Zone plate as a convergent lens:

from equation (1) radius of the nth zone is given by—

$$r_n^2 = \left(\frac{u \cdot v}{u+v}\right) n\lambda$$

$$\therefore \frac{u+v}{u \cdot v} = \frac{n\lambda}{r_n^2}$$

or, $$\frac{1}{v} + \frac{1}{u} = \frac{n\lambda}{r_n^2}$$

This expression is constant for a given zone plate. If we compare it withe the convex lens equation for a real image

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

we get, $\frac{1}{f_n} = \frac{n\lambda}{r_n^2}$ $\therefore$ $f_n = \frac{r_n^2}{n\lambda}$ — (11)

Thus a zone plate acts as a converging lens. A zone plate has a number of foci which depend on the number of zones used as well as the wavelength of light employed.

If n is each even, each clear is occupied by an even number of zones which concle in pairs; but if n is odd there is maximum intensity at p. Thus a zone plate gives a succesion of images corresponding to focal length f, $\frac{f}{3}$, $\frac{f}{5}$ etc where $u = \infty$ for a plane wave

In n be given odd negative values in equation (11) then even with a distant source, virtual images are formed corresponding to focal lenghts $-f, -f/3, -f/5$ etc. for a zone plate acts like a circular diffraction grating of unequal spacing and wavelets issuing out may be considered to arise from points on left of zone plate. The rays which meet at points p may be considered as diffracted rays, but other side of line O, P. It means in upward direction. These will give rise to a series of virtual images on the side of zone plate in which s is situated. Thus a zone plate acts like a divergent lens.