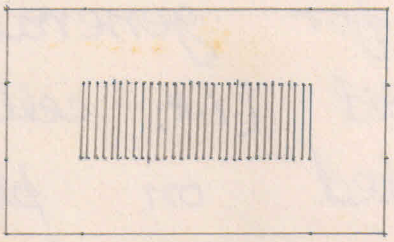
* Describe the construction and spectrum formation of a plane transmission. Explain it's use in determination of wavelength of light. [Identification of a gas in a discharged tube.]

Plane grating



Nearly 6000 lines per centimeter

Figure ⇒ 1

A plane grating consists of fine equidistant rulings on thin, plane, parallel glass plate. The lines are parallel, equispaced and nearly about 6000 per centimeter. This is done by diamond worked by machine. A grating of this contribution is called plane grating. It may be used both in reflection and in transmission. For practical region transmission grating is used.

The grating of above contribution is called parent grating. It becomes costly. therefore for general purposes it's celluloid [i.e; cellulose acetate] replica pasted on plane parallel glass plate is used. In any case the ruling acts as opaque space of width b while plane portion between the ruling acts as slit and is of width a. The distance 'a+b' contains one ruling and is known as grating element. Therefore the number of lines per centimeter or per unit length will be;

$$\frac{1}{a+b} = n \quad \ldots\ldots\ldots\ldots \text{(i)}$$

Spectrum formation is explained with the help of Fig-2 where normal incidence has been considered.

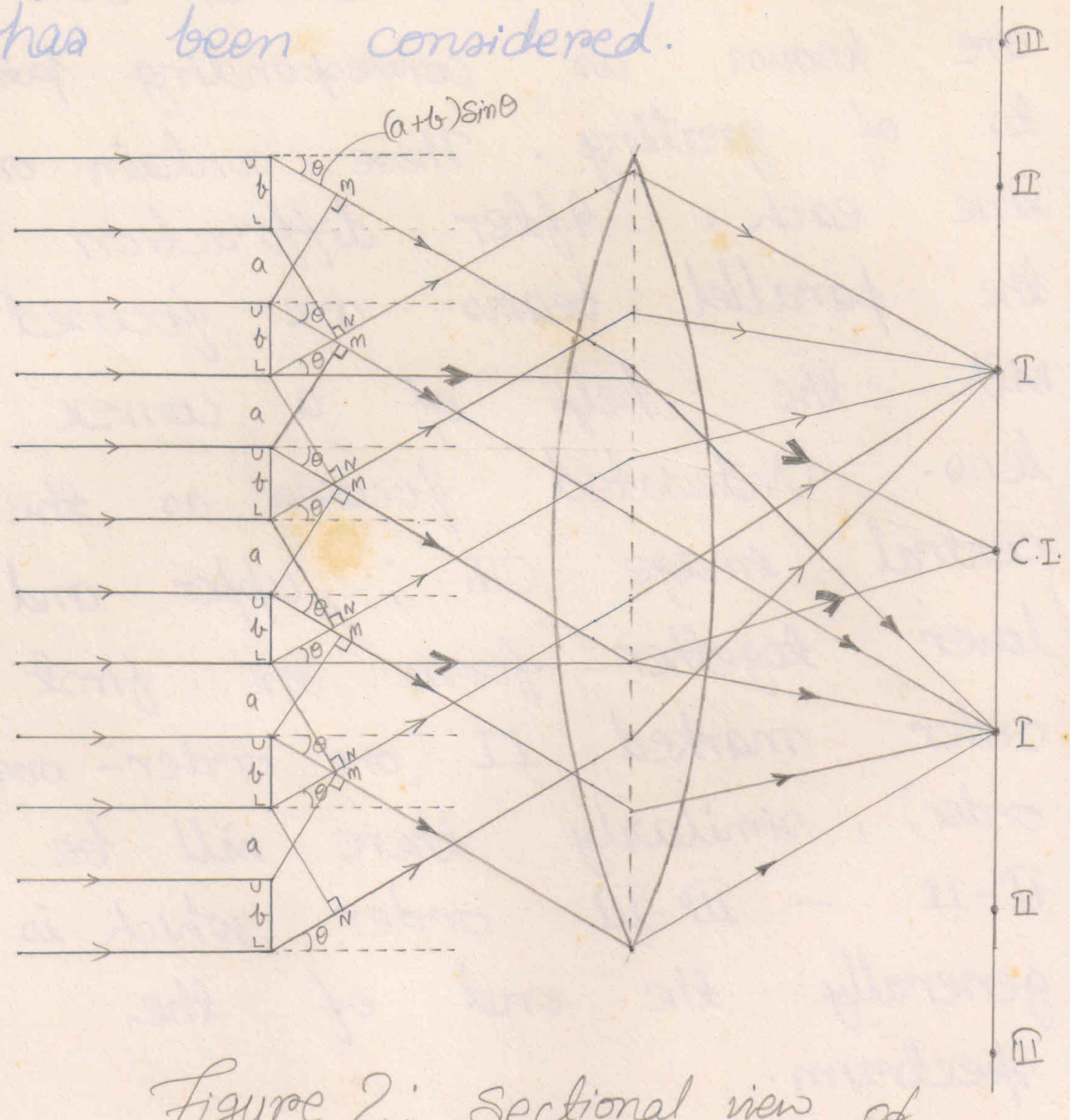


Figure 2: Sectional view of plane grating.

A parallel incident beam is divided into three parts —

One is direct; A second is due to diffraction of successive upper edges UU while the third corresponding to successive lower point LL. In any case LL or UU are known as corresponding points of grating. These contain one line each. After diffraction the parallel beams are focused with the help of a convex lens. Undeviated focuses as the central image C.I.; upper and lower together form the first order marked II (one order- one order), similarly there will be II-II — III-III order which is generally the end of the spectrum.

As indicated in Fig 2, the path difference between the rays diffracted by corresponding points of the grating is – $(a+b)\sin\theta$.

If this is $m\lambda$ where m is any integer (i.e., 1, 2, 3 --) then there will be maximum spectrum value of m is ± 1 corresponding to first order for which angle of diffraction θ_1.

$$\sin\theta_1 = \frac{m\lambda}{a+b} = mn\lambda \cdots\cdots (ii)$$

where $n = \frac{1}{a+b}$ = number of lines per cm of the grating.

Wavelength of light is determined by equation (ii). In actual experiment for accuracy 2θ is measured in each order and value of λ calculated.

If a gas of a discharged tube is to be identify, then the discharged tube is made the source. Each spectral line produces it's first order, second order etc. wavelength of each line is determined and compared with standard chart.

For example Hydrogen discharged tube has four lines —

H_α, H_β, H_γ, H_δ ;

Helium discharged tube have seven lines etc.

This identify the gas in the discharged tube.

A grating may also be used for determination of fine structure of spectral lines-

for example Sodium

D_1 [5890 Å] and D_2 [5896 Å].