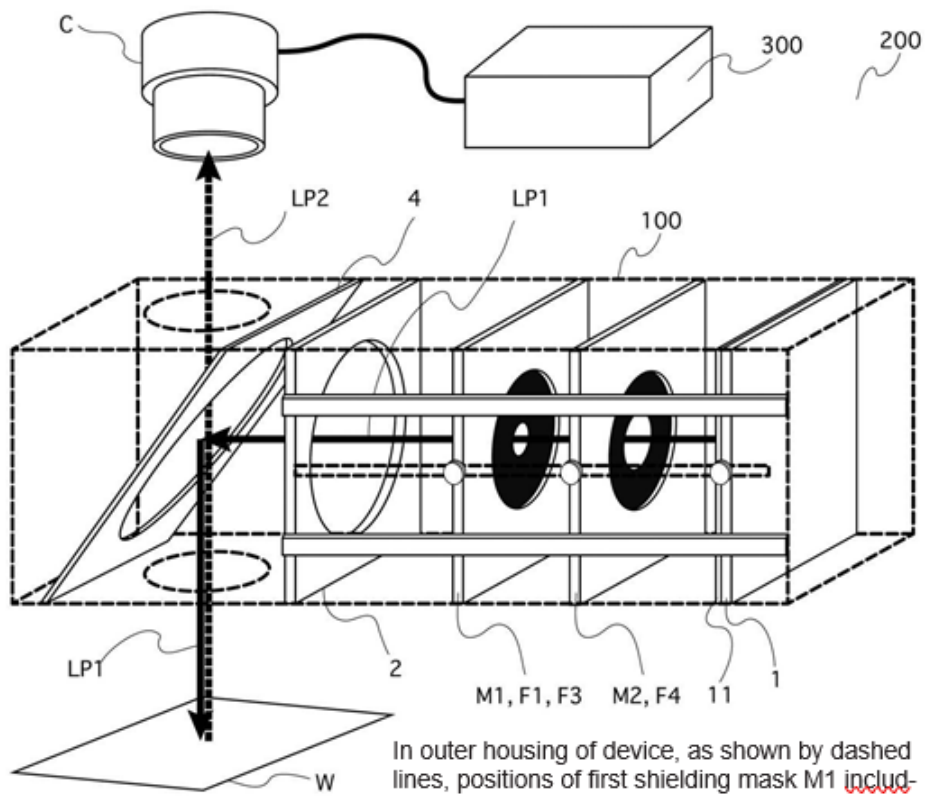
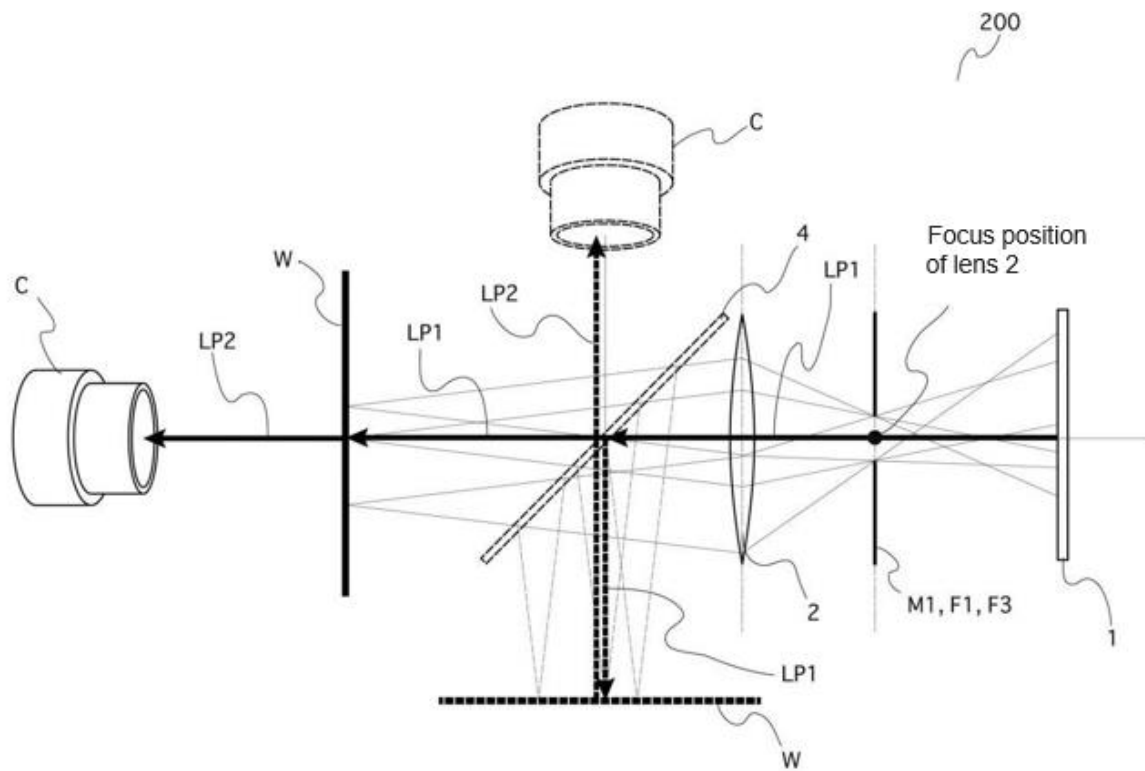


Fig. 1



In outer housing of device, as shown by dashed lines, positions of first shielding mask M1 including first filtering means F1 and third filtering means F3, second shielding mask M2 including fourth filtering means, and surface light source 1 including light-emitting face 11 can each be adjusted by being moved forward and rearward relative to lens 2, and can be fixed.

Fig. 2



* Half mirror 4, imaging device C, inspection object W, and light path in the case where half mirror is provided are indicated by dashed lines.

Fig. 3

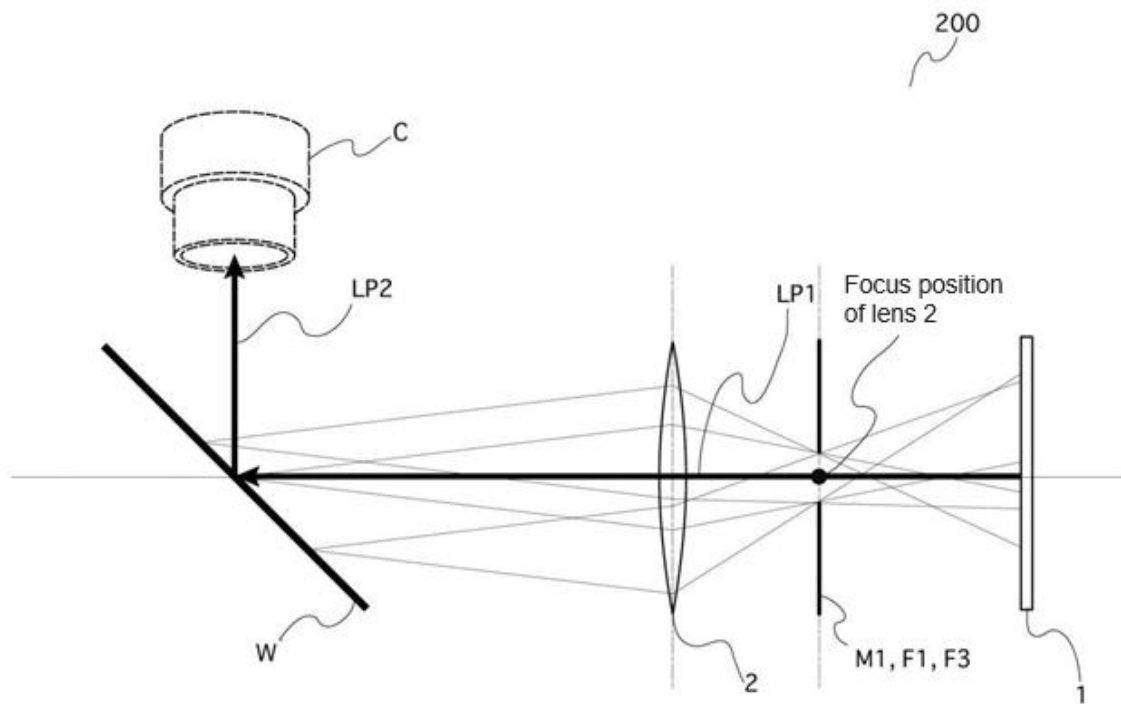
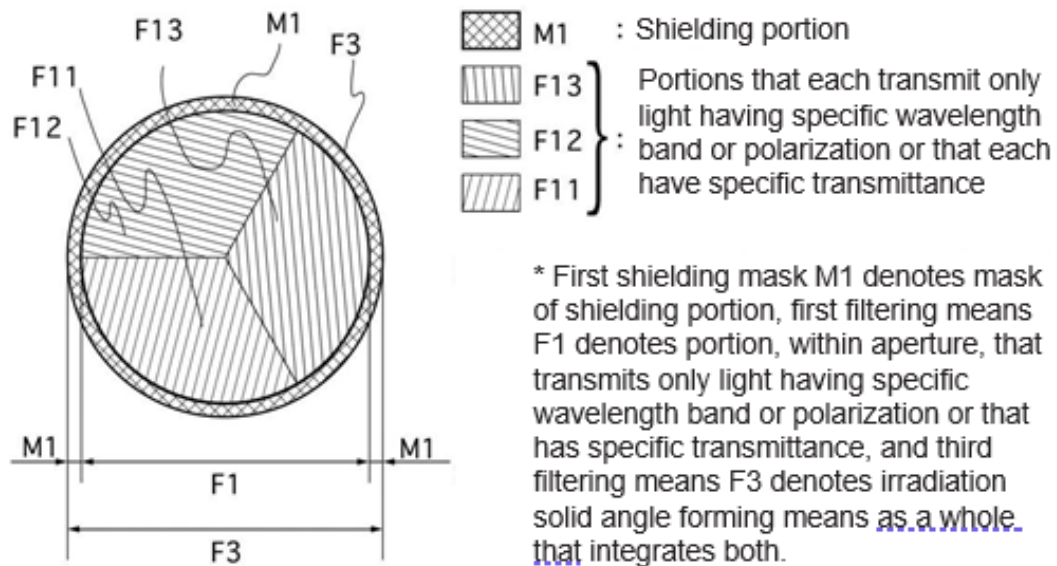
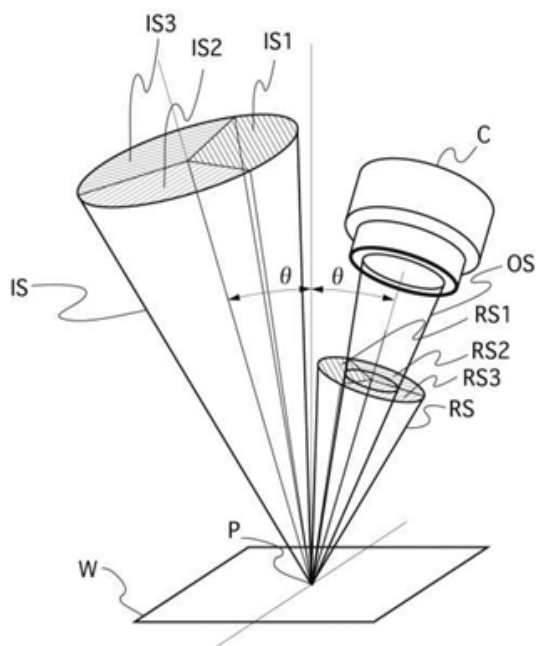


Fig. 4

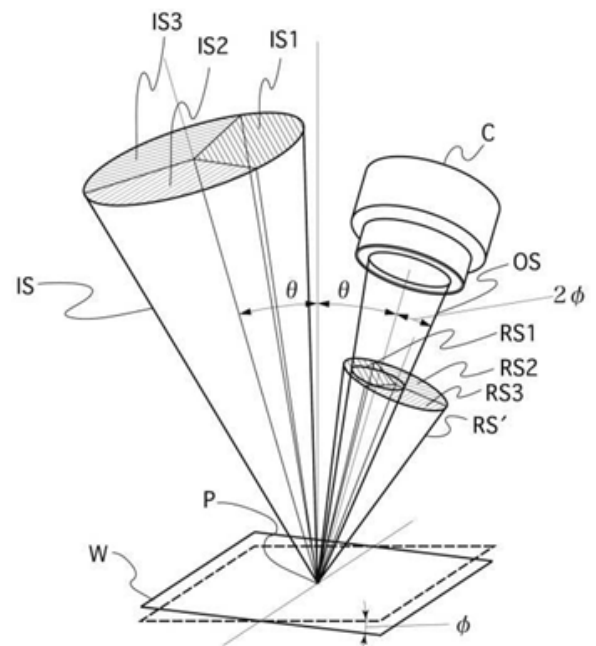


* Except for first shielding mask, M1 of shielding portion may also function as portion that transmits only light having specific wavelength band or polarization or that has specific transmittance.

Fig. 5

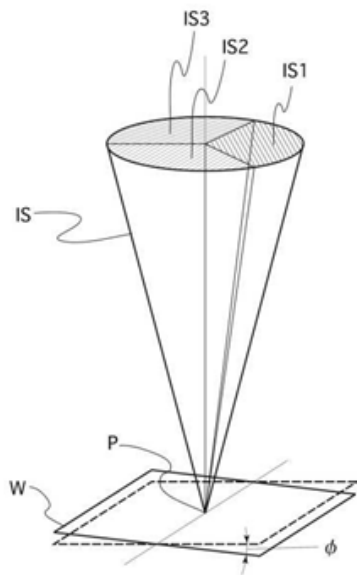


(a) When inspection surface is planar, optical axis of reflected light and optical axis of observation solid angle coincide with each other.

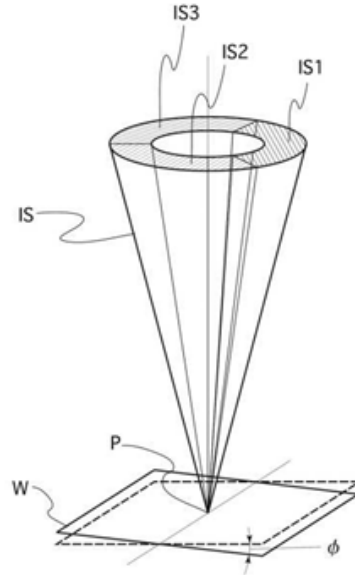


(b) When inspection surface is inclined, optical axis of reflected light is shifted from optical axis of observation solid angle.

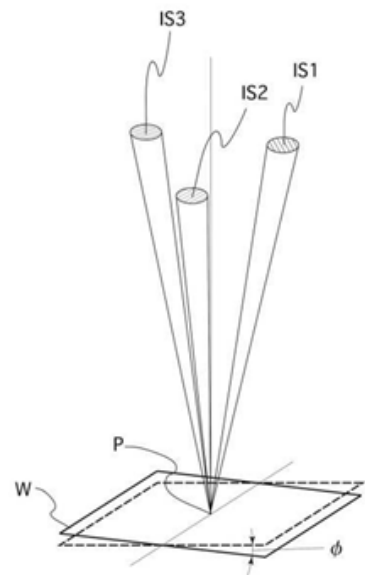
Fig. 6



(a) IS1 to IS3 are radially and continuously arranged.

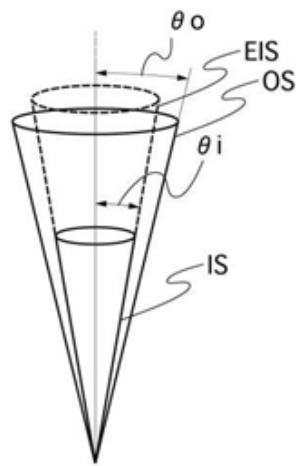
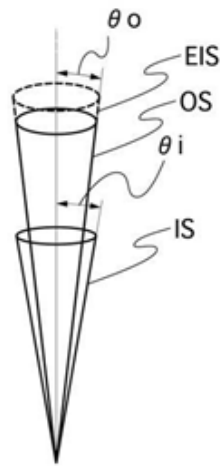


(b) IS1 to IS3 are radially and continuously arranged in peripheral portion of irradiation solid angle.



(c) IS1 to IS3 are radially and discretely arranged.

Fig. 7

(a) $\theta_i \leq \theta_o$ (b) $\theta_i > \theta_o$

Effective half plane angle: $\theta = \min(\theta_i, \theta_o)$

* If optical axes of irradiation solid angle and observation solid angle coincide with each other, or extend in directions of regular reflection, with regard to direct light returned from object, object light corresponding to effective irradiation solid angle EIS that varies within range of effective half plane angle θ that is smaller one of half plane angle θ_i of irradiation solid angle and half plane angle θ_o of observation solid angle can be sensed as contrast information thereof.

Fig. 8

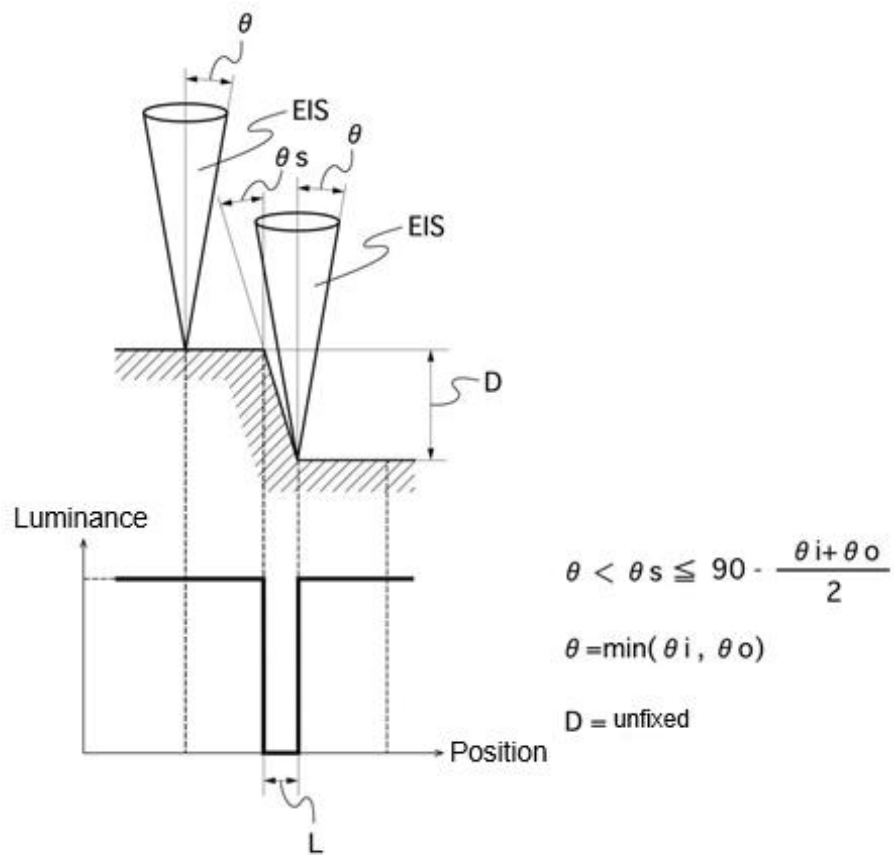
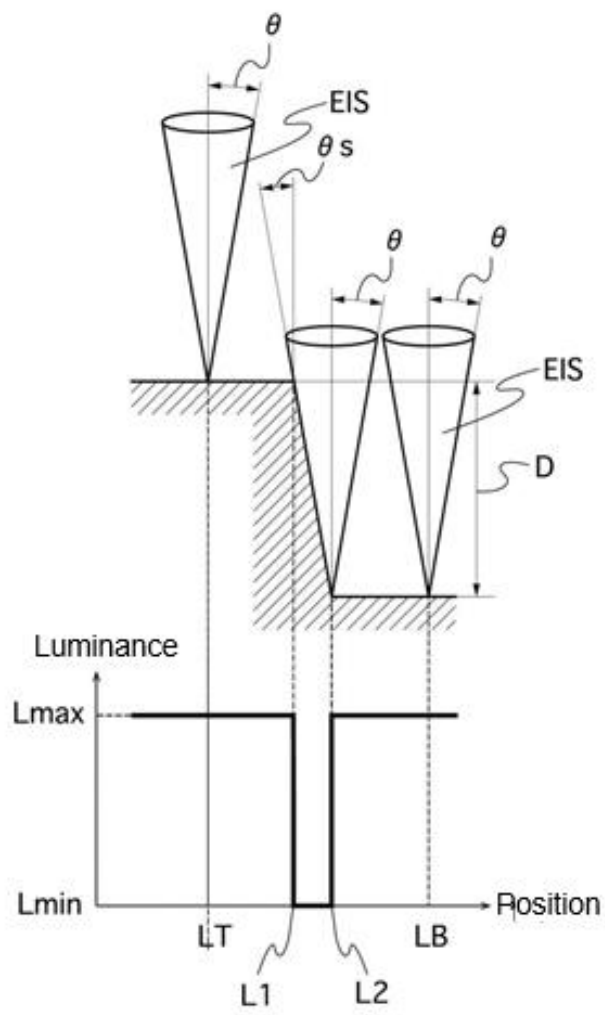


Fig. 9



$$\theta_s \leq \theta$$

$$\theta = \min(\theta_i, \theta_o)$$

$$D = \frac{L_2 - L_1}{\tan \theta}$$

Fig. 10

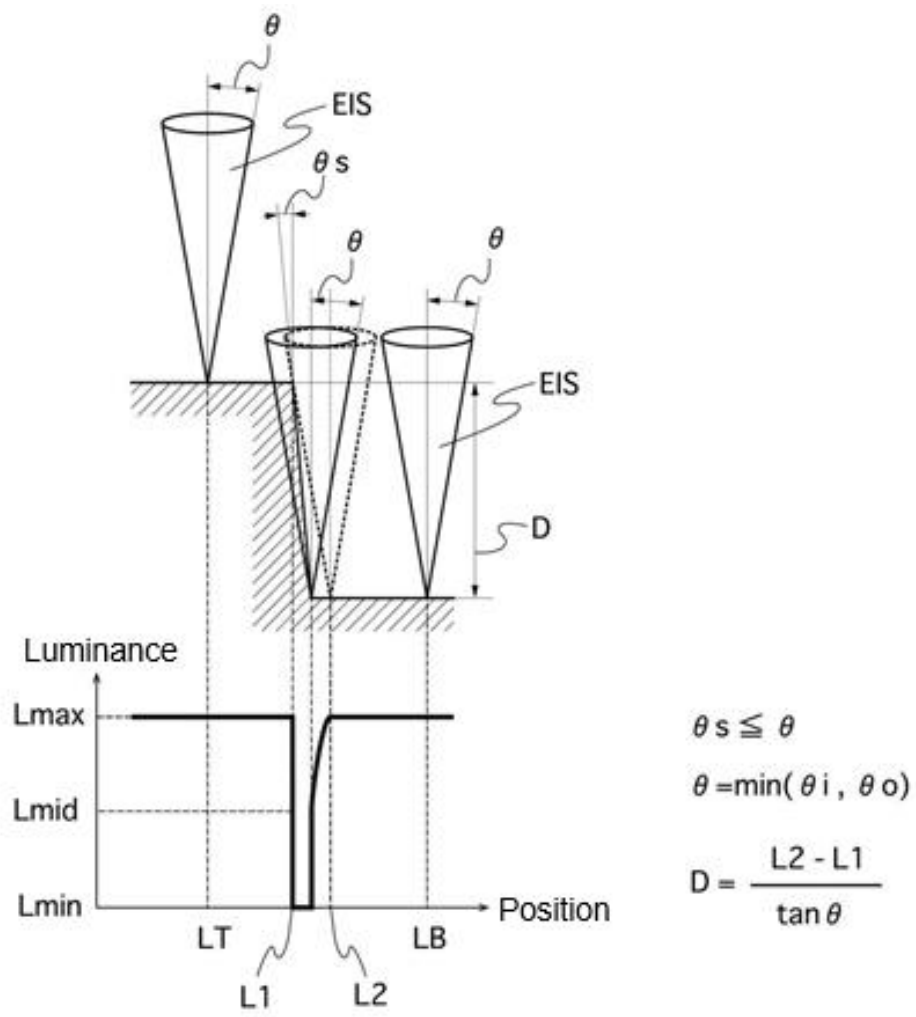


Fig. 11

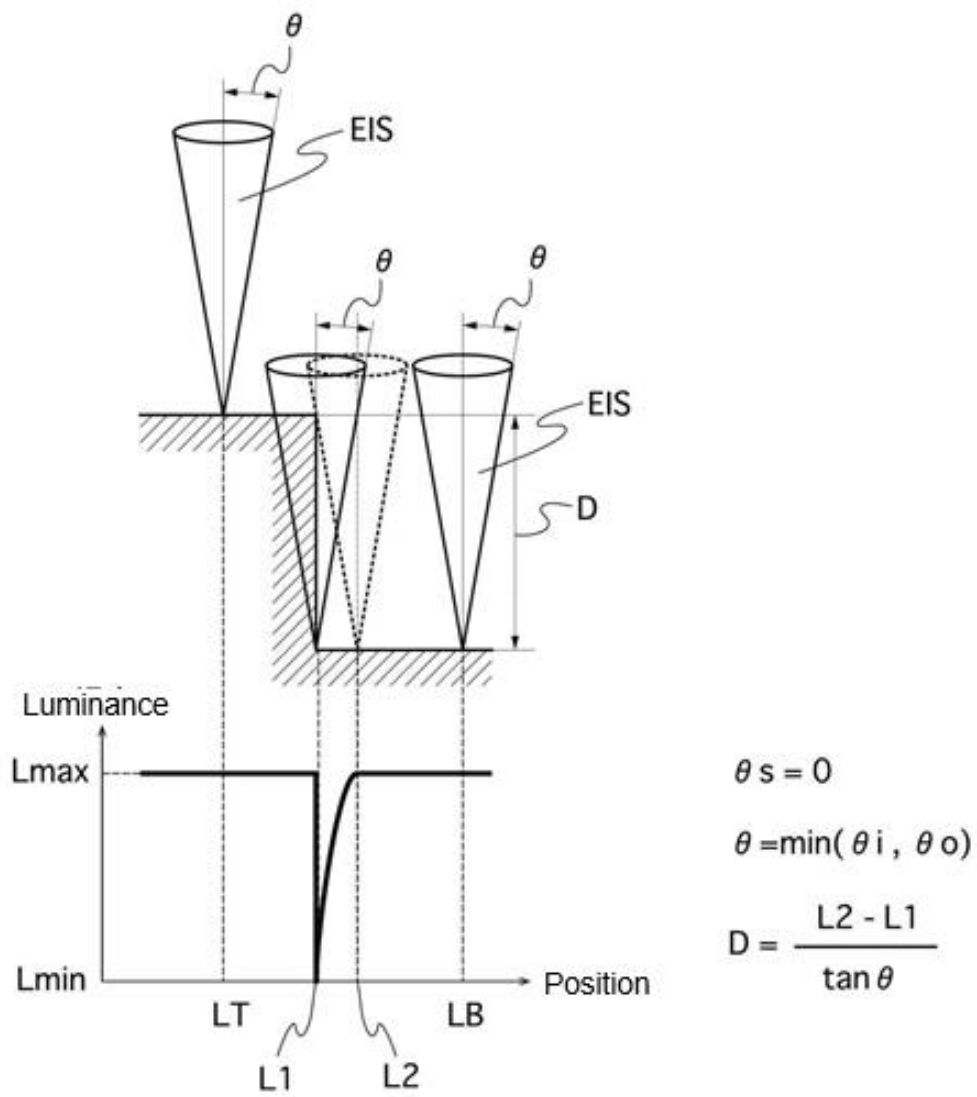


Fig. 12

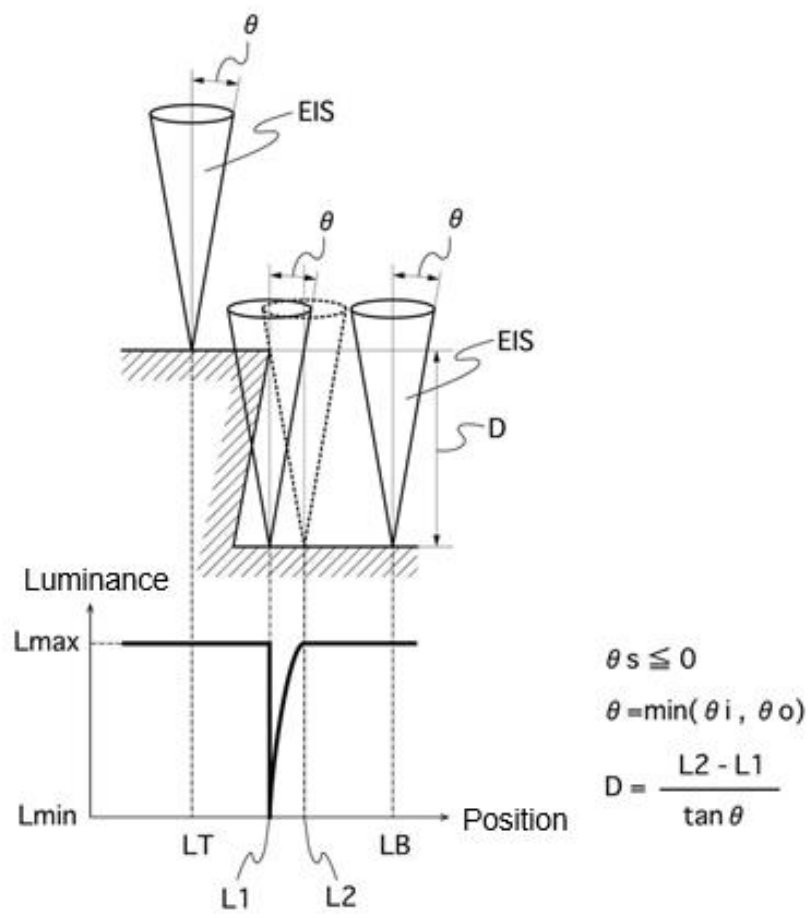
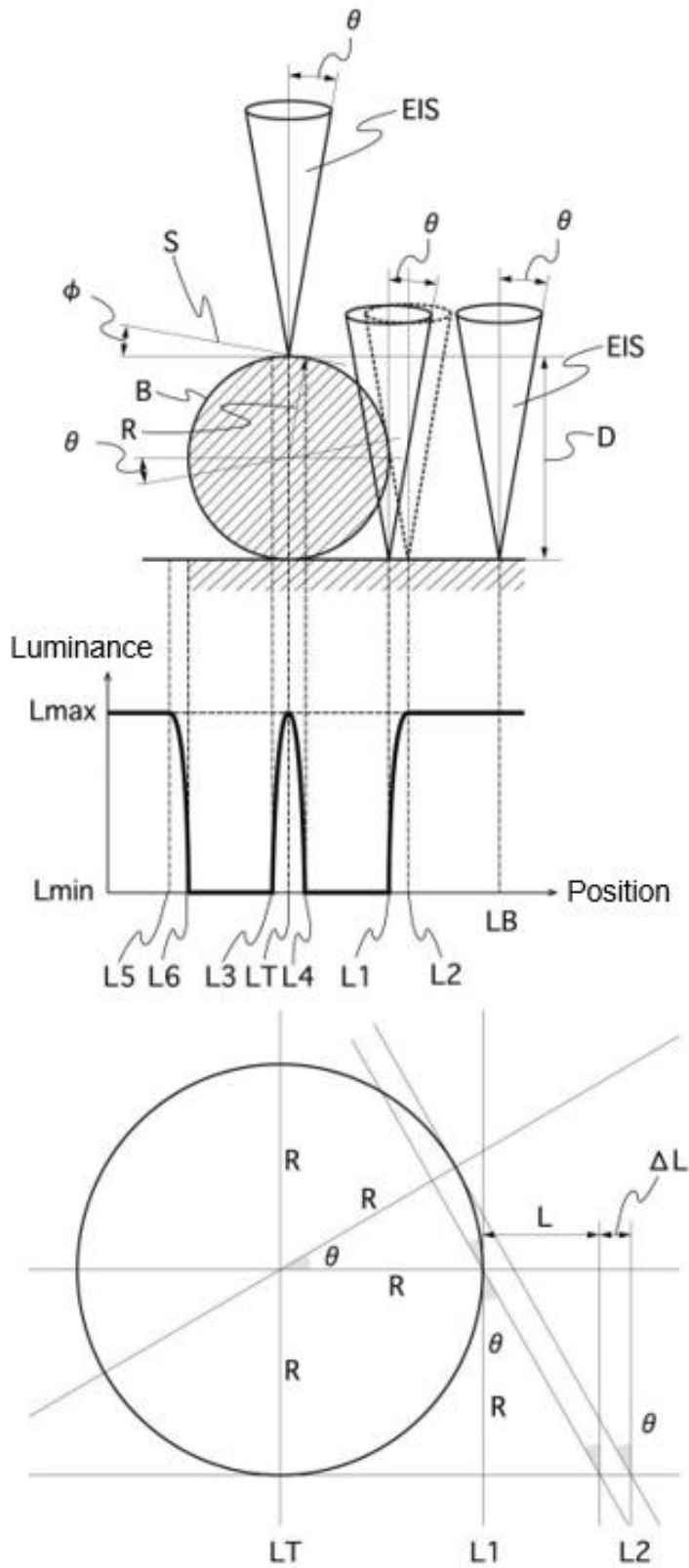


Fig. 13



$$\phi = \frac{\theta_i + \theta_o}{2}$$

$$\theta = \min(\theta_i, \theta_o)$$

$$r1 = L4 - LT = \frac{L4 - L3}{2}$$

$$r2 = L1 - LT = \frac{L1 - L6}{2}$$

$$R1 = \frac{r1}{\sin \phi}$$

$$R2 = r2$$

$$R3 = \frac{r3 \cos \theta}{\sin \theta - \cos \theta + 1}$$

$$R = R1 = R2 = R3$$

$$D = 2R$$

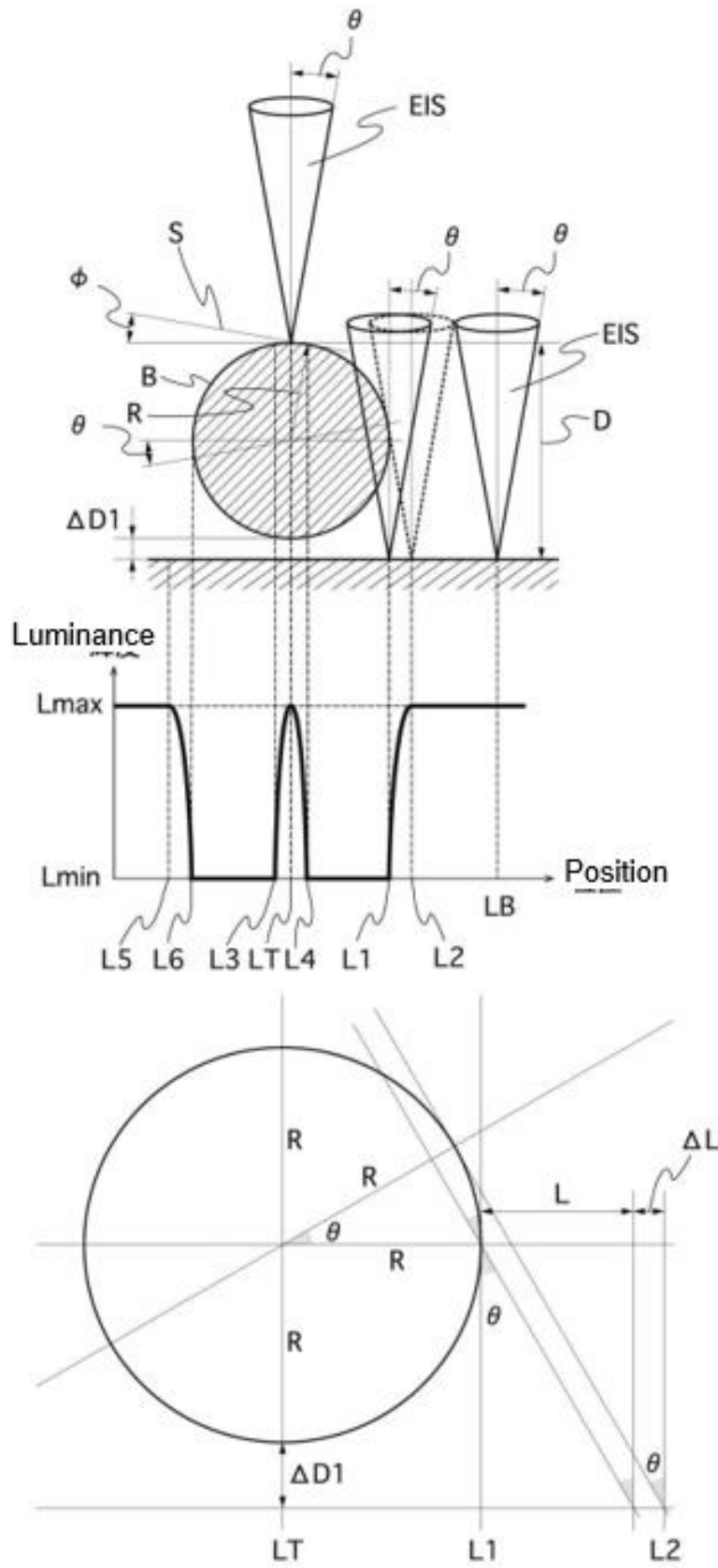
$$= R + \frac{r3 - \Delta L}{\tan \theta}$$

$$\begin{aligned} r3 &= L + \Delta L \\ &= L2 - L1 \\ &= L6 - L5 \end{aligned}$$

$$L = R \tan \theta$$

$$\Delta L = \frac{R(1 - \cos \theta)}{\cos \theta}$$

Fig. 14



$$\phi = \frac{\theta_i + \theta_o}{2}$$

$$\theta = \min(\theta_i, \theta_o)$$

$$r1 = L4 - LT = \frac{L4 - L3}{2}$$

$$r2 = L1 - LT = \frac{L1 - L6}{2}$$

$$R1 = \frac{r1}{\sin \phi}$$

$$R2 = r2$$

$$R3 = \frac{r3 \cos \theta}{\sin \theta - \cos \theta + 1}$$

$$R1 = R2, R3 > R1, R2$$

$$R = R1 = R2$$

$$D = 2R + \Delta D1$$

$$= R + \frac{L}{\tan \theta}$$

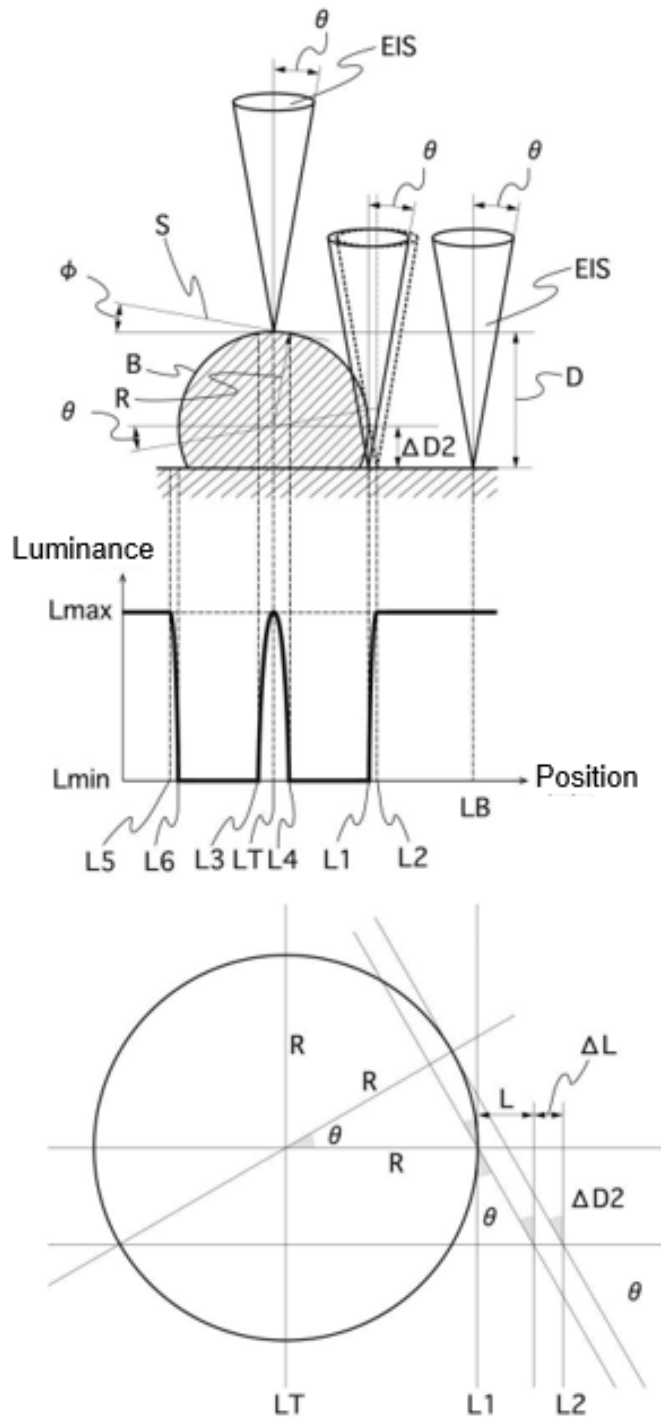
$$= R + \frac{r3 - \Delta L}{\tan \theta}$$

$$\begin{aligned} r3 &= L + \Delta L \\ &= L2 - L1 \\ &= L6 - L5 \end{aligned}$$

$$\Delta L = \frac{R(1 - \cos \theta)}{\cos \theta}$$

$$\tan \theta = \frac{L}{\Delta D1 + R}$$

Fig. 15



$$\phi = \frac{\theta_i + \theta_o}{2}$$

$$\theta = \min(\theta_i, \theta_o)$$

$$r_1 = L_4 - L_T = \frac{L_4 - L_3}{2}$$

$$r_2 = L_1 - L_T = \frac{L_1 - L_6}{2}$$

$$R_1 = \frac{r_1}{\sin \phi}$$

$$R_2 = r_2$$

$$R_3 = \frac{r_3 \cos \theta}{\sin \theta - \cos \theta + 1}$$

$$R_1 = R_2, \quad R_3 < R_1, R_2$$

$$R = R_1 = R_2$$

$$D = R + \Delta D_2$$

$$= R + \frac{r_3 - \Delta L}{\tan \theta}$$

$$r_3 = L + \Delta L$$

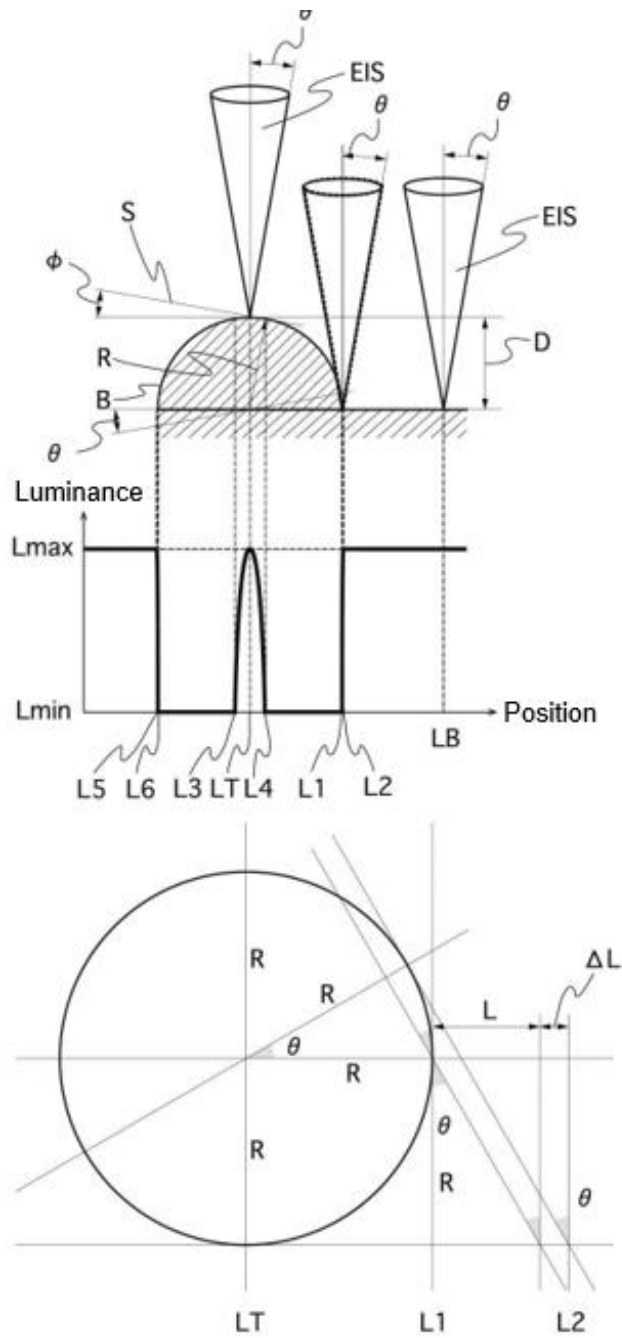
$$= L_2 - L_1$$

$$= L_6 - L_5$$

$$\Delta L = \frac{R(1 - \cos \theta)}{\cos \theta}$$

$$\Delta D_2 = \frac{r_3 - \Delta L}{\tan \theta}$$

Fig. 16



$$\phi = \frac{\theta_i + \theta_o}{2}$$

$$\theta = \min(\theta_i, \theta_o)$$

$$r1 = L4 - LT = \frac{L4 - L3}{2}$$

$$r2 = L1 - LT = \frac{L1 - L6}{2}$$

$$R1 = \frac{r1}{\sin \phi}$$

$$R2 = r2$$

$$R3 = \frac{r3 \cos \theta}{\sin \theta - \cos \theta + 1}$$

$$R1 = R2, \quad R3 \approx 0$$

$$R = R1 = R2$$

$$D = R$$

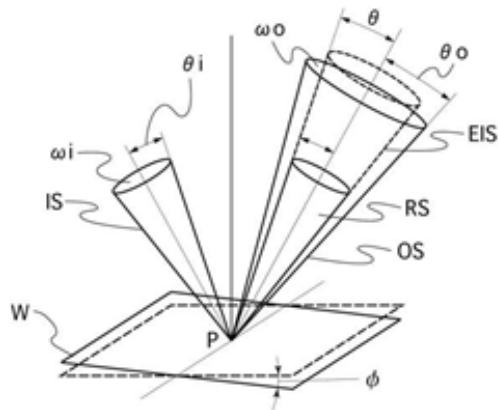
$$= R + \frac{r3 - \Delta L}{\tan \theta}$$

$$r3 = \Delta L$$

$$\Delta L = \frac{R(1 - \cos \theta)}{\cos \theta}$$

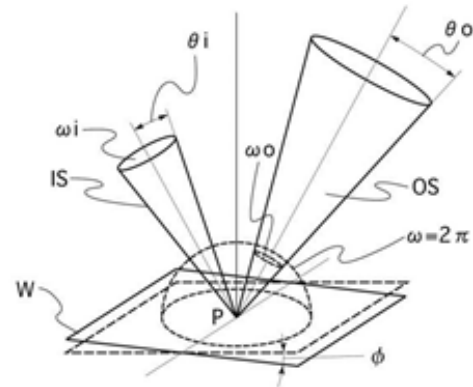
$$\tan \theta = \frac{L}{\Delta D1 + R}$$

Fig. 19



Effective half plane angle: $\theta = \min(\theta_i, \theta_o)$

(a) When object light is direct light

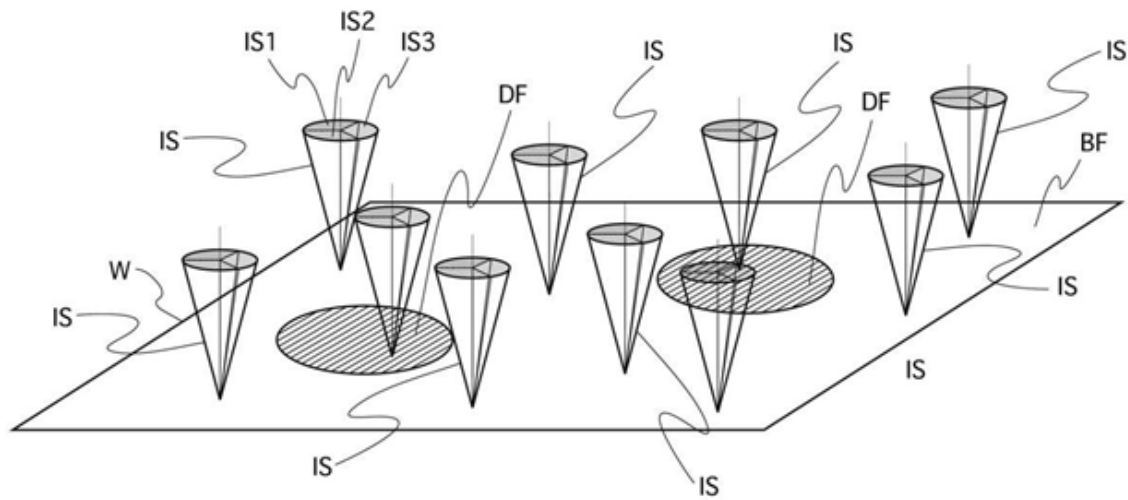


Solid angle of scattered light: $\omega = 2\pi$

(b) When object light is scattered light

* When object light is direct light, brightness of point P depends on inclusive relation between solid angle RS of direct light and observation solid angle OS assuming that reflectance is 1, and maximum brightness of point P depends on effective irradiation solid angle EIS that has effective half plane angle θ that is the smaller one of half plane angles of irradiation solid angle ω_i and observation solid angle ω_o , while when object light is scattered light, since light applied to point P with irradiation solid angle ω_i is converted to substantially homogeneous scattered light with solid angle of 2π , which is in turn detected using observation solid angle ω_o , brightness thereof is determined by value obtained by dividing product of ω_i and ω_o by 2π , and therefore, ratio between maximum brightness of scattered light detected using observation solid angle and maximum brightness of direct light detected using observation solid angle is a value that is obtained by dividing the larger one of irradiation solid angle ω_i and observation solid angle ω_o by 2π relative to 1.

Fig. 20



* If respective points in observation area on inspection surface W are irradiated with light having identical irradiation solid angles IS in each of which solid angle regions IS1, IS2, and IS3 with different optical attributes are radially arranged, observation area is divided into bright-field region BF that returns direct light and dark-field region DF that returns scattered light, by setting threshold for luminance value or by using polarization state of object light returned, and three-dimensional shape is inspected and measured based on variation in brightness for each of the different optical attributes at respective points in each of divided regions, and, in this manner, it is possible to perform continuous inspection and measurement of three-dimensional shape of inspection surface whose three-dimensional shape cannot be continuously inspected and measured by observing only direct light or only scattered light.