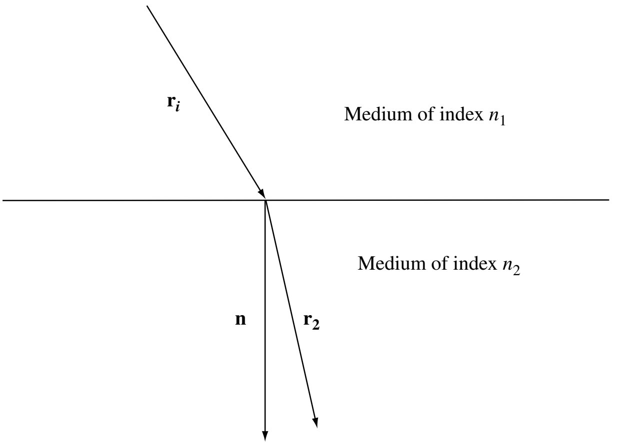

Figure 11.22 Vector relations during refraction

11.4.3 The Parabolic Concentrator

A basic concentrator configuration is the reflective parabolic concentrator shown in Figure 11.23. The two-dimensional cross section is shown, which could represent the cross section of either a two-dimensional linear parabolic trough or the cross section of a three-dimensional paraboloid of revolution.

The equation relating the x and y components of the parabolic surface is $y = 1/4Fx^2$, where F is the focal length of the parabola. It can be shown that all rays coming from straight up (i.e. with no x-component) will pass through the focus. If D is the diameter or width of the parabola, then this can be written in the normalized form

$$\frac{y}{D/2} = \frac{1}{8f}\left(\frac{x}{D/2}\right)^2$$

where $f = F/D$ is called the f-number of the parabola. Note that if $f = 1/4$, then when $x = D/2$, that is, at the rim of the parabola, $y = D/4 = F$. In other words, for an $f = 1/4$ parabola, the rim height is equal to the focal length. Obviously the slope at the rim is then 45°. Another useful relation that relates the distance from the focus to the parabolic surface, r, to the angle that the ray hits the receiver, θ_r, is

$$r = \frac{2F}{1 + \cos\theta_r}$$

and

$$x = r\sin\theta_r = \frac{2F\sin\theta_r}{1 + \cos\theta_r}$$

From this we can see that at the rim, when $x = D/2$ and the angle of rays at the receiver is maximum, we have

$$f = \frac{F}{D} = \frac{1}{4}\,\frac{1 + \cos\theta_{\max,r}}{\sin\theta_{\max,r}}$$