34. Cont.

Then Eqs. (3.311) and (3.312) become

$$x = C_x + A \sin(\omega t + \theta) + \frac{at}{\omega}, \tag{3.322}$$

$$y = C_y + A \cos(\omega t + \theta). \tag{3.323}$$

There are now only four constants, A, θ, C_x, C_y, to be determined by the initial values x_0, y_0, $\dot{x}_0$, $\dot{y}_0$. The z-motion is, of course, given by Eq. (3.304). If $E_y = 0$, the xy-motion is in a circle of radius A with angular velocity ω about the point (C_x, C_y); this is the motion considered in the previous example. The effect of E_y is to add to this uniform circular motion a uniform translation in the *x-direction*! The resulting path in the xy-plane will be a cycloid having loops, cusps, or ripples, depending on the initial conditions and on the magnitude of E_y (Fig. 3.43). This problem is of interest in connection with the design of magnetrons. The translation has the velocity

$$v_D = a/\omega = E_y c/B.$$

$$\mathbf{v}_D = c\mathbf{E} \times \mathbf{B}/B^2. \tag{3.324}$$

This drift velocity of a charged particle in crossed electric and magnetic fields is of fundamental importance in the theory of plasmas.

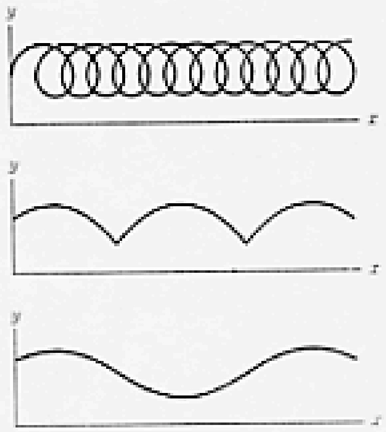

Fig. 3.43 Orbits in the xy-plane of a charged particle subject to a magnetic field in the z-direction and an electric field in the y-direction.