I was at Fremont Peak State Park, near Salinas, California, on September 7-8, 1996. I did something I had been meaning to do for a while, but had kept forgetting: I brought along a set of Ramsden eyepieces, one each of inch, half-inch, and quarter-inch focal length.

The Ramsden is a quite old design; it was first described in a 1782 paper by its inventor, Jesse Ramsden. In simplest form, it comprises two identical plano-convex lenses, both made of any garden-variety crown glass (such as a good grade of window glass), separated by their focal length, with the convex sides facing each other. Such a simple device is inexpensive: I bought several Ramsdens new in the early 1980s, at prices of about ten dollars each. Recently I obtained some used ones at comparable cost. And when I was a kid, I even made a few, using cheap lenses from Edmund Scientific.

Ramsdens have several flaws, compared to modern designs. First, the apparent field of view is quite narrow; 35 degrees is typical. For many people, that's about two hand spans at arm's length -- no porthole to the heavens, this.

Second, in the classic design, the front lens ("field lens") of the eyepiece is at the focal plane of the back lens ("eye lens"); thus when you look through the eyepiece, any bits of dust on either surface of the field lens will be in reasonable focus, and will be very annoying. For this reason the Ramsden was never very popular for terrestrial viewing, with brightly-lit fields, but the problem is less noticeable when most of the background is dark sky. Variations of the design, in which the two lenses have different focal lengths and are separated by half the sum of their focal lengths, reduce this problem.

Third, Ramsdens do not work well at the fast f numbers that characterize an increasing number of modern telescopes. I once did comparison testing with my set on a variety of SCTs, long-focus Newtonians, and fast Dobsons, at a star party, and confirmed this assertion. Much below about f/7, forget it!

On the other hand, the design has some often-unappreciated virtues, even beyond low cost. There are only four air/glass interfaces, and many of the Ramsdens on the market a generation ago were made from military-surplus lenses, which often had very high standards for quality of polish. Thus scattered light is often very low, even compared to the best of modern eyepieces. If such a Ramsden is coated (I have never seen or heard of one being multicoated) and its interior is well-blackened, the view is then remarkably glare-free.

Furthermore, Ramsdens have superb color correction, often much better than newer designs which use several glass types and achromatic lenses. Just how one gets superb color correction out of two identical hunks of window glass, I will leave as an exercise for the reader*, whose successful solution will demonstrate that there is a good deal more to optical design than picking wild glass types out of a manufacturer's catalog. Jesse Ramsden was a smart man.

Anyhow, the proof of the pudding is in the eating, and what prompted this report was one particular test. One local observer was at the Peak with his six-inch f/9 Astro-Physics refractor. He had expressed curiosity about my Ramsden set in the past, so I asked if he would like to try one out. Seeing was okay -- diffraction rings continuously visible and occasionally steady, good enough that later in the evening we successfully elongated gamma-two Andromeda in this instrument, at 560x. So we pointed the six-inch at Saturn. The owner was using his Takahashi 7.5 mm eyepiece (186x). I don't know for sure what design the Takahashi uses, but it was certainly a nice view -- the Cassini division and the crepe ring were visible, as were two broad, shaded bands in the north and south temperate zones of the planet's disc.

Then I put in my quarter-inch Ramsden (6.35 mm, 220x). I was gratified to hear the owner of the six-inch make the unsolicited comment that the view through the Ramsden was excellent. I myself thought so -- to me, the planet appeared at least as sharp and perhaps a tad more glare-free with the Ramsden than with the Takahashi eyepiece, but the owner knows his own equipment better than I do, and is more into planetary work than I am. (He has a lot of first-rate equipment that he uses regularly, including several refractors of the same quality as the six-inch, and a box full of eyepieces comparable to the Takahashi.)

Thus we ended up concluding that at least at f/9 and slower, a ten-dollar eyepiece made to a design two centuries old is a first-rate ocular for work that does not require a wide field of view, such as observation of planets or double stars. It is a sad testimonial to the stupidity of telescope marketeers and the gullibility of us, their customers, that such eyepieces have all but vanished from catalogs. If they were still available, and properly appreciated, the market for entry-level telescopes would surely be larger, and the supply of new customers greater, for beginners on a budget would no longer believe that they had to spend more on a collection of whizzy eyepieces than on their telescope itself. They would no doubt learn about the legitimate virtues of fancy, expensive equipment later.

* (answer to the "exercise for the reader", above):

The problem with color correction which Ramsden eyepieces address so well, so simply, is chromatic difference of magnification, also known as lateral color or lateral chromatic aberration. The issue is, that if the focal length of an eyepiece is different in different wavelengths of light, then the magnification it produces will similarly vary with wavelength. What one sees will be a superposition of images of different colors, which have different sizes! Thus, anywhere away from the optical axis, colored fringes will be present wherever there is an abrupt change in brightness or color, because the "different images" don't line up exactly.

Many binoculars have lateral color. Point one at something like a dark-colored telephone pole in silhouette against either the white wall of a building or a cloudy sky. Sweep the binocular so that the pole is at the edge of the field, then look for color at its edges, red on one side and blue on the other.

Simple lenses have focal lengths that vary with wavelength, and in crown glass, the difference is something like 1.5 percent between blue and red. Thus if you use a simple lens as a telescope eyepiece, the magnification will vary by 1.5 percent between blue and red, and you will see colored fringes to things whose widths are something like 1.5 percent of the distance the object is away from the center of the field of view. If we take the resolving power of the eye to be three arc minutes (your mileage may vary), then in order for the fringes not to be noticeable, we must restrict the apparent field of view to a radius of 200 arc minutes, so that the whole field may not exceed 6.6 degrees in apparent diameter. That is about the width of three fingers at arm's length -- tunnel vision indeed.

Now consider an eyepiece made with two lenses, whose focal lengths are F1 and F2, separated by distance D. From simple lens theory, the focal length of the combination is (F1 * F2)/(F1 + F2 - D). And now we can see how a Ramsden eyepiece works. For definiteness, suppose that F1 and F2 are both exactly 10 mm in red light, and that D is also exactly 10 mm. The combination will have a focal length of (10 * 10)/(10 + 10 - 10) mm, or 10.0000 mm, in red light, so that if we use it on a telescope of one meter focal length, the red-light magnification will be 100.000. Now if the lenses are "typical" crown glass, each will have a focal length of 9.85 mm in blue light, so that the eyepiece focal length in blue will be (9.85 * 9.85)/(9.85 + 9.85 - 10) mm, or (97.0225)/(9.7) mm, or 10.0023 mm, and the magnification with our one-meter focal-length telescope will be 99.977; and similarly for other wavelengths.

Do you see what has happened? Because of the way the formula for the combination of two lenses works, a focal-length difference of a percent and a half between red and blue for each lens separately has become a difference of only 2.3 HUNDREDTHS of a percent for the combination, and for its lateral color. Our eyepiece will not have its usable apparent field limited by fringes -- some other aberration (and there are plenty) will have to do the job...

If you play with the formulae algebraically, you find that for lateral color to be corrected through first order, D must be half the sum of F1 and F2, a condition that is also met by several common variants of the Huygenian eyepiece design. Common variants on the Ramsden have F1 somewhat different from F2, but with D still equal to half their sum, which gets the field lens out of sharp focus but preserves the excellent correction of lateral color.

Much less desirable variants use F1 equal to F2 but reduce D, which gets the field lens out of sharp focus but at the expense of increased lateral color. For example, reducing D to 0.8 of F1 (which still equals F2) brings the lateral color back to about half a percent in the sample eyepiece described, which is noticeable at an apparent field of about twenty degrees. (It also changes the focal length of the eyepiece, of course.)