A DEVICE FOR MARKING OUT ARCS OF LONG RADIUS

by

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ABSTRACT

The paper describes a facile method evolved for marking out arcs of long radius.

Introduction

Difficulties have always been experienced in checking the templates of long radius of curvature. These templates serve while roughly carving out the radius of curvature of lens surfaces and for rough adjustment of the radius of curvature of the optical tool used for grinding and polishing the lenses. Although in the final stages the radii of curvature of lens surfaces are measured more precisely by optical methods, a rough estimate of the radius is always necessary to be made in the early stages of manufacture, by using the templates. The difficulty of measuring the radius of the template was overcome by using the shadowgraph and an accurately turned disc say of $\frac{1}{100}$ *th* the radius of the template. Apart from this a method has been worked out, based on the properties of a rolling cone, for marking out the arc.

The Meteorology Division of the National Physical Laboratory, Teddington has given a noval method of both marking and cutting of arcs of long radius([1]). The method described here is simpler and has been in use only for marking out the arc.

Details of the method

Let a cone of semi-apex angle α roll on a horizontal plane AB. (Fig. 1).

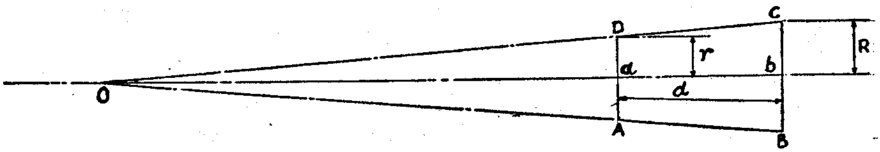

FIG. 1

Further let—

$$Aa = r$$
$$Bb = R$$
$$ab = d$$

Then, as the cone rolls on the horizontal plane AB, the section AD of the cone describes a circle of radius

$$OA = r \operatorname{cosec} \alpha = r\sqrt{1+\frac{d^2}{(R-r)^2}} = \frac{r}{R-r}\sqrt{d^2+(R-r)^2}$$

The section BC of the cone describes a circle of radius

$$OB = R \operatorname{cosec} \alpha = R\sqrt{1+\frac{d^2}{(R-r)^2}} = \frac{R}{R-r}\sqrt{d^2+(R-r)^2}$$

The rolling cone is formed by two co-axial discs or wheels of different diameters connected by a shaft provided with a style for marking out the arc. By a suitable choice of R, r and d, arc of any long radius can be traced out with reasonable accuracy. The shaft is urged to roll by a push in the mid-point of a b, the push being normal to the axis a b. If necessary mechanical drive may be incorporated in the device.

Error involved

We have

$$OA = \frac{\gamma d}{R-\gamma}\sqrt{1+\left(\frac{R-\gamma}{d}\right)^2} = \rho_i \quad \text{(say)}$$

$$\text{Then, } \frac{\delta \rho_i}{\rho_i} = \delta\gamma\left[\frac{1}{\gamma}+\frac{1}{R-\gamma}\left\{1+\left(\frac{R-\gamma}{d}\right)^2\right\}^{-1}\right]$$

$$+\delta R\left[-\frac{1}{R-\gamma}\left\{1+\left(\frac{R-\gamma}{d}\right)^2\right\}^{-1}\right]+\delta d\left[\frac{1}{d}\left\{1+\left(\frac{R-\gamma}{d}\right)^2\right\}^{-1}\right]$$

For maximum value of $\delta\rho_i$ we may take $\delta\gamma = -\delta R$ and write down

$$\frac{\delta \rho_i}{\rho_i} = \delta\gamma\left[\frac{1}{\gamma}+\frac{2}{R-\gamma}\left\{1+\left(\frac{R-\gamma}{d}\right)^2\right\}^{-1}\right]$$

$$+\delta d\left[\frac{1}{d}\left\{1+\left(\frac{R-\gamma}{d}\right)^2\right\}^{-1}\right] = \delta\gamma\left[\frac{R+\gamma}{\gamma(R-\gamma)}-\frac{2(R-\gamma)}{d^2}\right]+\frac{\delta d}{d}$$

neglecting terms involving powers, higher than the first of $(R-\gamma)$

For all practical purposes we may take $R+r=2r$ and get the percentage error as

$$\frac{2\,\delta r}{R-r}\times 100\,\%$$

Similarly the error in the radius OB may be calculated.

Reference

Notes on Gauge making and measuring—2nd edition, May 1946.