Eyepieces

$MP = 10$ $\qquad MP = \frac{250mm}{f_{e.p.}}$ $\qquad f_{e.p.} = 25mm$

- To be used with a relaxed eye, the intermediate image must be at the front focal plane $F_{e.p.}$ of the eyepiece.
- The intermediate pupil is 200 mm to the left of the intermediate image plane or $F_{e.p.}$

a) Simple Eyepiece

$f_{eye} = 25mm$

The eye lens is 25mm to the right of the intermediate image plane.

Image pupil through eye lens for XP and ER

Eye relief $= z'$ $\qquad z = -200 - f_{eye} = -225mm$

$$\frac{1}{z'} = \frac{1}{z} + \frac{1}{f_{eye}}$$

$$ER = z' = 28.125 \text{ mm}$$

b) Compound Eyepiece

$f_F = 40$ mm $t = 25$ mm

Because the field lens is located at F_{eye}, only the rear principal plane and the ER change from the simple eyepiece.

$f_{e.p.} = f_{eye} = 25$ mm

$F_{e.p.}$ coincident with F_{eye}
(and intermediate image plane)

$P_{e.p.}$ coincident with P_{eye}

Rear principal plane:

$$d' = -\frac{\phi_F}{\phi_{e.p.}} t = -\frac{\phi_F}{\phi_{eye}} t = -\frac{f_{eye}}{f_f} f_{eye}$$

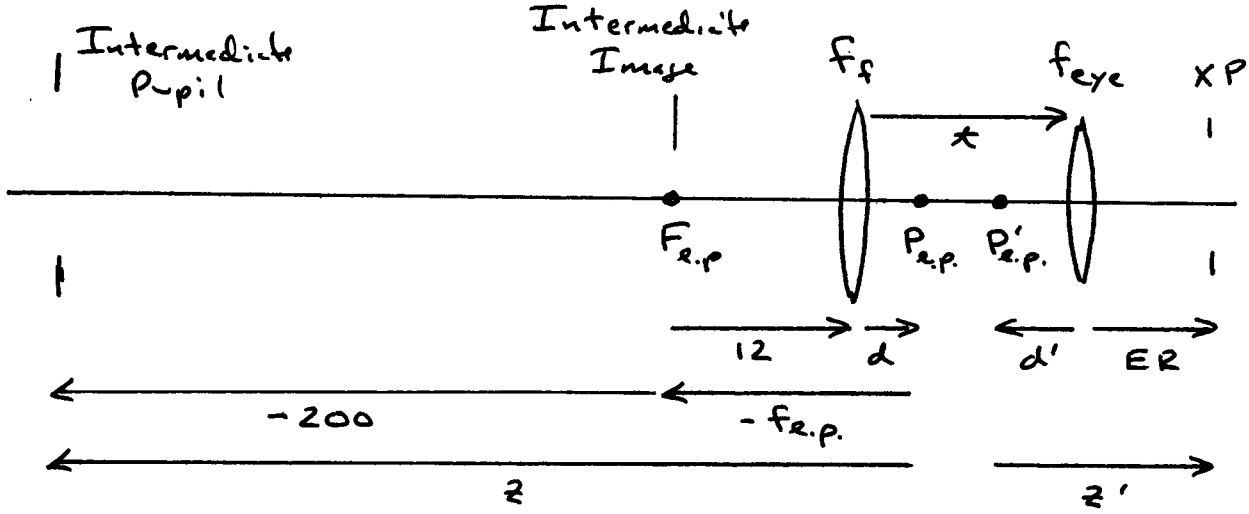
$$d' = -15.625 \text{ mm}$$

This shift reduces the eye relief of the simple eyepiece.

$$ER = 28.125 - 15.625 = \underline{12.5 \text{ mm}}$$

c) Ramsden Eyepiece

- same ER as compound eyepiece.



Three conditions:

1) $f_{e.p.} = 25$ mm

2) $F_{e.p.}$ located at the intermediate image

3) The intermediate pupil is imaged to the proper ER

ER = 12.5 mm

① $\phi_{e.p.} = \phi_f + \phi_{eye} - \phi_f \phi_{eye} t = 1/f_{e.p.}$

$$d = \frac{\phi_{eye}}{\phi_{e.p.}} t \qquad d' = -\frac{\phi_f}{\phi_{e.p.}} t$$

② $f_{e.p.} = 12 + d$

(3) $\frac{1}{z'} = \frac{1}{z} + \frac{1}{f_{e.p.}}$

$z' = ER - d'$

$z' = 12.5 - d'$

$z = -200 - 12 - d$

Solve for f_{eye}, f_F and t:

From (2)

$f_{e.p.} = 12 + d = 25$

$d = 13$ mm

$d = \frac{\phi_{eye}}{\phi_{e.p.}} t$

$\phi_{eye} t = d\, \phi_{e.p.} = \frac{d}{f_{e.p}} = \frac{13}{25}$

(4) $\phi_{eye} t = .52$

From (3)

$z = -200 - 12 - d$

$z = -225$

$\frac{1}{z'} = \frac{1}{z} + \phi_{e.p.}$

$z' = 28.125$

$z' = ER - d' = 12.5 - d'$

$d' = -15.625$

$$d' = -\frac{\phi_f}{\phi_{e.p.}} t$$

$$\phi_f t = -d' \phi_{e.p.} = -\frac{d'}{f_{e.p.}}$$

(5) $\qquad \phi_f t = .625$

Three equations (1), (4) and (5); three unknowns

$$\phi_{e.p} = \phi_s + \phi_{eye} - \phi_f \phi_{eye} t$$

$$\phi_{e.p} t = \phi_f t + \phi_{eye} t - (\phi_f t)(\phi_{eye} t)$$

$$\phi_{e.p.} t = .625 + .52 - (.625)(.52)$$

$$\phi_{e.p.} t = .82$$

$$t = \frac{.82}{\phi_{e.p.}} = .82 \; f_{e.p.} \qquad f_{e.p.} = 25$$

$$\underline{t = 20.5 \text{ mm}}$$

$$\phi_{eye} = .52/t = .02536$$

$$\underline{f_{eye} = 39.42 \text{ mm}}$$

$$\phi_f = .625/t = .03049$$

$$\underline{f_f = 32.8 \text{ mm}}$$