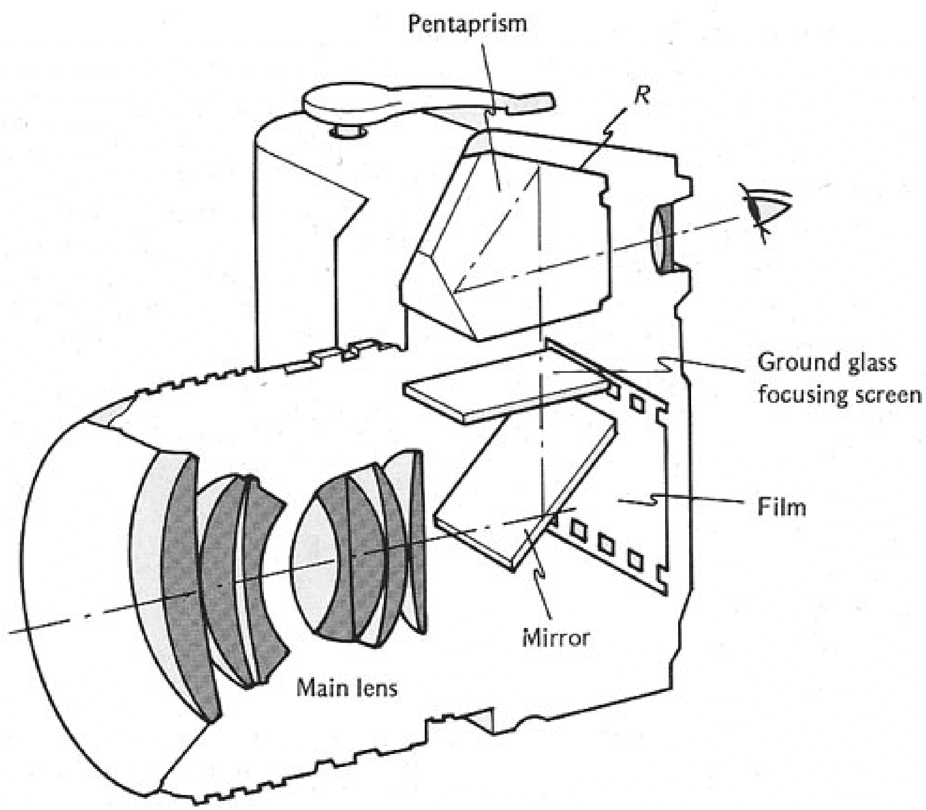


FIGURE 4.4

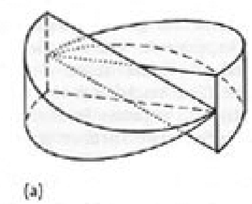
The main parts of a modern single-lens reflex camera. The distance of the light path from the lens to the film is the same as from the lens to the focusing screen by way of the mirror. The pentaprism inverts the image on the focusing screen before the photographer sees it. The roof *R* of the pentaprism consists of two faces that provide extra reflections perpendicular to the plane of the figure in order to reverse the image in that direction as well.

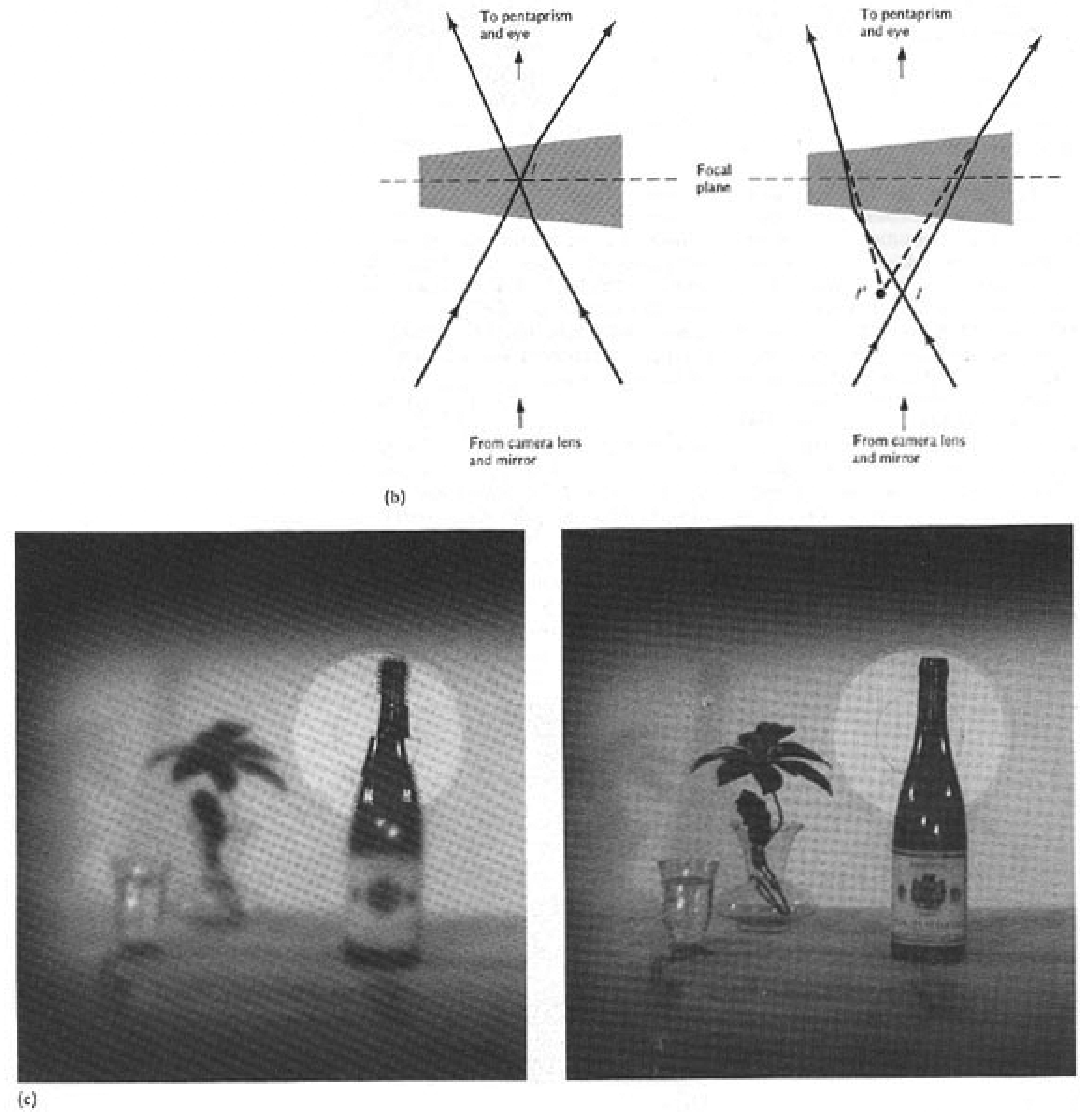
Focusing onto a screen

- **Biprisms will shift an out of focus image, opposite directions for each prism, by an amount proportional to the defocus**

FIGURE 4.5

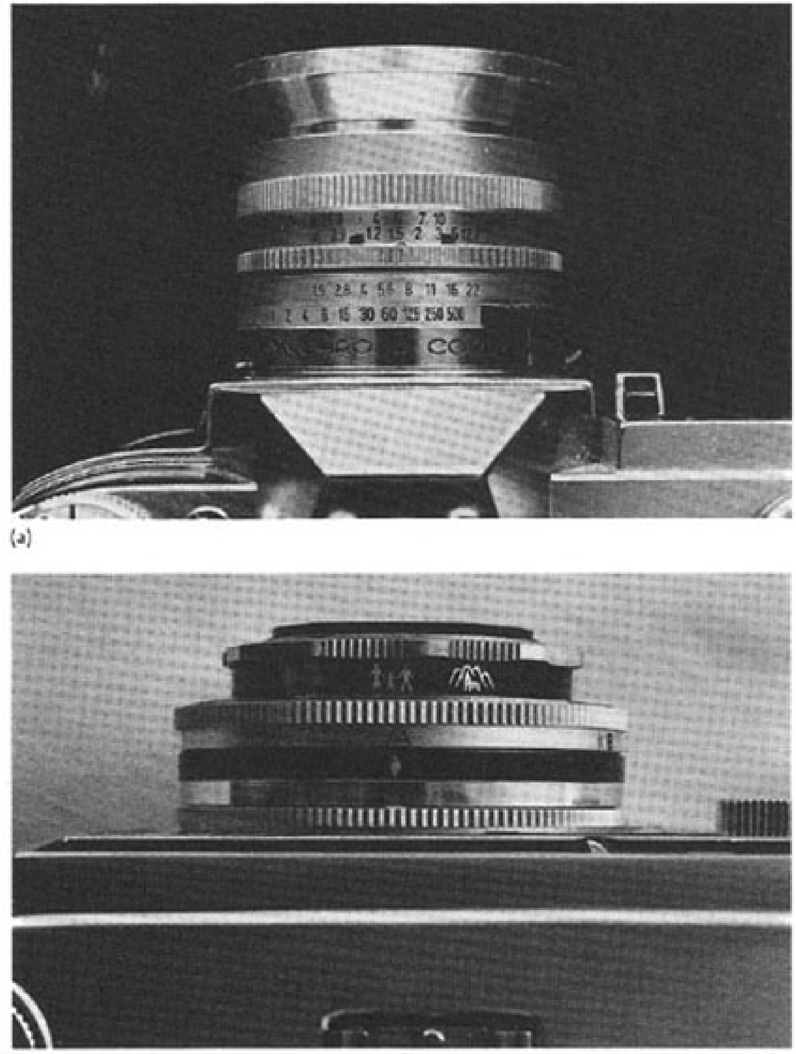
(a) A biprism of the type often mounted in the center of the ground-glass screen of an SLR. (b) Effect of one of the prisms: When image I is on the focal plane, it is seen undisplaced (left). When it is below (or above) the focal plane, it is seen displaced, as I' (right).
(c) Photograph of the resulting split-image effect, when in focus (left) and out of focus (right). (Note the ring of microprisms around the central biprism.)





- **Distance scales on the focussing part of a camera lens**

- **Depth of field is also sometimes shown**



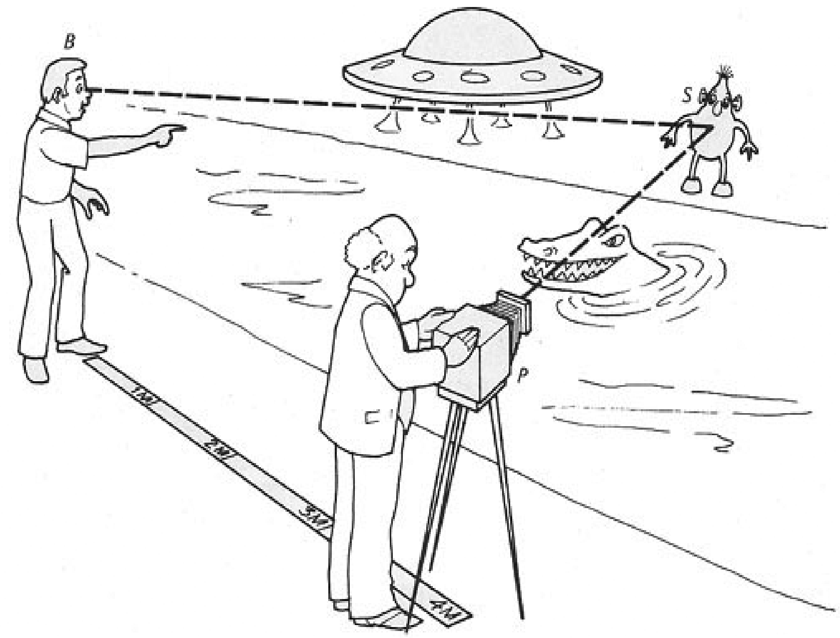
(a)

(b)

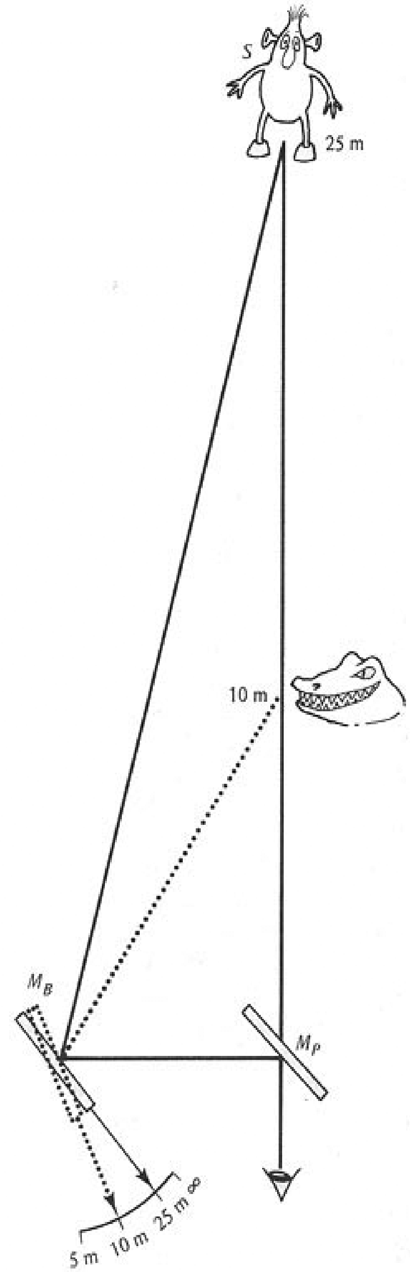
FIGURE 4.6

Photograph of distance scales on photographic lenses. **(a)** Distance scales in meters and feet. Pointers not only indicate the distance of best focus, but also bracket the depth of field. Note how the close distances are spread out, and the far distances are crowded together on this scale, corresponding to the way the lens crowds together the images of distant objects. **(b)** Size of common objects as seen in viewfinder may serve as distance indicator.

- **Rangefinder principles**



(a)

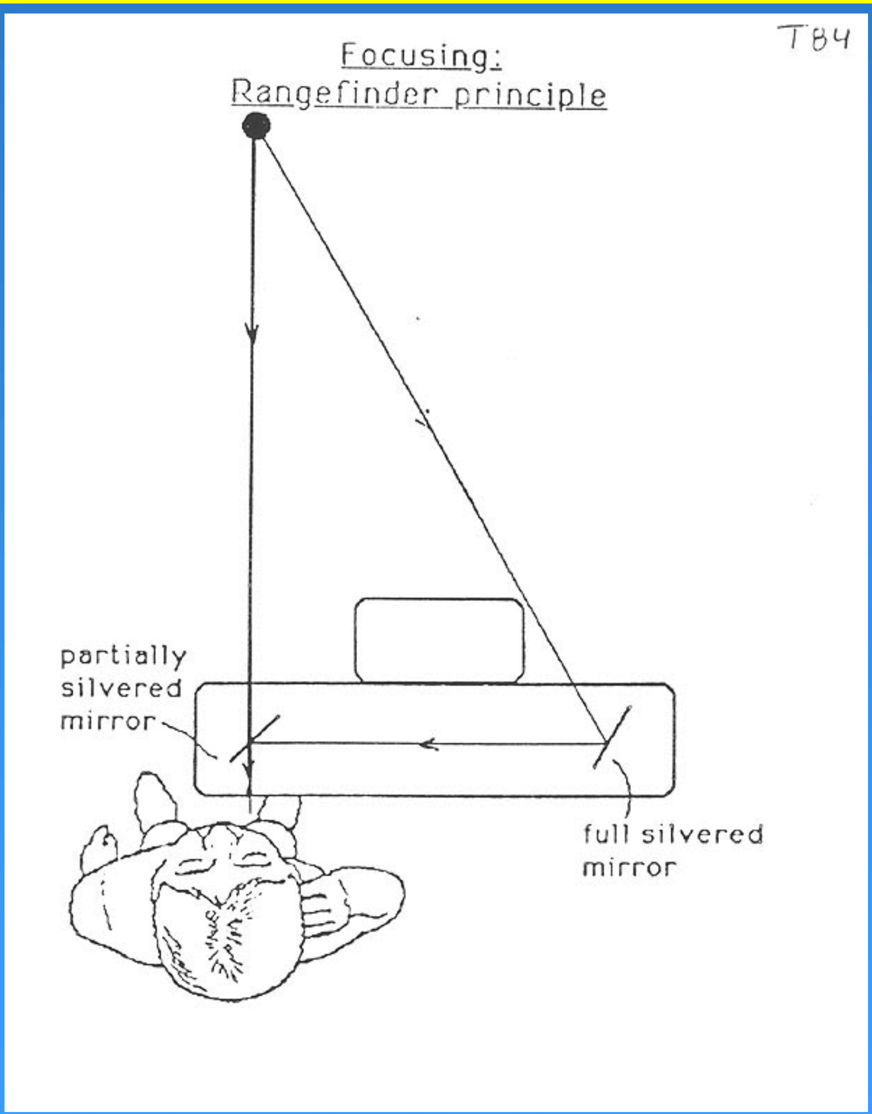


(b)

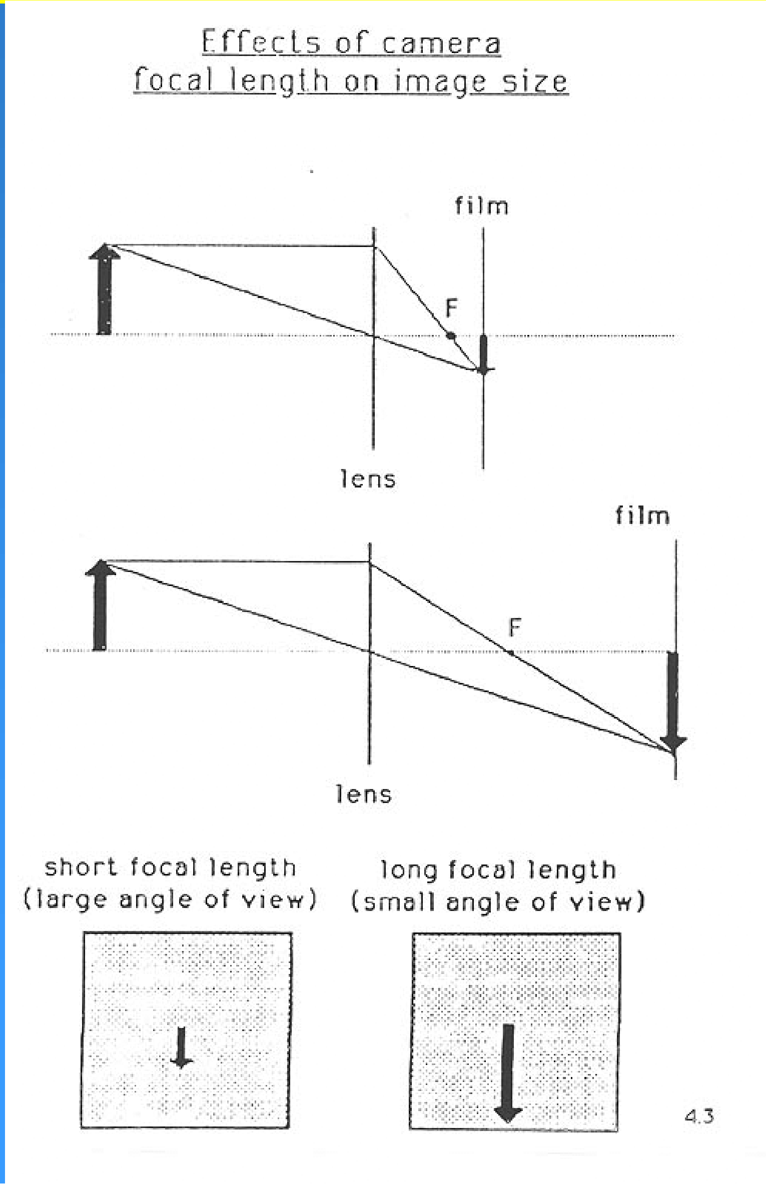
FIGURE 4.7

(a) The rangefinder problem: Our photographer *P* wants to measure the distance $\overline{PS}$ to a subject *S*. A bystander *B*, a little distance away, is also staring at *S*. **(b)** Solution to the rangefinder problem.

Rangefinder focusing



Effect of camera focal length



Camera focal length

- **Lens focal length influences image size on film**
  - Long focal length produces larger images but has a smaller field of view
  - Short focal length produces smaller images and has a larger field of view

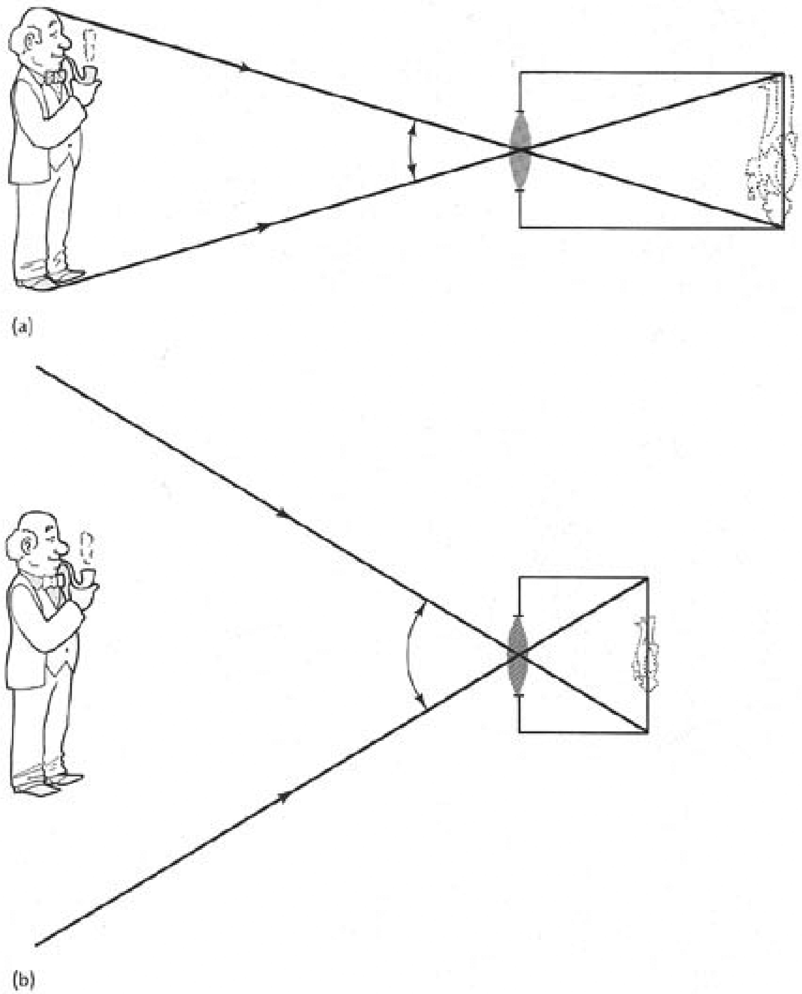
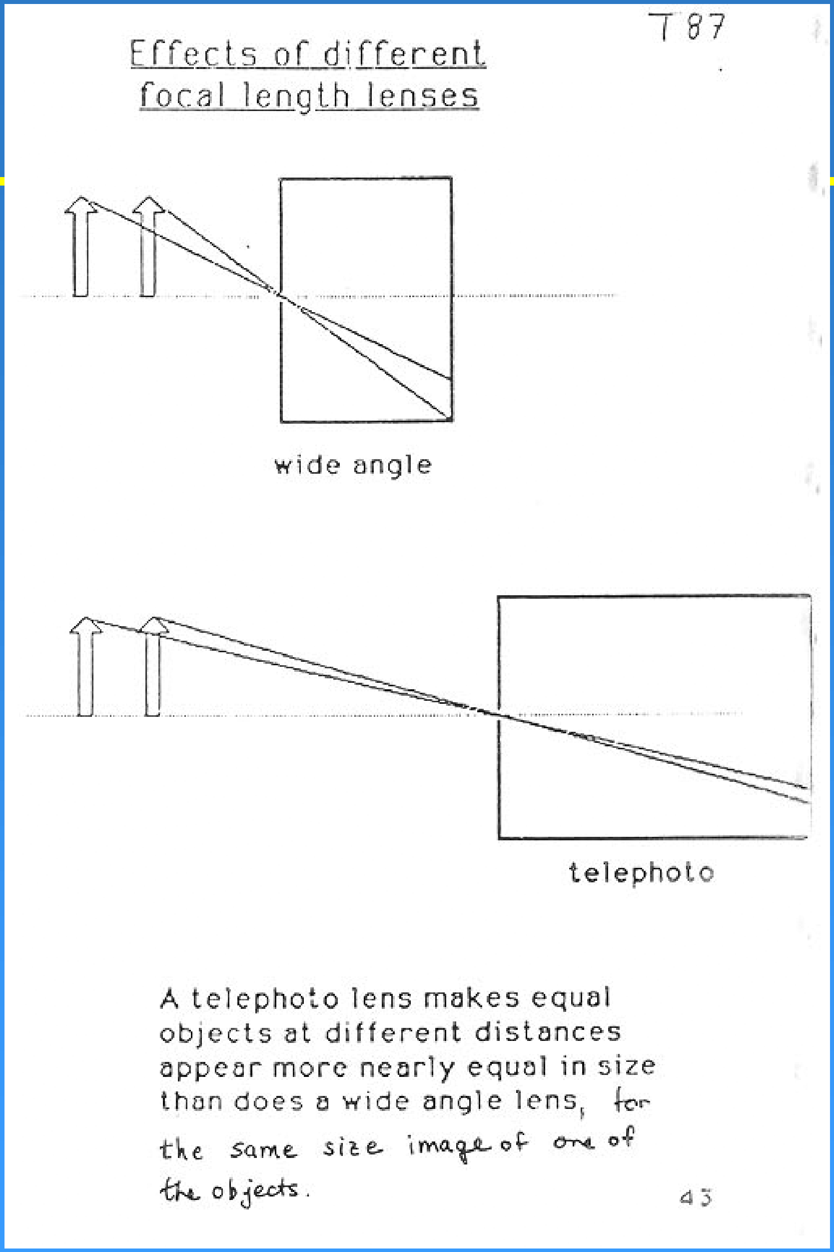


FIGURE 4.8

Image size and angle of view depend on lens-film distance. The two lenses have different focal lengths and must be at different distances from the film to produce a sharp image of a given object. **(a)** The long focal-length lens produces a large image of the object and has a small angle of view. **(b)** The short focal-length lens produces a small image of each object and has a large angle of view.

- **Effects of different focal length lenses**



- **Effects of different focal length lenses**
  - 8 mm
  - 28 mm
  - 50 mm
  - 75 mm
  - 100 mm
  - 150 mm
  - 200 mm
  - 400 mm

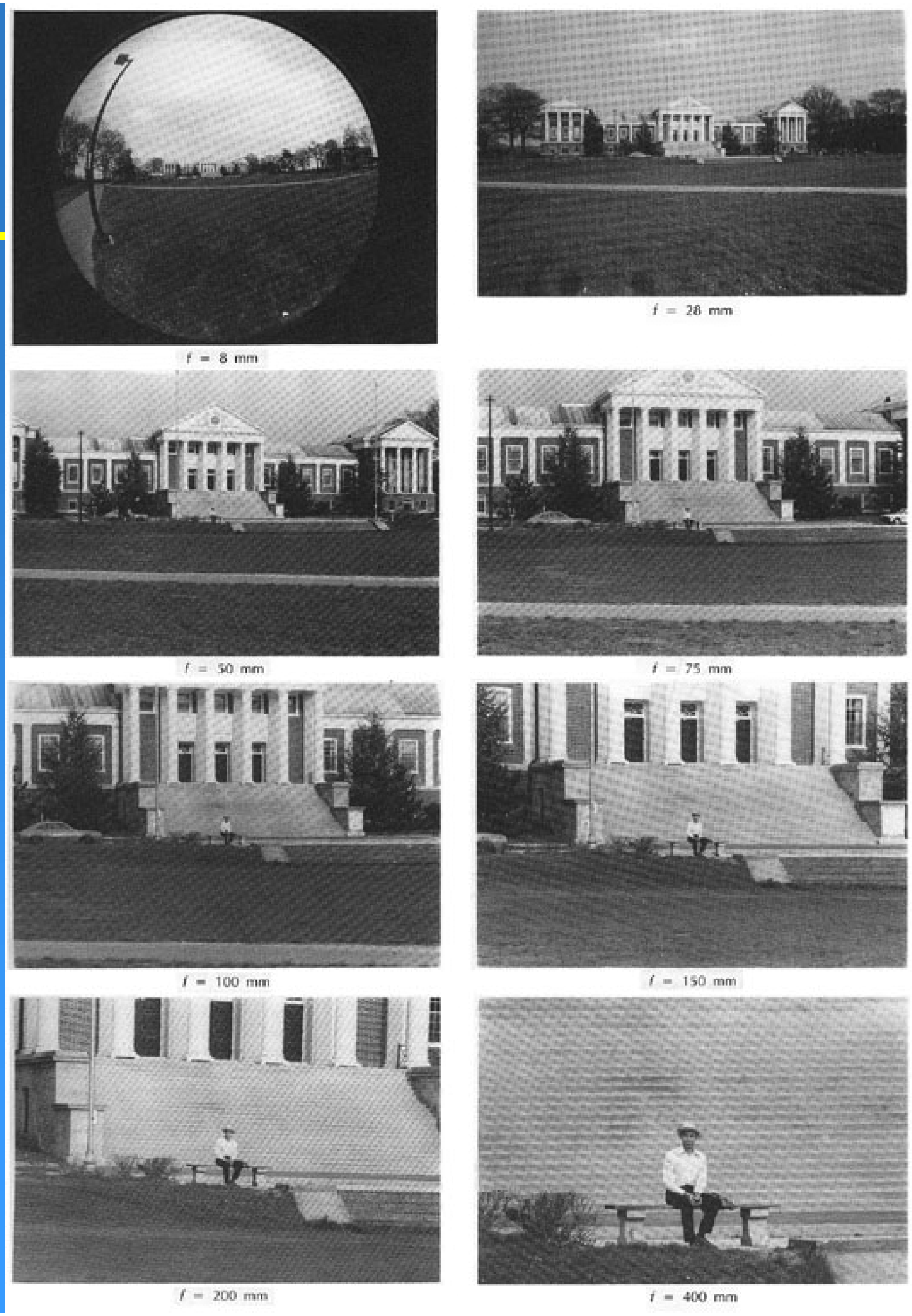
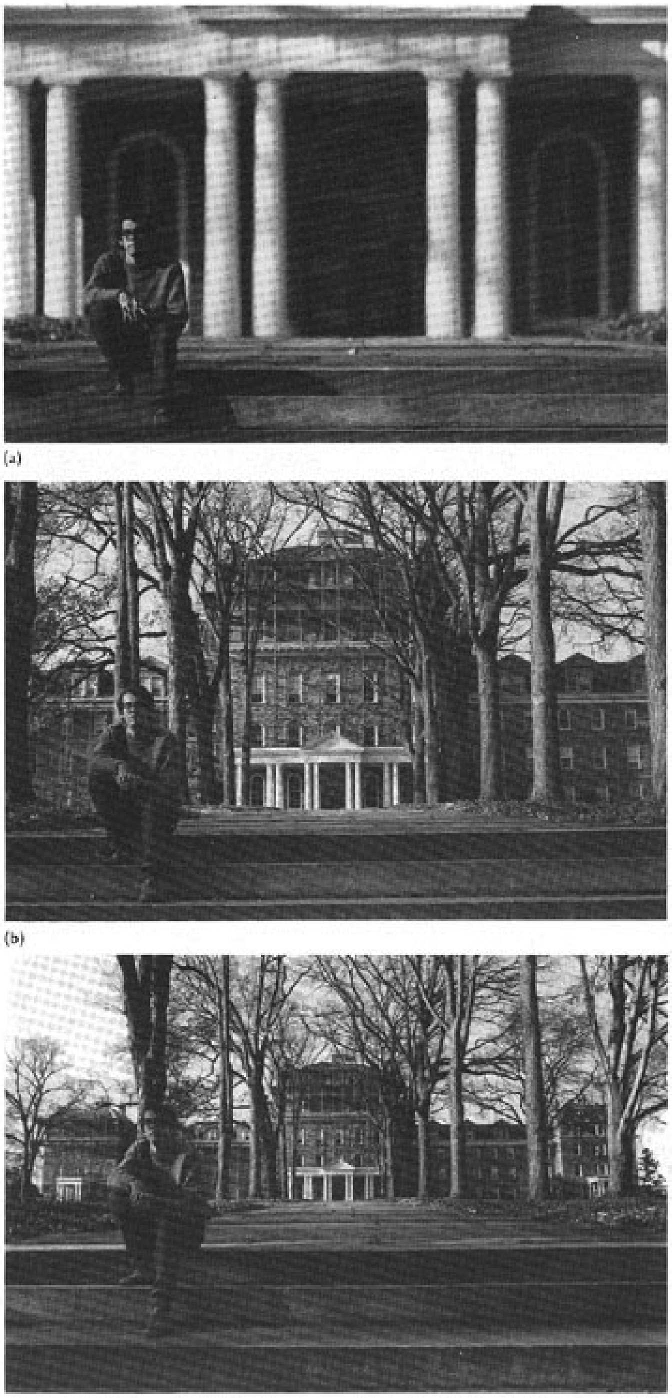


FIGURE 4.9

Photographs taken by a 35-mm camera with lenses of different focal lengths, as given below the pictures. Notice that the telephoto pictures are the same as smaller regions of the f = 50-mm picture.

Changing object distance and focal length

- **The distance to the object was changed along with the focal length**
  - Telephoto
  - Normal
  - Wide angle



(a)

(b)

(c)

FIGURE 4.10

Object distance and focal length were changed simultaneously in these photographs so as to keep the size of the main subject constant. The size of objects at other distances varies, changing the perspective: **(a)** telephoto perspective, **(b)** normal perspective, **(c)** wide-angle perspective. If you hold your eye about 5 cm from **(c)**, the perspective should look normal again. (You probably cannot focus clearly on such a short distance, unless you use a magnifying glass.)

- **Converging lines and consequences**

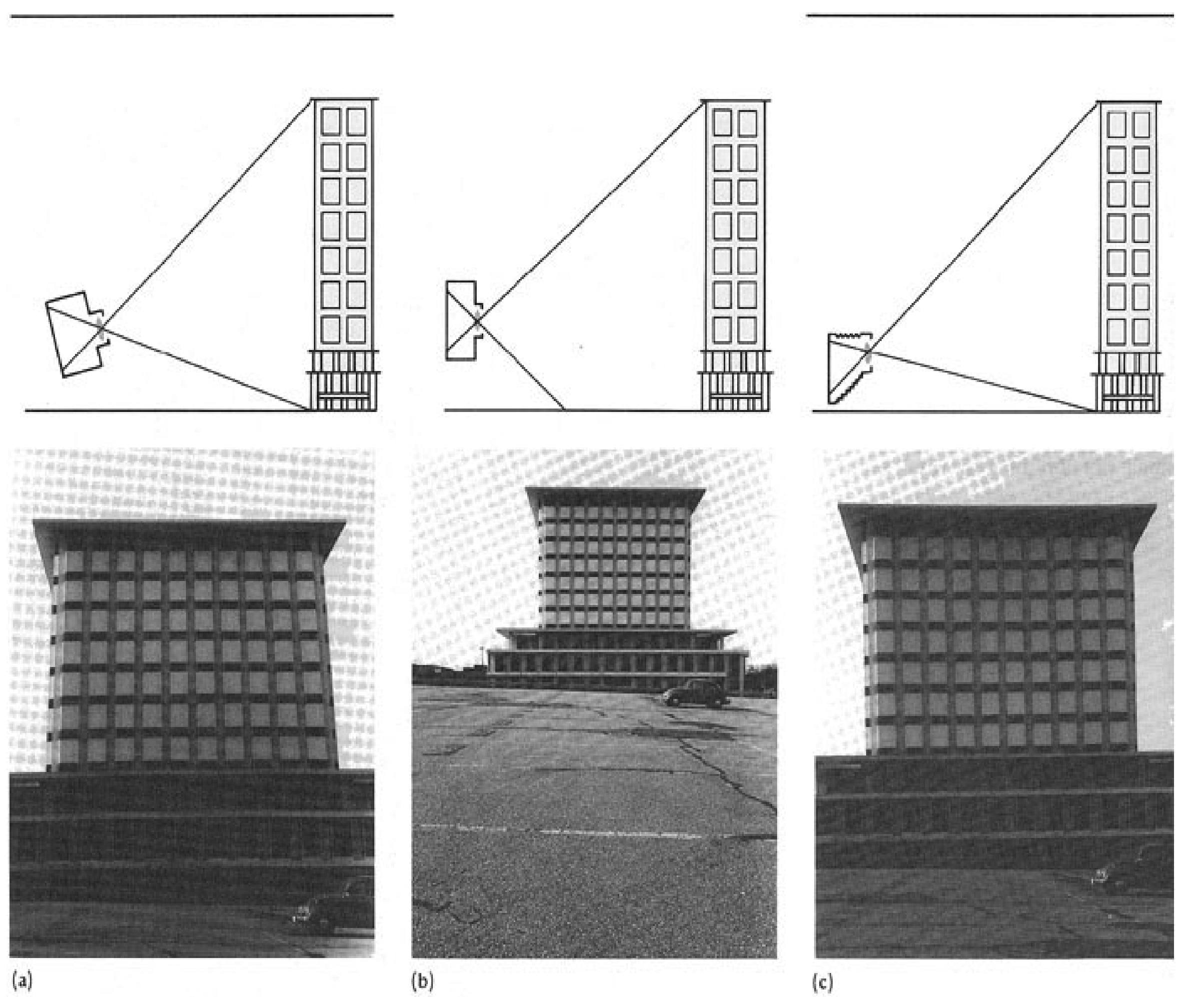


FIGURE 4.11

Converging lines—problem and solution. The upper row shows the camera arrangement, the lower row shows the corresponding photographs. **(a)** Camera tipped up, film not parallel to building, converging lines. **(b)** Camera horizontal, film parallel to building, using wide-angle lens; photograph shows building as desired in upper half, too much foreground in lower half. **(c)** Camera with PC lens, film parallel to building. Photograph is equivalent to an enlarged version of the upper half of photo **(b)**.

- **Effect of a stop on field curvature**

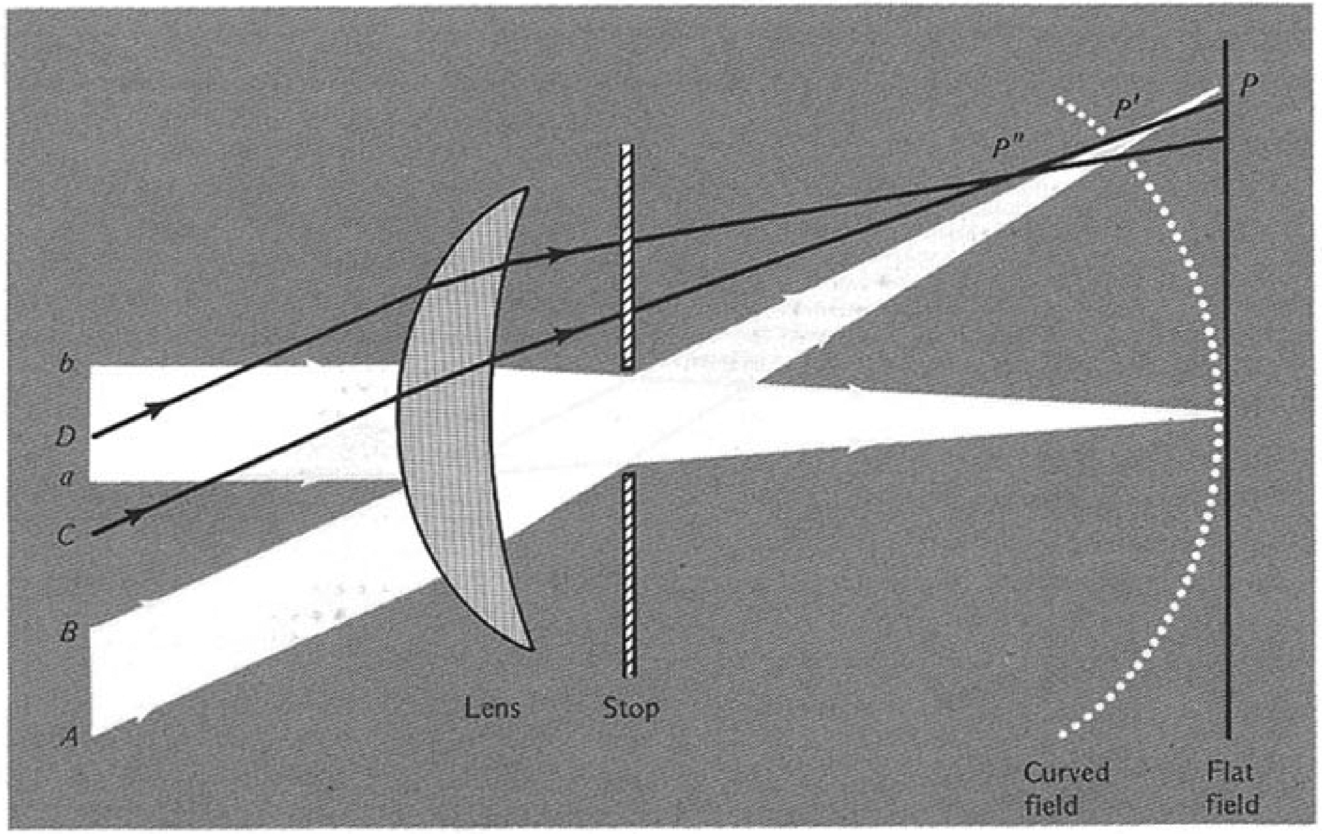


FIGURE 4.13

A meniscus lens with a stop to flatten the field. Due to aberrations, different parallel incident rays *A*, *B*, *C*, and *D* do not intersect in one point after emerging from the lens. *A* and *B* intersect at *P*; *B* and *C* at *P*′; and *C* and *D* at *P*″. If there were no stop, the circle of least confusion for all four rays would be near *P*′, leading to a curved field. The stop selects rays *A* and *B*, intersecting at *P*, hence flattens the field. (Rays *a* and *b*, parallel to the axis, locate the film plane.)

Popular lenses

- **Popular commercial lenses**
  - Contain multiple elements to reduce aberrations
  - Contain stops to reduce aberrations

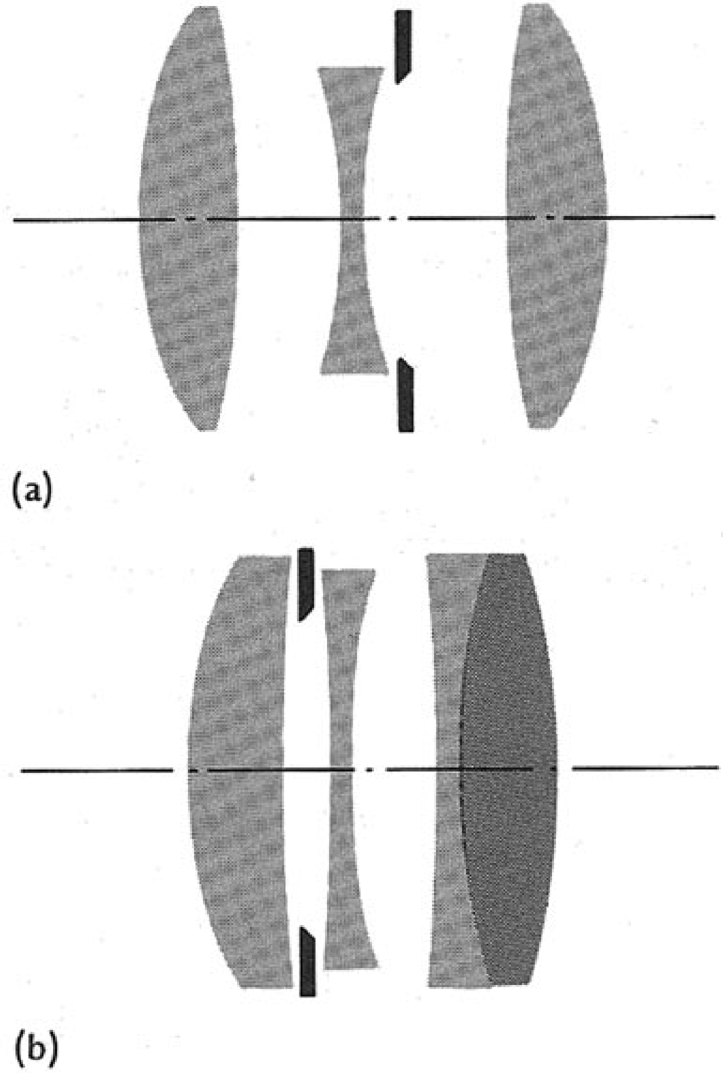


FIGURE 4.14

(a) A Cooke Triplet. **(b)** A Zeiss Tessar.

- **Principle of telephoto lens**
  - Use of a converging and diverging lens allows the system to be shorter than a single converging lens of the same focal length

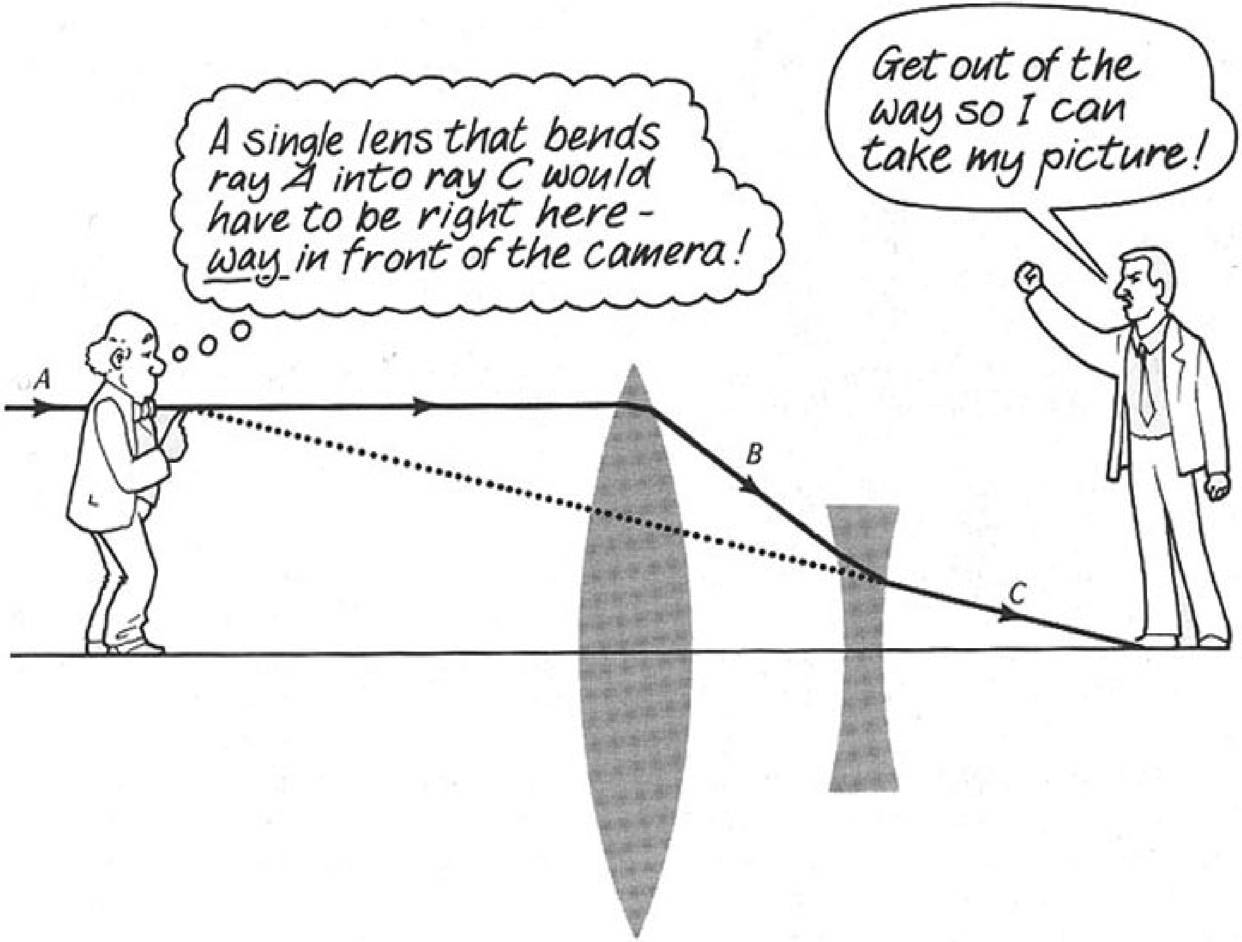


FIGURE 4.15

Principle of a telephoto lens. By extending the final emerging ray backward to the incident ray, we find the position and focal length of an equivalent single lens. Note that the single lens would have to stick out much farther in front of the camera than the telephoto combination.

- **Anamorphic distortion on film to compensate for projection lens giving a wide screen image**

FIGURE 4.16

Frames from the wide-screen movie film "Hello Dolly." When projected through a suitable lens the images would look normal. (You can see how they would look by tilting the book and looking at the figure from the bottom.) The lines on the left are the sound track.

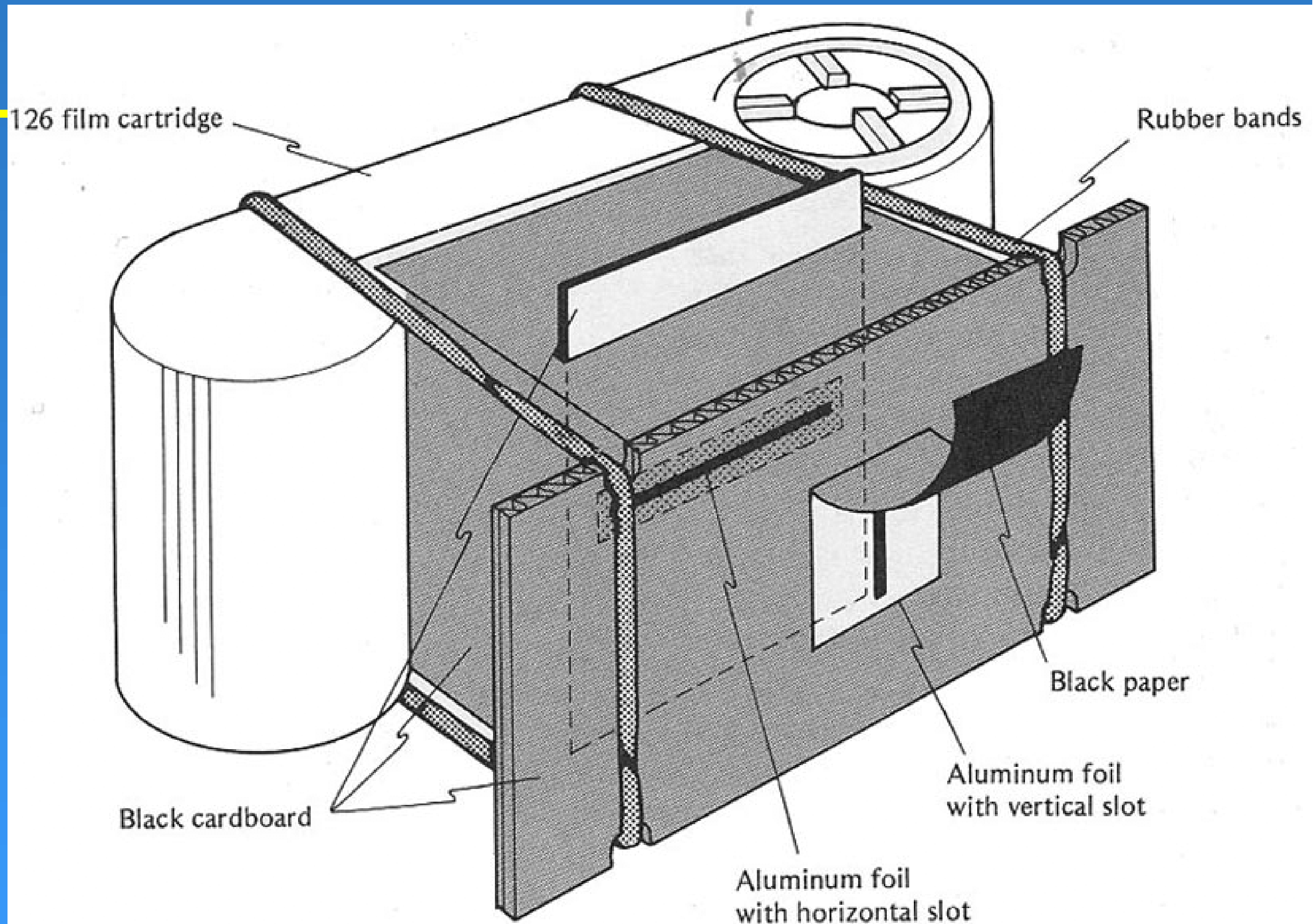
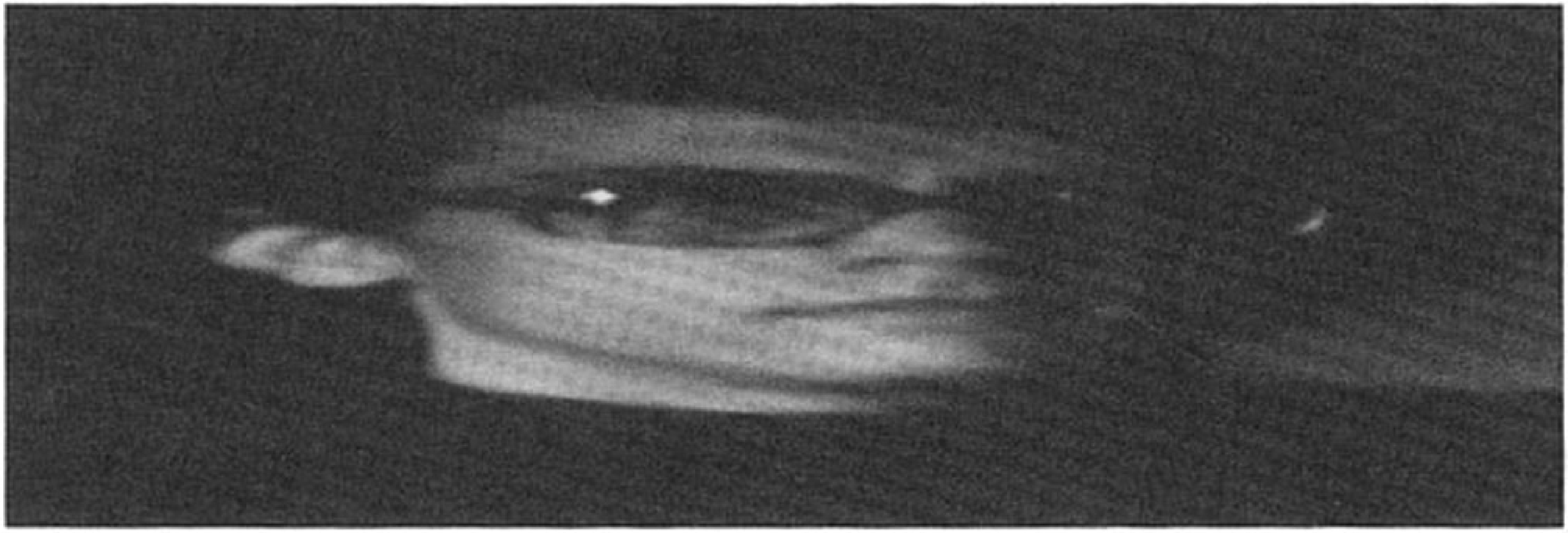


FIGURE 4.17

Design of an anamorphic pinhole camera.

FIGURE 4.18

Anamorphic author: photograph taken using camera like one in Fig. 4.17.



Zoom lens

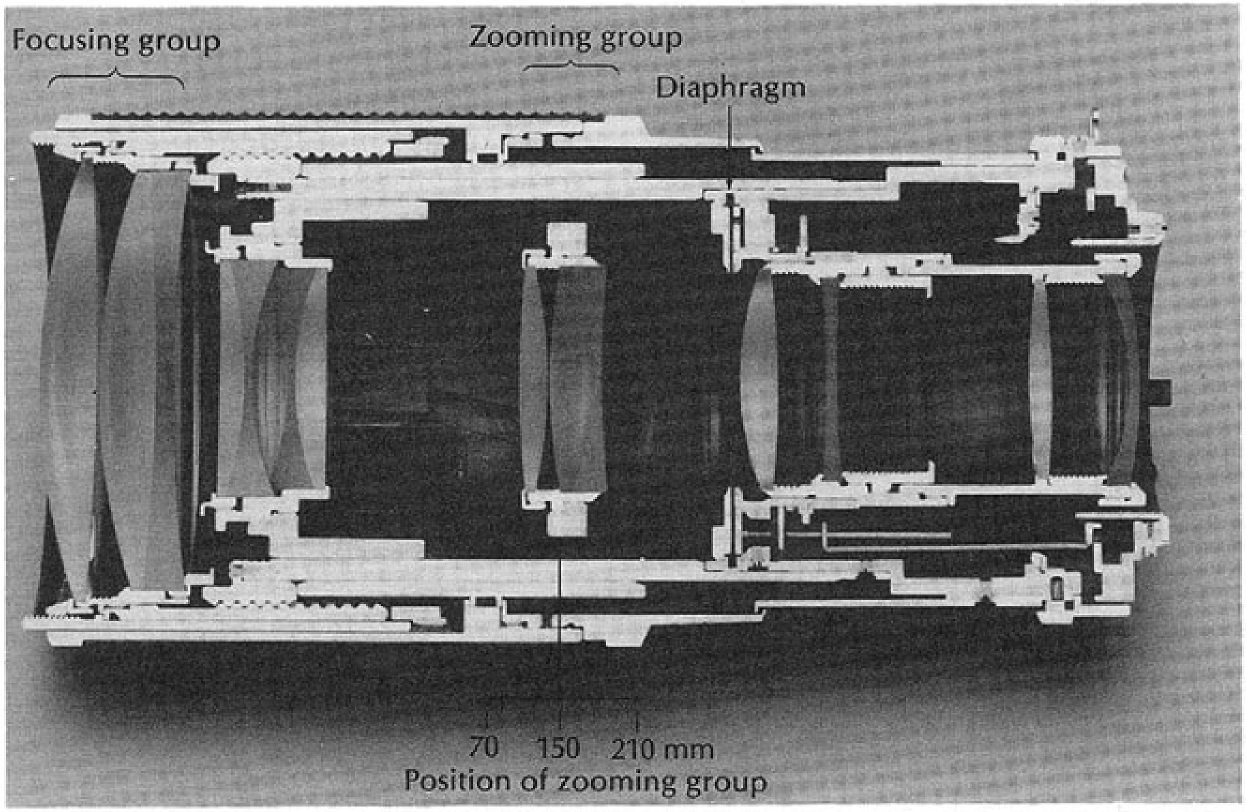


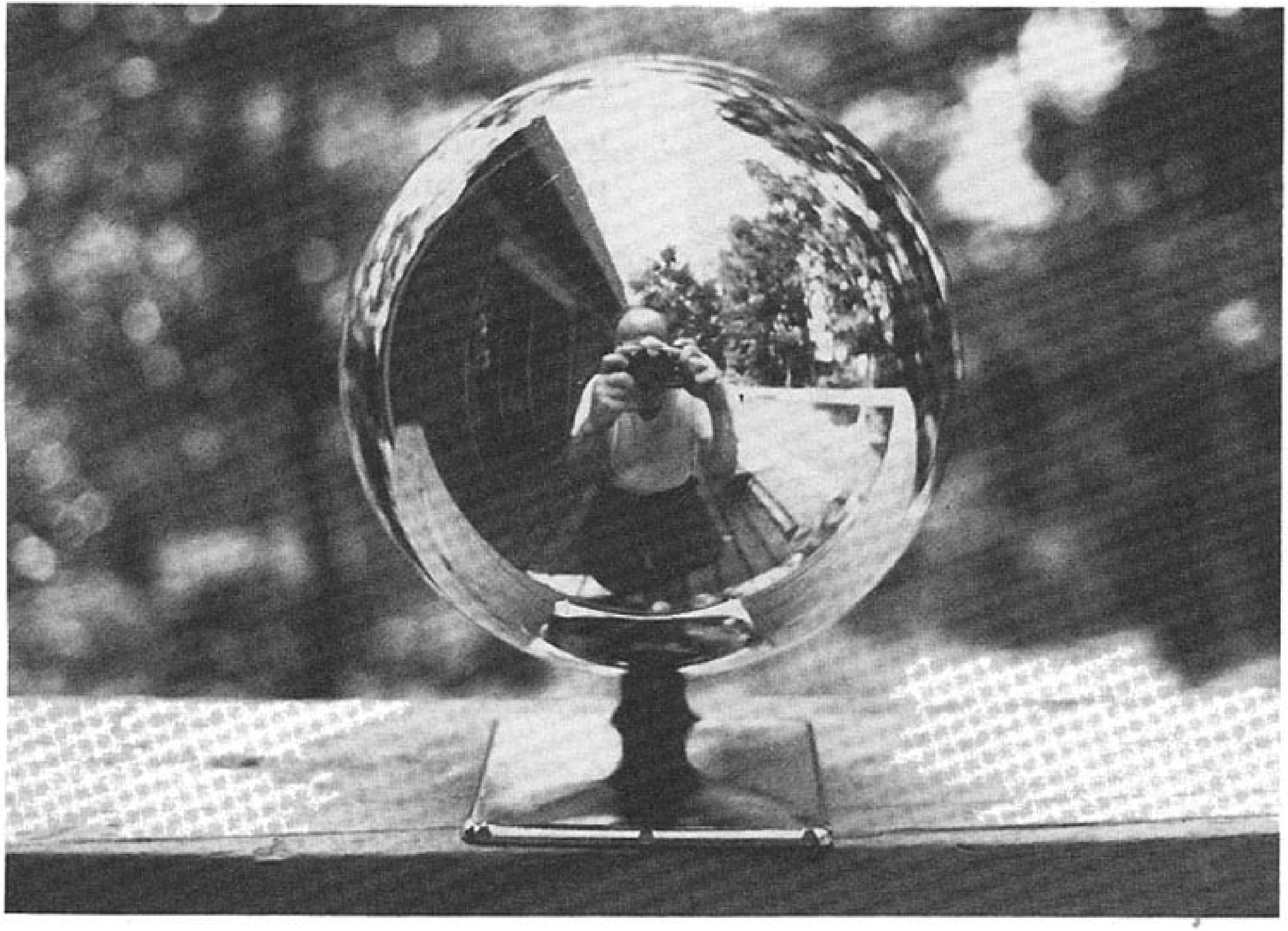
FIGURE 4.19

A zoom lens (Vivitar Series 1 Macro) at f = 70 mm and f = 210 mm. The lens elements move and also change their spacing in just such a way as to keep the image on the film plane.

- **Wide angle photograph of a convex mirror**

FIGURE 4.20

Wide-angle photograph taken in a convex mirror. Compare with Figure 3.9 and note that the place of Escher's head is here taken by the camera that took the picture. See also Figure 3.5b. Note the circles of confusion resulting from light points in the (out-of-focus) background.



- **1/1000**
- **1/500**
- **1/250**
- **1/125**
- **1/60**
- **1/30 s**

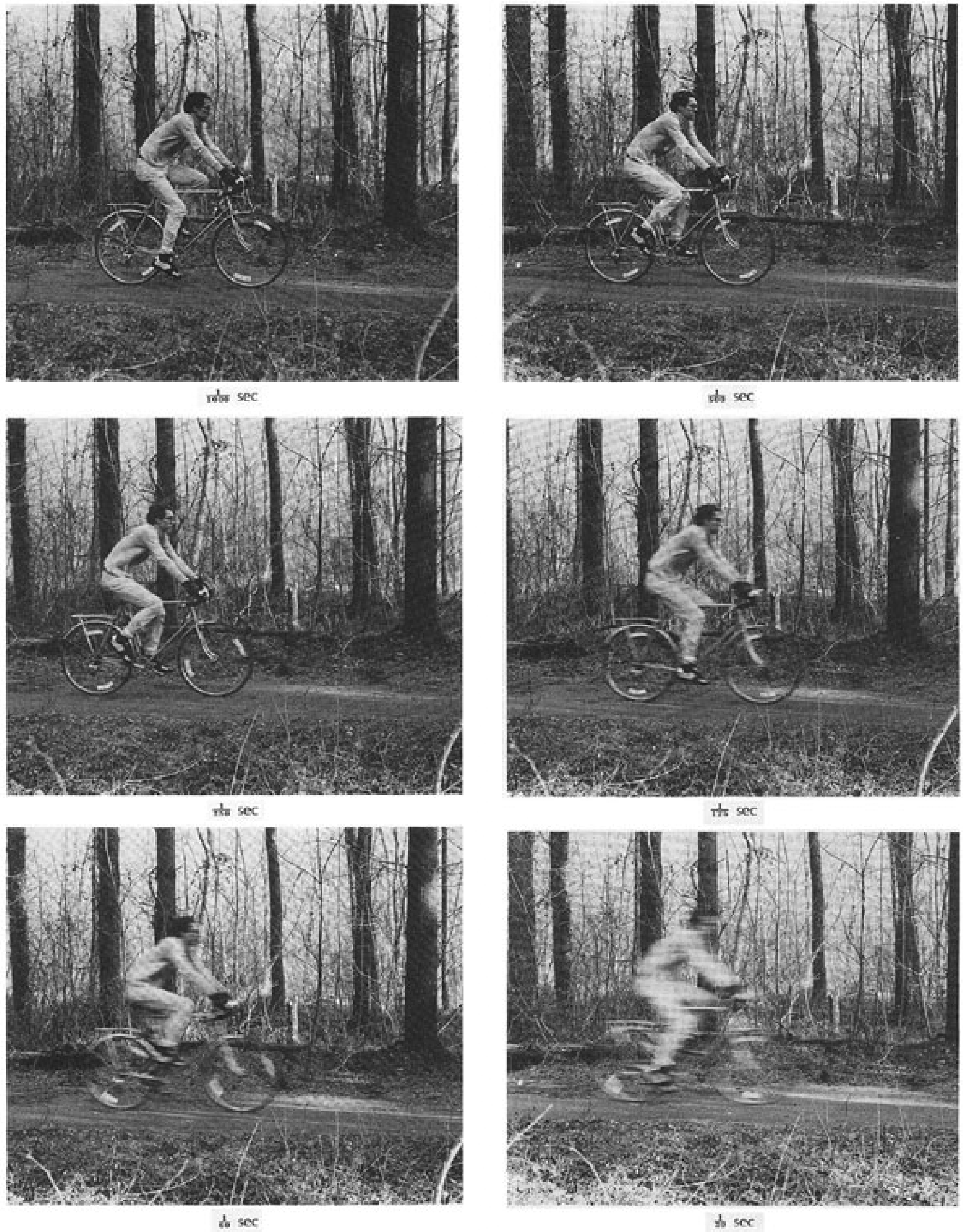


FIGURE 4.21

The action-stopping power of a shutter. The shutter speeds are given below each photo. (Also see stars in Fig. 2.41b.)

- **1/15 second**
- **1/8**
- **1/4**
- **1/2**

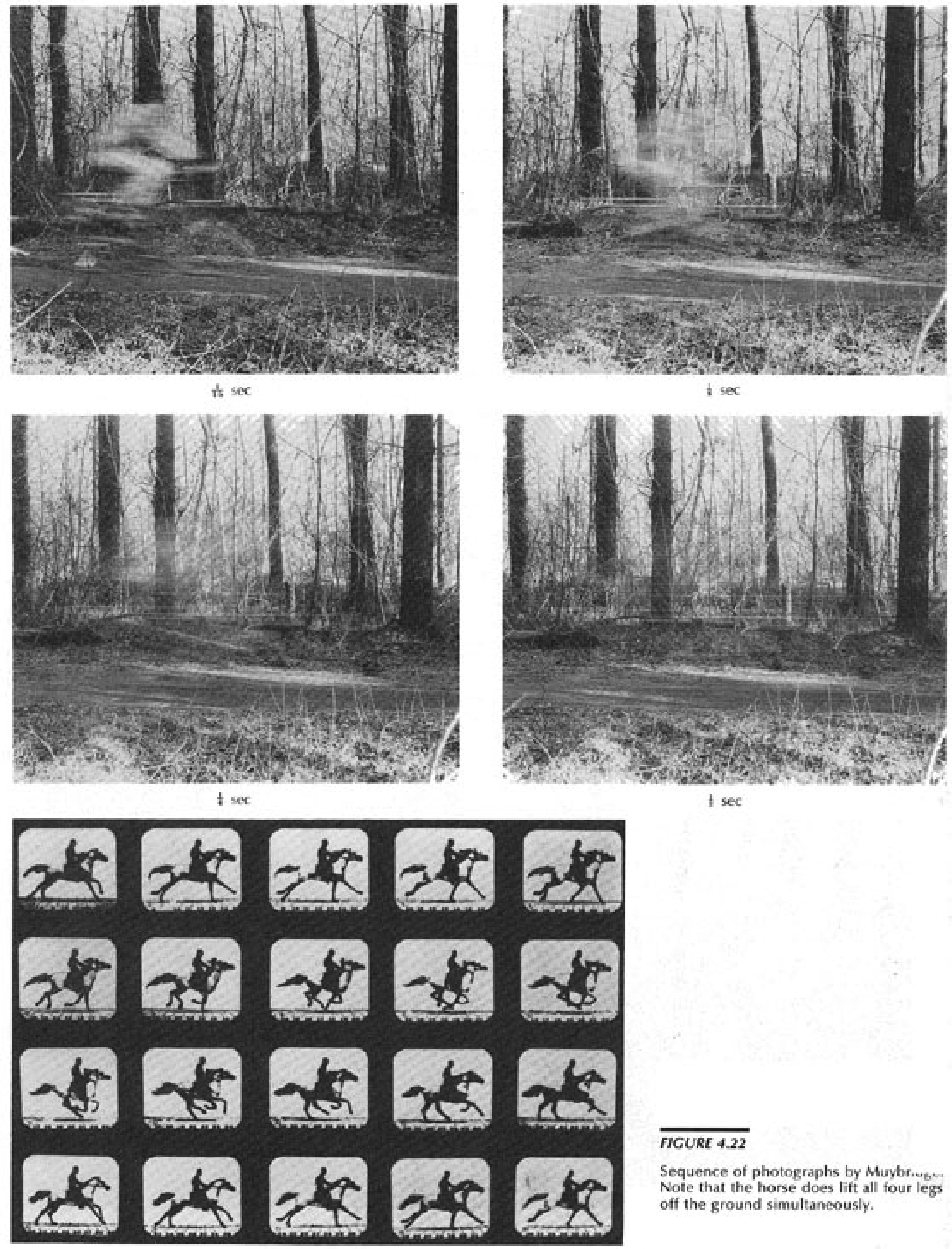


FIGURE 4.22

Sequence of photographs by Muybr... Note that the horse does lift all four legs off the ground simultaneously.

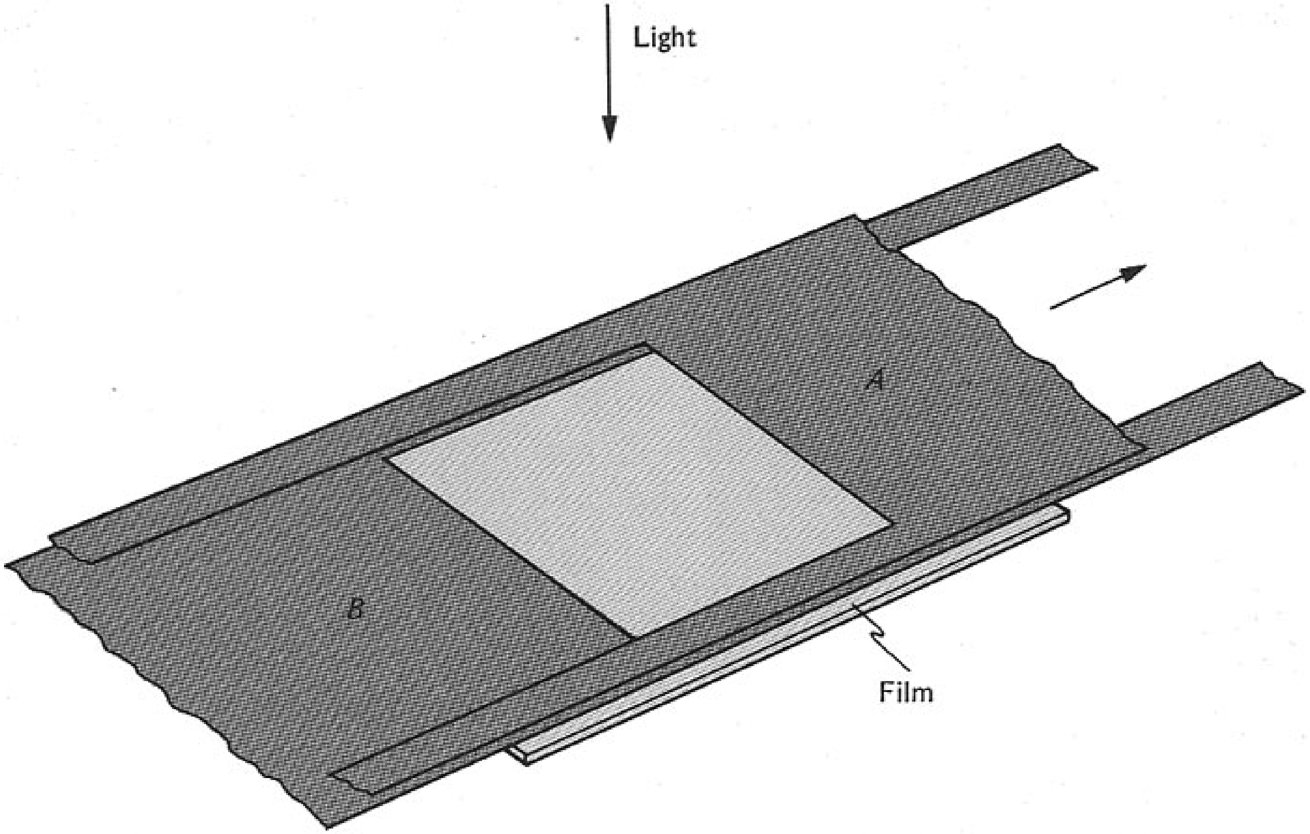


FIGURE 4.23

The principle of the focal-plane shutter. The two parts of the curtain always move across the film at the same speed, but part *B* is delayed by different amounts behind part *A* for different exposure times, creating a moving slot of different widths.

Effect of vertical motion shutter

- **Photographing a high speed object, along with shutter motion, can distort the image**

FIGURE 4.24

Photograph illustrating the distortion of a rapidly moving car due to a focal-plane shutter, here moving vertically. Modern focal-plane shutters move much faster, so the distortion is usually negligible, except for extremely rapidly changing scenes such as in Figure 4.26.