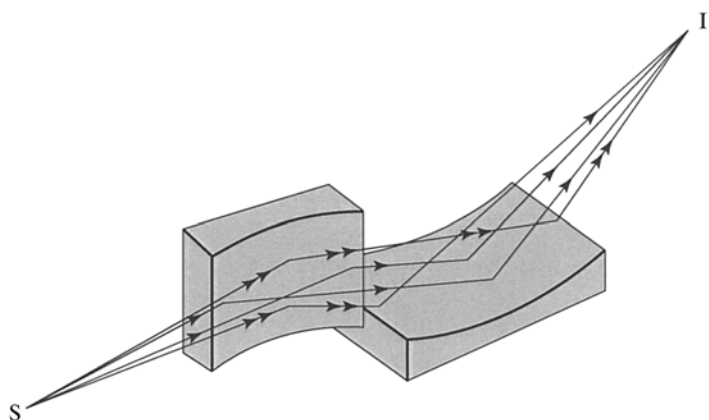6. RADIATION SOURCES AND OPTICS

Fig. 6.1.4.1. Production of a point focus by successive reflections at two orthogonal curved mirrors. Arrangement due to Kirkpatrick & Baez (1948) and to Franks (1955).

Fig. 6.1.4.2. The 'catamegonic' arrangement of Montel (1957), in which two confocal mirrors with orthogonal curvatures lie side-by-side.

Fig. 6.1.4.4. Triangular mirror bender as described by Lemonnier *et al.* (1978) for crystal plates and by Milch (1983) for glass mirrors. The base of the triangular plate is clamped and the bending force is applied at the apex along the arrow.

calls a 'catamegonic roof' (Fig. 6.1.4.2). The mirrors are then best made from thicker material, and the reflecting surfaces are ground to the appropriate curvature. The same arrangement has been used by Osmic Inc. (1998) for their Confocal Max-Flux Optics, in which the curved surfaces are coated with graded-spacing multilayers.

Flat mirror plates can be bent elastically to a desired curvature by applying appropriate couples. Fig. 6.1.4.3 shows the bending method adopted by Franks (1955). A cylindrical curvature results from a symmetrical arrangement that produces equal couples at both ends. With appropriate unequal couples applied at the two ends of the plate, the curvature can be made parabolic or elliptical. Precision elliptical mirrors have been produced by Padmore *et al.*

(1997); unequal couples are applied in this way. Cylindrically curved mirrors can be produced by applying a force at the tip of a triangular plate whose base is firmly anchored (Fig. 6.1.4.4). Lemonnier *et al.* (1978) first used this method for making curved-crystal monochromators. Milch (1983) described X-ray mirrors made in this way; the effect of the linear increase of the bending moment along the plate is compensated by the linear increase of the plate section so that the curvature is constant. An elliptical or a parabolic curvature results if either the width or the thickness of the plate is made to vary in an appropriate way along the length of the plate. Arndt, Long & Duncumb (1998) described a monolithic mirror-bending block in which the mirror plates are inserted into slots cut to an elliptical curvature by ion-beam machining. The solid angle of collection is made four times larger than for a two-mirror arrangement by providing a pair of horizontal mirrors and a pair of vertical mirrors in tandem in one block (Fig. 6.1.4.5).

Mirror plates for these benders are usually made from highly polished glass, quartz, or silicon plates which are coated with nickel, gold, or iridium.

Mirrors for synchrotron beam lines that focus the radiation in the vertical plane are most often ground and polished to the correct shape, rather than bent elastically. Much longer mirrors can be made in this way.

The collecting efficiency of specularly reflecting mirrors depends on the reflectivity of the surface and on the solid angle of collection; this, in turn, is a function of the maximum glancing angle of incidence, which is the critical angle for total external reflection, θ_c.
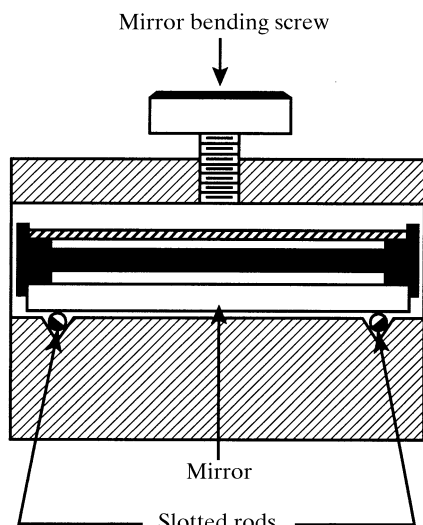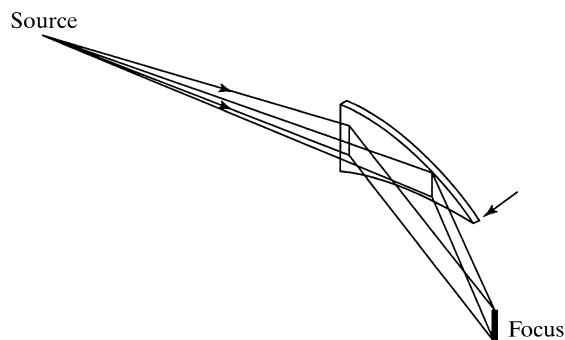

Fig. 6.1.4.3. Mirror bender (after Franks, 1955). The force exerted by the screw produces two equal couples which bend the mirror into a circular arc. The slotted rods act as pivots and also as beam-defining slits.
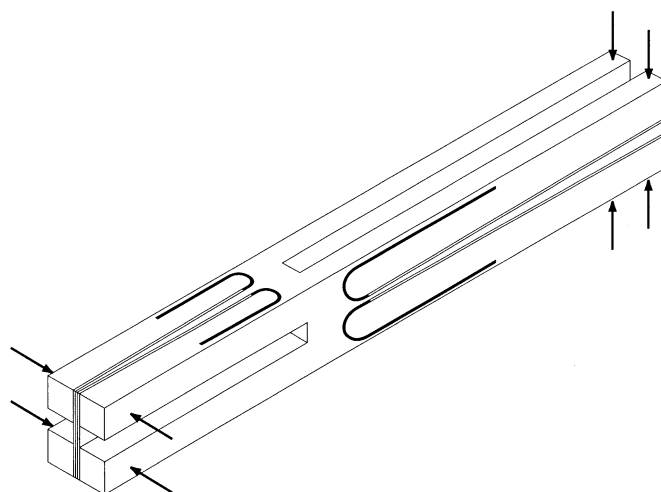

Fig. 6.1.4.5. Mirror holder with machined slots for two orthogonal pairs of curved mirrors (after Arndt, Duncumb *et al.*, 1998).

references