Contents

- *Newton's ring formed by two curved Surface*
- *Curved surface placed on each other*
- *Both curved surface contact with each other*

Special Cases:

Newton's ring formed by two curved Surface:

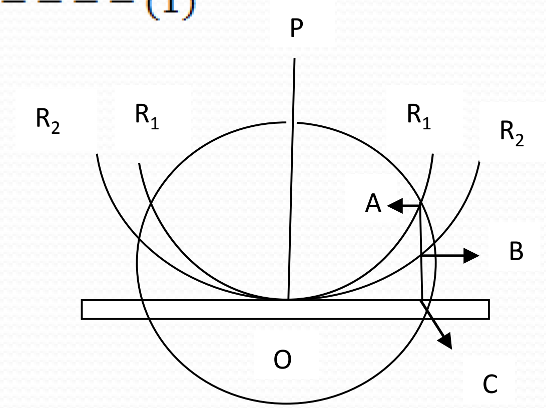
Consider two curved surface radius of curvature R_1 and R_2 placed in such a way that they are contact at a point O Then air film of increasing thickness is formed between the two surfaces. Then at particular constant thickness AB interference take place in the form of concentric ring. Suppose that is n^{th} ring and radius of that n^{th} ring is r_n. That n^{th} ring will appear dark and bright depend upon path difference between the two reflected ray that comes out to be:- $2\mu t \cos(r+\alpha) + \frac{\lambda}{2}$ ------------------ (1)

For normal incidence $r = 0$

Angle of inclination $\alpha = small$

So that $(r+\alpha) = 0 + small = 0$

For air film $\mu = 1$



[redacted]

Then the path difference between the reflected rays would be

$$2t + \frac{\lambda}{2} - (2)$$

Now calculate value of AC from fig. 1.3.4(a) and BC from 1.3.4(b)

$$Here\ AB = t = (AC - BC) - - - - - - - - - - - - - - - - - (3)$$

Now calculate value of AC from fig. 1.3.4(a) and BC from 1.3.4(b)

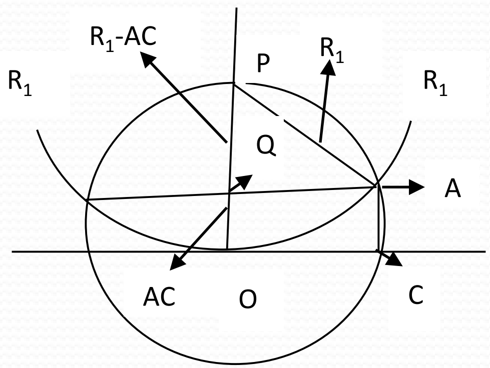
Taking right angle triangle PQA in this triangle

$$OP = R_1, OQ = AC, PQ = R_1 - AC, AP = R_1, AQ = r_n.$$

Applying Pythagoras Theorem we get

$$AP^2 = PQ^2 + QA^2 \qquad R_1^2 = (R_1 - AC)^2 + r_n^2$$

$$R_1^2 = R_1^2 + AC^2 - 2R_1AC + r_n^2$$



[redacted]

$$=> 0 = AC^2 - 2 R_1 AC + r_n^2$$

Now AC is very small as compared to R_1 *and* r_n

So in that case AC^2 *can be neglected then we get*

$$0 = -2 R_1 AC + r_n^2 \ or\ r_n^2 = 2 R_1 AC$$

$$Or \quad AC = \frac{r_n^2}{2 R_1}$$

Similarly we can calculate value of BC

- Now taking right angle triangle PQB in this right angle triangle:

$$OP = R_2, PQ = R_2 - BC, \ QB = R_2, \qquad QB = r_n$$

Applying Pythagoras Theorem we get

$$PB^2 = PQ^2 + QB^2 \qquad R_2^2 = (R_2 - BC)^2 + r_n^2 \qquad R_2^2 = R_2^2 + BC^2 - 2R_1 BC + r_n^2$$

$$=> 0 = BC^2 - 2\,R_1\,BC + r_n^2$$

- Now $Now\ BC\ is\ very\ small\ as\ compared\ to\ R_2\ and\ r_n$

$So\ in\ that\ case\ BC^2\ can\ be\ neglected\ then\ we\ get\quad 0 = -\,2\,R_2\,BC + r_n^2\ \ or\ \ r_n^2 = 2\,R_2\,BC \quad Or \quad BC = \dfrac{r_n^2}{2\,R_2}$

$Putting\ value\ of\ AC\ and\ BC\ in\ equation\ (3)\ we\ get AB \quad t = AB = (AC - BC) = \dfrac{r_n^2}{2\,R_1} - \dfrac{r_n^2}{2\,R_2}$

$Putting\ value\ of\ t = AB\ in\ Eq.(2) we\ get\ value\ Path\ Diffrence$

$$\frac{r_n^2}{2\,R_1} - \frac{r_n^2}{2\,R_2} + \frac{\lambda}{2} - - - - - - - - - - - - - - - (4)$$

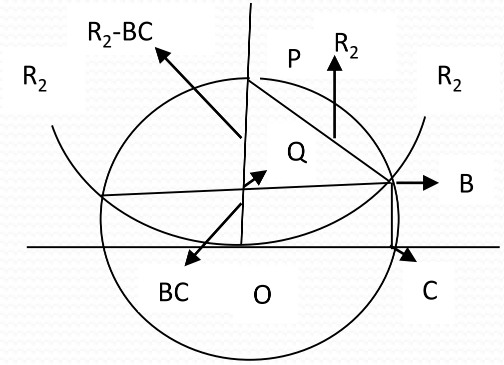
Thus the ring will appear bright only when path-difference between both of the reflected ray = n λ

$$2\left(\frac{r_n^2}{2\,R_1} - \frac{r_n^2}{2\,R_2}\right) + \frac{\lambda}{2} = n\lambda$$

$$r_n^2\left(\frac{1}{R_1} - \frac{1}{R_2}\right) + \frac{\lambda}{2} = n\lambda$$

$$r_n^2\left(\frac{R_2 - R_1}{R_2 R_1}\right) = n\lambda - \frac{\lambda}{2}$$

$$r_n^2\left(\frac{R_2 - R_1}{R_2 R_1}\right) = (2n - 1)\frac{\lambda}{2}$$



[redacted]

- $r_n^2 = \frac{\lambda R_2 R_1 (2n-1)}{2(R_2 - R_1)}$ But $D_n = 2r_n \Rightarrow r_n = \frac{D_n}{2}$

Putting value of r_n *and get diameter of bright ring*

$$\frac{D_n^2}{4} = \frac{\lambda R_2 R_1 (2n-1)}{2(R_2 - R_1)} \Rightarrow D_n^2 = \frac{2\lambda R_2 R_1 (2n-1)}{(R_2 - R_1)}$$

And the ring will appear dark only when

$$Path\ diff. = 2t + \frac{\lambda}{2} = \frac{(2n+1)\lambda}{2} \qquad 2\left(\frac{r_n^2}{2R_1} - \frac{r_n^2}{2R_2}\right)\frac{\lambda}{2} = \frac{(2n+1)\lambda}{2}$$

$$r_n^2\left(\frac{1}{R_1} - \frac{1}{R_2}\right) + \frac{\lambda}{2} = \frac{(2n+1)\lambda}{2} \qquad r_n^2\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{(2n+1)\lambda}{2} - \frac{\lambda}{2}$$

$$r_n^2\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = n\lambda \qquad r_n^2\left(\frac{R_2 - R_1}{R_2 R_1}\right) = n\lambda \qquad r_n^2 = \frac{R_2 R_1 n\lambda}{(R_2 - R_1)}$$

But $D_n = 2r_n \Rightarrow r_n = \frac{D_n}{2}$ *Putting value of* r_n *and get diameter of dark ring*

$$\Rightarrow \boldsymbol{D_n^2 = \frac{4R_2 R_1 n\lambda}{(R_2 - R_1)}}$$

- Case II
- When both curved surface are placed in such a way that whose convex surface are contact at a point. Then air film of increasing thickness is formed between the two curved surfaces. Then at particular constant thickness AB interference take place in form of concentric ring. Suppose that it is nth ring whose radius is r_n that n^{th} ring will appear dark or bright depend upon path difference between the two reflected rays that is

$$2t + \frac{\lambda}{2} ---------------------(5)$$

$$Here\ t = AB = AC + BC \quad value\ of\ AC\ and\ BC\ are$$

$$AC = \frac{r_n^2}{2\,R_1}\ and\ BC = \frac{r_n^2}{2\,R_2}$$

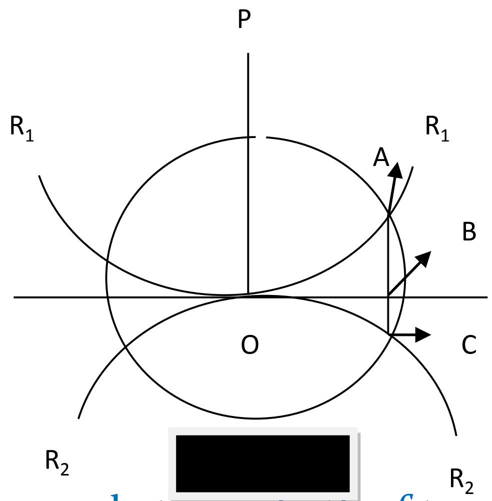
$$Putting\ value\ of\ AC\ and\ BC\ in\ eq.(5)\ \ we\ get$$

$$t = AB = (AC + BC) = \frac{r_n^2}{2\,R_1} + \frac{r_n^2}{2\,R_2}$$

$$Putting\ value\ of\ t = AB\ in\ Eq.(2)$$

$$we\ get\ value\ Path\ Diffrence$$

$$\frac{r_n^2}{2\,R_1} + \frac{r_n^2}{2\,R_2} + \frac{\lambda}{2} ---------(4)$$



- Thus the ring will appear bright only when path-difference between both of the reflected ray = n
- λ

$$2\left(\frac{r_n^2}{2\,R_1}+\frac{r_n^2}{2\,R_2}\right)+\frac{\lambda}{2}=n\lambda \qquad r_n^2\left(\frac{1}{R_1}+\frac{1}{R_2}\right)+\frac{\lambda}{2}=n\lambda \qquad r_n^2\left(\frac{R_2+R_1}{R_2R_1}\right)=n\lambda-\frac{\lambda}{2}$$

$$r_n^2\left(\frac{R_2+R_1}{R_2R_1}\right)=(2n-1)\frac{\lambda}{2} \qquad r_n^2=\frac{\lambda R_2R_1(2n-1)}{2(R_2+R_1)}$$

$$But\ D_n=2r_n \Rightarrow r_n=\frac{D_n}{2}$$

Putting value of r_n *and get diameter of bright ring*

$$\frac{D_n^2}{4}=\frac{\lambda R_2R_1(2n-1)}{2(R_2+R_1)} \Rightarrow D_n^2=\frac{2\lambda R_2R_1(2n-1)}{(R_2+R_1)}$$

- And the ring will appear dark only when $Path\ diff.=2t+\frac{\lambda}{2}=\frac{(2n+1)\lambda}{2}$

$$2\left(\frac{r_n^2}{2\,R_1}+\frac{r_n^2}{2\,R_2}\right)\frac{\lambda}{2}=\frac{(2n+1)\lambda}{2} \qquad r_n^2\left(\frac{1}{R_1}+\frac{1}{R_2}\right)+\frac{\lambda}{2}=\frac{(2n+1)\lambda}{2}$$

$$r_n^2\left(\frac{1}{R_1}+\frac{1}{R_2}\right)=n\lambda \qquad r_n^2\left(\frac{R_2+R_1}{R_2R_1}\right)=n\lambda \qquad r_n^2=\frac{R_2R_1n\lambda}{(R_2+R_1)}$$

$$But\ D_n=2r_n \Rightarrow r_n=\frac{D_n}{2}$$ *Putting value of* r_n *and get diameter of dark ring*

$$D_n^2=\frac{4R_2R_1n\lambda}{(R_2-R_1)}$$