(*b*) *The amplitude reflected by a plane sheet of atoms:* We shall first consider the amplitude of the wave reflected by an infinite plane sheet of atoms, each of which scatters the incident X-rays.

Suppose A, fig. 15, is the source of the radiation, and let the amplitude of the reflected wave be required at B. Let the plane APB be normal to the plane of atoms, and let AP, PB make equal angles θ with this plane. Then P is such that the distance APB is the shortest distance from A to B *via* the plane. Let M be a point of the plane such that the distance AMB is greater by $\lambda/2$ than the distance APB. Then M is on the edge of the first Fresnel zone corresponding to the points A and B, and the whole zone boundary, which is the locus of points such as M, is an ellipse having P as centre and the trace of the plane APB on the reflecting plane as major axis. Proceeding in this way, we may divide the surface of the plane up into the successive Fresnel zones, all of which are elliptical. In the usual Fresnel construction, we are dealing with a wave-front which is supposed to contain the sources of an indefinitely great number of Huyghens wavelets. Here we have a set of actual sources, and, if we are to apply the Fresnel construction, we must show that the scattering points are closely enough set on the planes, in comparison with the areas of the zones, for them to be considered effectively as having a continuous distribution. The area of the first zone is easily shown to be

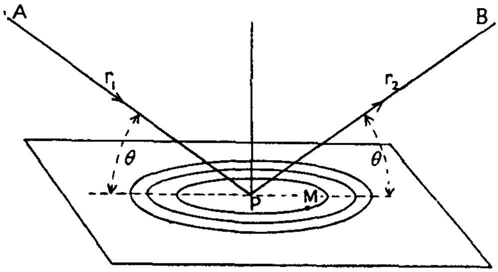

FIG. 15

$$\frac{\pi r_1 r_2}{r_1+r_2}\frac{\lambda}{\sin\theta}, \tag{2.17}$$

where r_1 and r_2 are the distances AP and BP respectively. Now let us suppose that r_1 is large, corresponding to a nearly plane incident wave, and that r_2 is one centimetre. The area of the first zone is then $\pi\lambda/\sin\theta$. For the least favourable case we take $\sin\theta=1$, and since $\lambda\sim 10^{-8}$ cm., the area is then about 3×10^{-8} sq. cm. This seems very small, but we must remember that in an average crystal net-plane there are about 10^{15} atoms per sq. cm., so that the number in the first zone in the case we have considered is about thirty million. We shall not, therefore, make any appreciable error in assuming a continuous distribution of scattering points.

The ordinary Fresnel construction shows that the resultant amplitude is equal to half that due to the scattering points lying within the first Fresnel zone; and the resultant amplitude due to the first zone is $2/\pi$