A Simple Method for Testing the Accuracy of a Parabolic Mirror.

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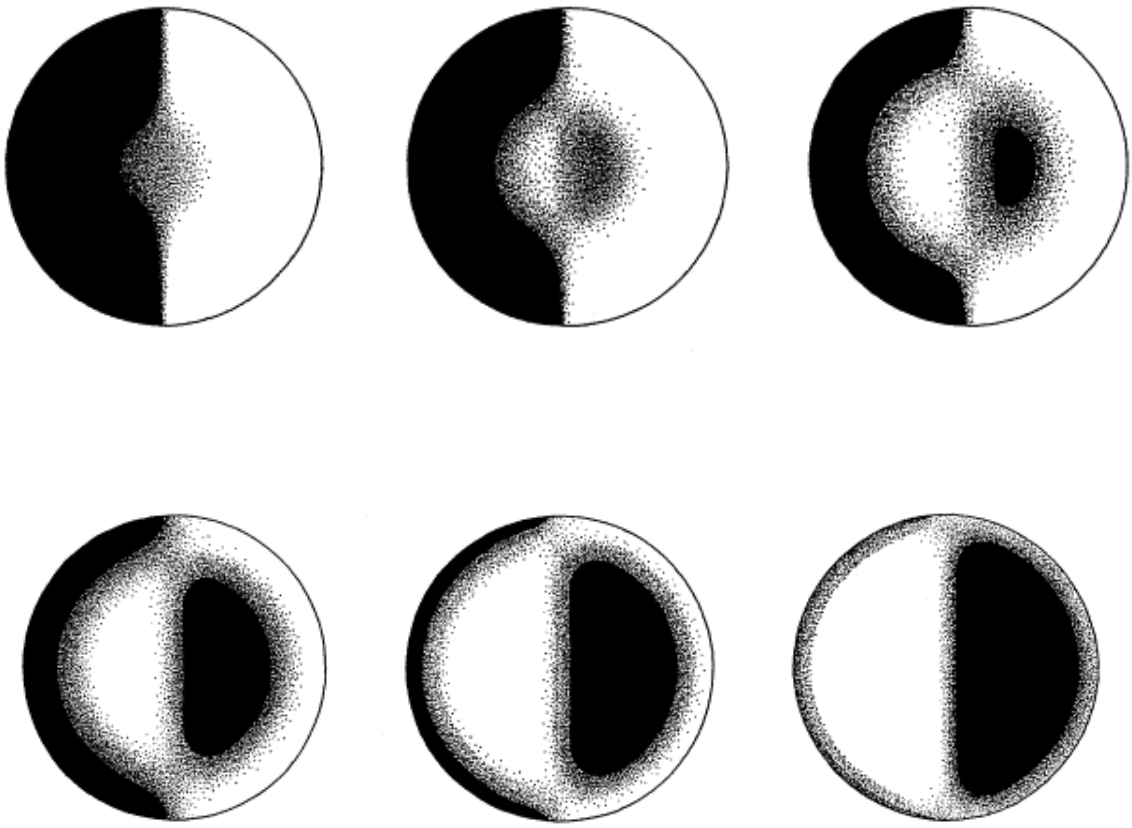
The method outlined here was first described by the Rev. William F A Ellison in his book The Amateur's Telescope. The test represents the simplest form of zonal testing and quantitative analysis of a mirrors surface.

The following sequence of images represents a perfect mirror as seen under the knife edge test at the radius of curvature. If the knife edge is introduced just inside the radius of curvature and slowly draw away from the mirror, a point will be reached when its appearance looks like the first image at top left below. Drawing the mirror slowly further away from the mirror will result in its appearance changing as represented in the images until the last image at bottom right.



The total distance travelled by the knife edge from the image at top left to the image at bottom right is given by the formula:

$$r^2/R$$

r= the radius of the mirror

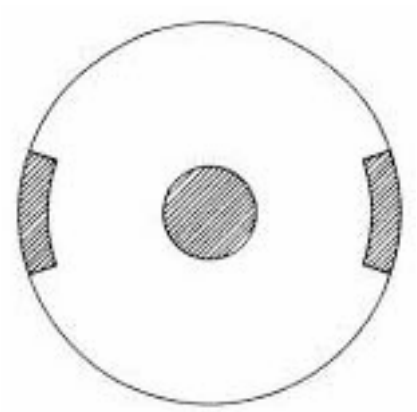
R= the radius of curvature of the mirror

Note that the figure given by this formula applies to a test set up with a fixed light source, if the light source is moving with the knife edge then this figure must be halved. Assuming that the mirror is smooth and free from zones, accurately measuring the distance moved by the knife edge from centre (top left image) to edge (bottom right image) will tell us how accurate the mirror's surface is. If the measured distance is less than the calculated value, the mirror is under corrected and needs more work. If the value measured exceeds the calculated value, the mirror is over corrected or hyperbolic.

For example, let's take a 355mm diameter mirror with a radius of curvature of 3195mm, the knife edge movement for a perfect mirror will be:

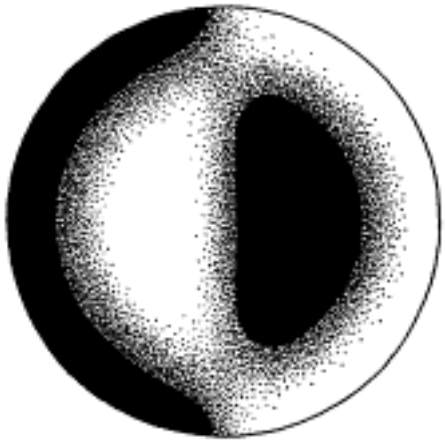
177.5 * 177.5 / 3195 = 9.86mm

The best way to make the measurements on a real mirror is to make a mask with two apertures, one to expose the outer zone and one the inner zone.



The width of the edge zone should be approximately 15-20 mm and the central hole should be somewhat larger than the required diagonal size. A moveable knife edge arrangement is needed together with some way of recording the distance travelled by the knife edge during testing. At its

simplest this could consist of a sliding knife edge sitting on some white card on which could be marked the position of the knife edge with a pencil. After locating the central and edge zones the distance between them can be measured using an accurate ruler. Needless to say all efforts should be made to measure this distance as accurately as possible, several readings could be made and an average arrived at. Whilst this simplest method is useable, more sophisticated arrangements employing micrometer scales are superior. Once an accurate figure is arrived at for the knife edge separation (between centre and edge zones) the knife edge should be placed at the 50% point of this value. The mirror should now be examined with the knife edge; the appearance of the mirror should be similar to the bottom left image shown at the top of these notes. The image seen is often described as a 'doughnut', with the knife edge at the 50% position the crest of the doughnut should be seen at 70% of the distance from the centre to the edge as show in the image below. This is indicative of a well figured mirror.



It should be noted that this test is based on the assumption that the paraboloid is smooth and free from zones, if this is not the case the mirror will not perform as well as expected. A ronchi ruling can be used to advantage here, nice smooth and regular ronchi bands indicate a smooth zone free mirror.

This simple two zone test may be build upon through the use of a multi-zone mask and appropriate software for reduction of the reading.

For more information on advanced testing see;

http://www.atmpage.org/contrib/Carlin/couder/

http://www.atm-workshop.com/foucault.html