a 3-inch refractor

Here is a fine portable and easily stored telescope that can be built for half of its commercial cost.

Completed reiractor la displayed here by Optical Expert Jack Wegener, who conitructed it ior photographer.

WHILE there are certain predominant qualities of both of the basic telescope types—reflector and refractor—that give one an advantage over the other in each of several special kinds of work, it remains an obvious fact that for the person who has limited storage space, who travels frequently or who cannot give as much time as he would like to astronomical observations, the refractor is *the* telescope.

It is much more portable and requires less care. Enclosed in a sealed metal tube, the refractor practically eliminates for its owner those irksome problems inspired by dust and moisture. This does not mean, of course, that its owner can be careless about the outer surfaces of lenses. A disadvantage of the refractor is that—size-for-size, comparatively—it is much more expensive than a reflector.

The refractor described on these pages normally sells for $125 and higher—depending on the quality of the objective lenses. Its useful objective diameter of almost three inches brings within its range the polar "ice" caps of Mars, the bands and spots of Jupiter as well as that planet's moons, the rings of Saturn and at least five of her nine moons, Uranus and Neptune and a big variety of nebulae—as well as that old standby: the craters and mountains of the Moon. •

3-inch color corrected, air-spaced achromats, mounted in cell	$42.95
3-inch o.d. aluminum tubing, 48 inches long	6.00
Refractor rack and pinion eyepiece mount	12.95
Finder	8.00
Miscellany (cardboard, black paper, screws, bolts, etc.)	.25
	$70.15

These prices are quoted by Edmund Scientific Co. Barrington, N. J. No eyepiece is included. Recommended are 28 mm focal length Kellner, $7.95. Alternate recommendations are the 1/2-inch Ramsden at $4.50; and 1/4-inch Ramsden at $4.75

All photos in this chapter are by Ed Pryor, with cooperation of Edmund Scientific Company

Below are basic parts of scope. Moving from left, clockwise, they are refractor rack-and-pinion eyepiece mount, hardware, paper lens-stops, black construction-paper, cardboard tubes for stops, aluminum tubing, black felt paper, eyepiece, finder and mount, 1 of 2 achromatic lenses and lens cell.

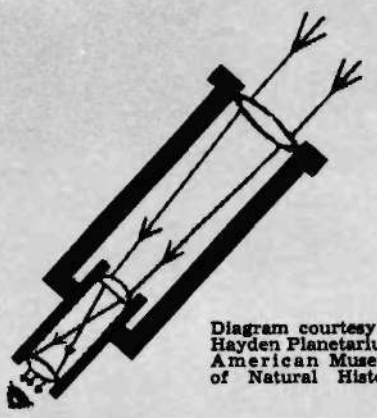
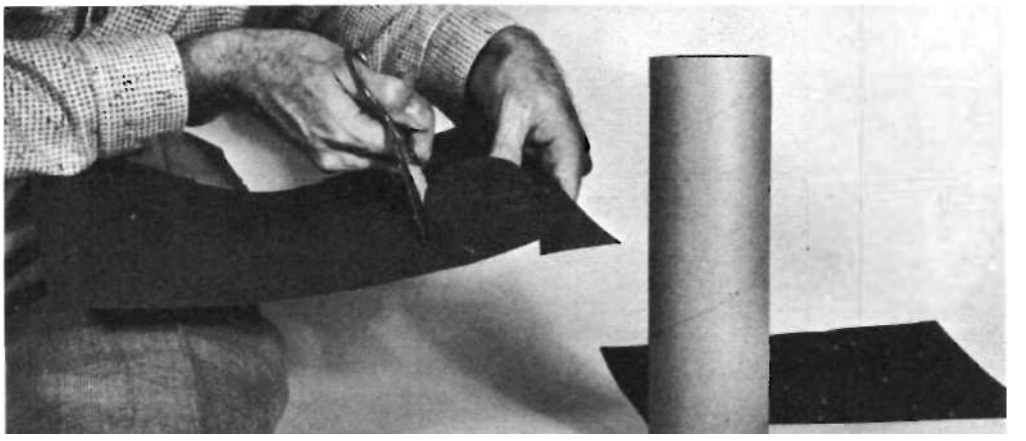


Diagram courtesy of Hayden Planetarium, American Museum of Natural History

Diagram shows in simplified way how light is refracted through objective lenses: it comes in scattered, is then bent straight.

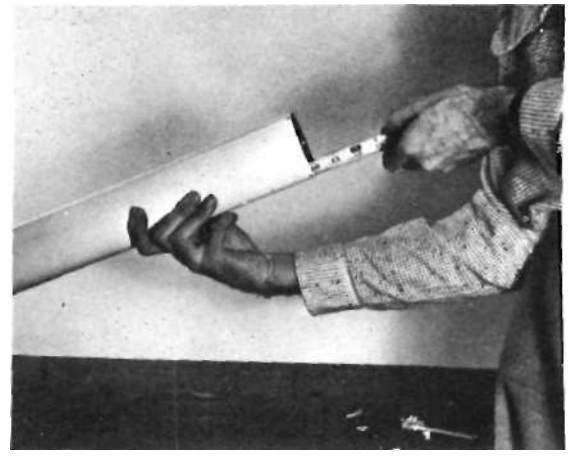
Lens-stops are of extreme importance in refractor, are cut from black paper after tracing size with compass.



Lens-stops *are* cemented onto ends of cardboard tube, but first tube Is deadened inside with black felt paper, which also Is cemented and smoothed.

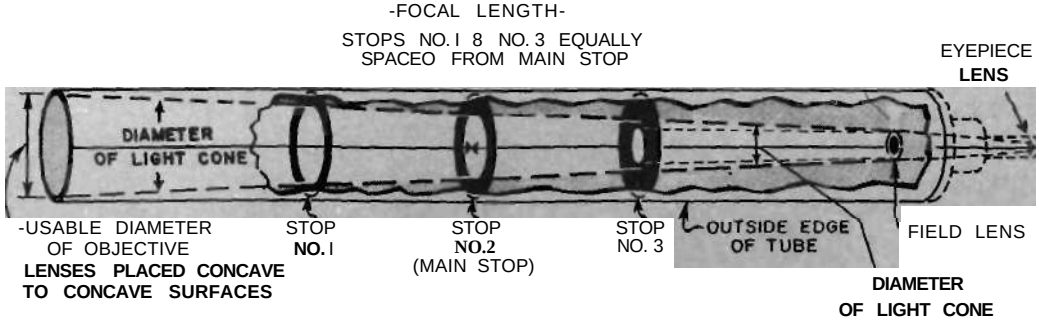
Here, stop Is being set In place. Stops are used at both ends of first tube, one or both end* of a second (study diagram across bottom of this page).

First lens-stop tube is slid into metal tube of telescope: cardboard tubes must be Just the right diameter to fit snugly, can be bought for few cents.

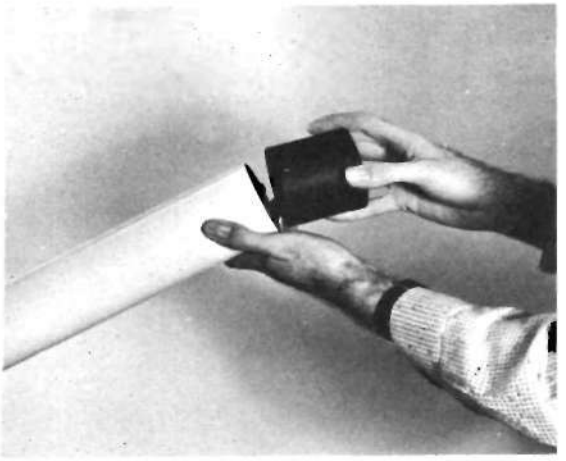


Measure distance to approximate center of inner stop-tube with long rule: hold scope-tube toward light, then peer inside and mark point on outside.

Diagram here shows position of stops and way cone of light Is focused by lenses. Stops are required so that light is not dissipated away from cone and doesn't scatter before entering eyepiece, thus dimming the image. Most important stop is No. 2 at scope-tube middle: hole-diameter must be 2 in. Stop in front of it (No. 1) is 2V« in. diameter and stop No. 3 is 1% in. diameter. Cut these stop-holes carefully with a razor.



Hole is drilled at marked point in aluminum tube, right through cardboard tube. Notch a strip of wood (or bend heavy wire into loop) to hold machine-screw, which is then guided from inside tube and inserted in hole. Nut is then tightened from outside. Whole process is repeated with the second cardboard stop-tube.

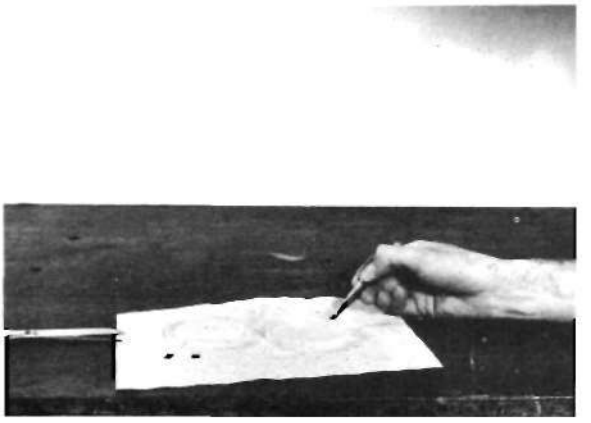


Long screws (1½ in.) should be used on previous steps, since screws will also serve to mount the telescope on tripod-head. But now attach lens-cell.

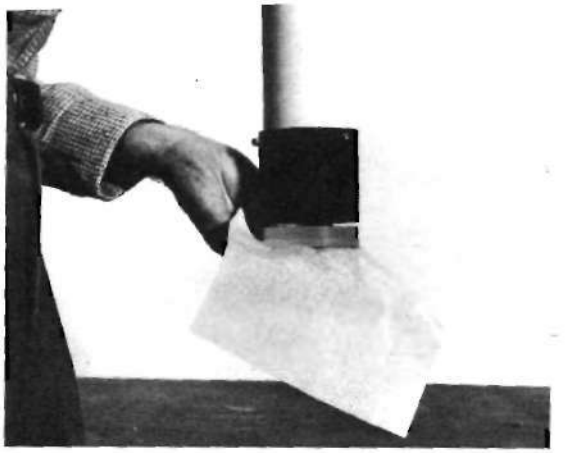
Holes are first drilled in lens-cell casing and aluminum scope-tube, then casing is made tight at front end of scope, using a wrench as shown above.

Now comes a tricky part of operation. Objective lenses must face concave-surface to convex. Slide one gently over other: right way creates suction.

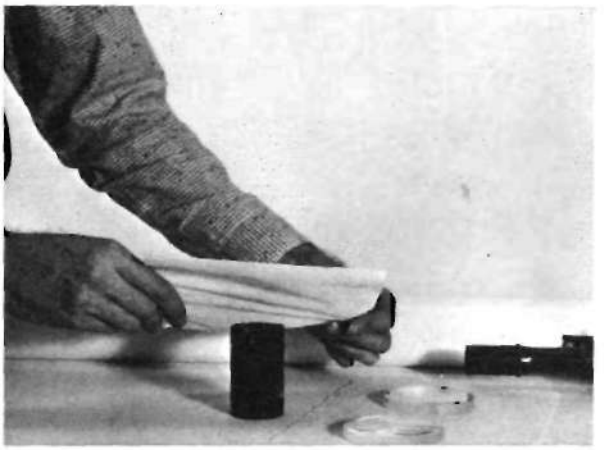
Edges of lenses are often marked with arrows: these should point toward each other. Next, 3 small squares of black paper are spaced around lens.



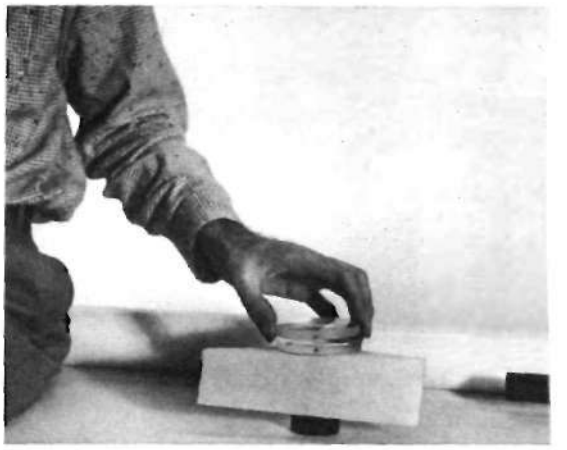
Separators provide air pocket between lenses. Place second lens carefully over one with separators. Both lenses should be resting on heavy tissue.



Lenses are then very carefully scooped up by sliding hand under tissue cloth. With other hand, lower cell casing evenly and gently over lenses.

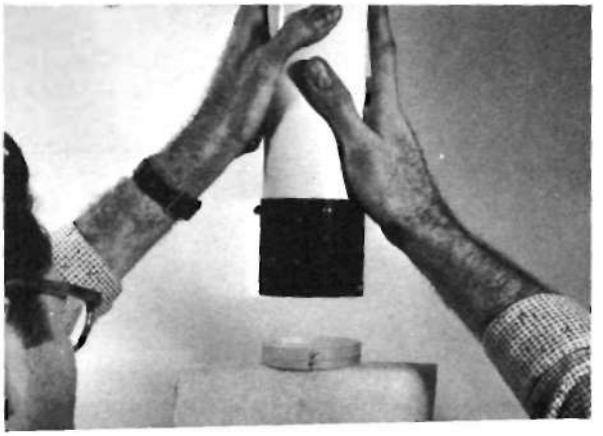


Another way to get lenses into cell is like this: using tin can or any sturdy cylinder as base, cover the cylinder with clean handkerchief, tissue.

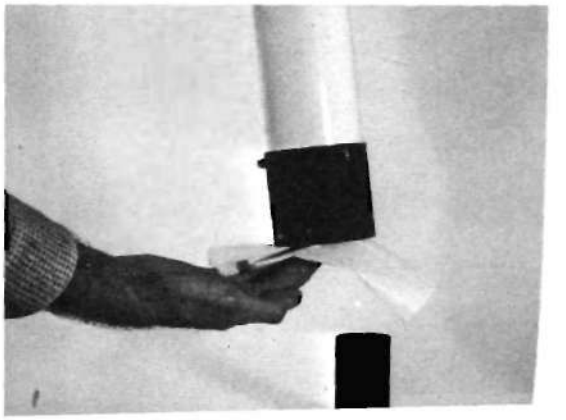


Place lens with separators in place on tissue or handkerchief. Then place other lens on top. Be sure that "flint" lens is on top. It is thickest.

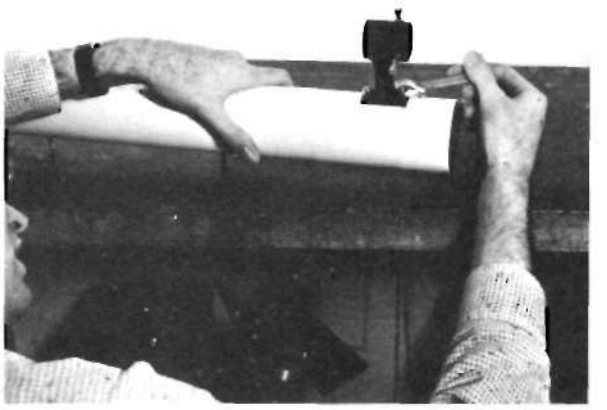
Then steadying telescope-tube with both hands, lower it carefully over both lenses, as shown here. If cell is not straight, it will cause lenses to jam.



After casing of lens-cell is over lenses, slide fingers beneath cylinder and lift tissue, pressing lenses up into cell part way. Turn tube over slowly.



Now that objective lenses have been settled into place gingerly, the lock-ring of casing is screwed in place. No tools are used: finger-tightness only.



Before going on, a word of caution: NEVER DROP lenses into the casing. Follow photo instructions here. Next, fasten finder-mounting on scope-tube.

Rack-and-pinion eyepiece mounting comes next: it is inserted in rear end of tube, anchored in place by machine-screws through already drilled holes.

Eyepiece of small finder-scope is unscrewed so that finder-tube may be inserted through its mounting bracket, fastened to the aluminum telescope-tube.

Finder-tube is anchored in place by half-tightening wing-screws of bracket. Eyepiece is screwed back into its former position, as shown in the photograph.

Final adjustment of wing-screws to center finder-scope tightly, completes the job. All that's left: select main-scope eyepiece and search the heavens.