



# USNO 26" Clark Refractor from Visual Observations to Speckle Interferometry



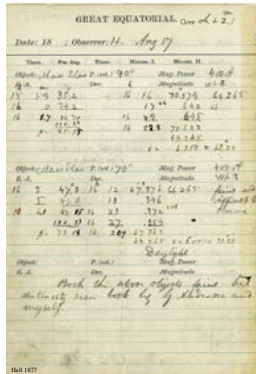
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## GREAT EQUATORIAL c1875



Original & Co. 1875

## MARS' MOONS NOTEBOOK



Hold 1877

## ORIGINS

- Aug. 1870 Alvan Clark & Sons contract for 2 identical 26" refractors; UVa telescope delayed due to McCormick financial problems
- Dec. 1871 Chance & Company (Birmingham, England) supply achromatic doublet blanks
- Oct. 1872 Alvan Clark & Sons complete testing, grinding, and polishing lenses
- Oct/Nov. 1873 Alvan Clark & Sons mount at original site in Foggy Bottom

## INITIAL CONFIGURATION

- World's largest lens by Alvan Clark mounted in 3-section tube; superseded by 27" Grubb refractor at Imperial Observatory of Vienna in 1880
- Harp-shaped equatorial mount by Alvan Clark & Sons
- Clock drive by Alvan Clark & Sons from design by Newcomb
- 2 finders: 2 1/2" by Kahler (visible at left) and 5" by Clark (not shown)
- 2 microscopes mounted on tube for reading declination to 12 arcsec (opera glasses suffice to 0.5")
- 2 microscopes reachable via south ladder for reading hour angle to 1 sec
- Other accessories supplied by Alvan Clark & Sons (not shown):
  - 4 eye pieces for telescope
  - 3 micrometers
  - 1 spectroscope with 3 eye pieces
  - 1 chronograph

## RELOCATION TO GEORGETOWN HEIGHTS

- 1893 US Naval Observatory relocated to present location on Georgetown Heights
- Clearer skies, healthier working conditions
- 1894 Congress defines protective Observatory Circle with radius of 1,000 feet centered on clock house; acquiring the land requires decades

## REFURBISHMENT

- 26" Clark lens mounted in 14-section Warner & Swasey tube
- Equatorial mount by Warner & Swasey
- Elevating floor by Warner & Swasey
- Clock drive driven by weights, sidereal/mean solar/mean lunar rate
- Initial error with period of 4 min, amplitude of 1 arcsec
- Original Kahler and Clark finders preserved
- 2 original microscopes for reading declination to 10 arcsecs remounted
- 2 new microscopes for reading hour angle to 1 sec mounted on slide to move with floor
- Other accessories:
  - 4 Clark eye pieces return
  - 2 Clark micrometers return
  - 1 Warner & Swasey micrometer added
  - 1 modified Clark chronograph returns in 1897

## GREAT EQUATORIAL 1911



USNO 1911

## Origins

Before addressing queries about how and what to preserve among astronomical devices, the question of what constitutes a historic instrument must be considered. Certainly, the lenses are the defining feature of a Clark refractor. Since 1867, when Newcomb inquired about the possibility of obtaining a great glass from Alvan Clark & Sons, the U.S. Naval Observatory 26-in (66-cm) equatorial has evolved in response to improvements in technology and changes in its observing program. After two major overhauls, only the objective remains of the original equipment installed by the Clarks in 1873 at the old Observatory site in Foggy Bottom. However, the telescope retains its reputation as a historic Clark refractor.

The USNO telescope was briefly renowned as the largest refractor in the world; the second of five such achievements by the Clarks. Through it, Hall first detected the moons of Mars in 1877. However, by that time, the Clarks had already refigured the flint glass. Hall and Gardiner had also altered the drive mechanism.



26-inch (0.66-m) CLARK REFRACTOR

Parameter	Value
Objective Clear Aperture	0.66 m
Optics	achromatic refractor
Focal Ratio	f/14.99
Effective Focal Length	9.897 ± 0.001 m
Focal Plane Scale	389.66 ± 0.05 in
	20.8510 arcsec mm <sup>-1</sup>

REFERENCE: Holden 1881, Josties et al. 1974

## Evolution

When the USNO moved to its present Georgetown Heights location in 1893, the great equatorial was refurbished with its original Clark optics installed on a more robust Warner & Swasey mount. Peters incorporated discarded parts from the original mounting into his photographic telescopes during the first half of the 20th century. The 26" refractor underwent further modernization in the early 1960s to facilitate the xy-slide of a Hertzprung-style, photographic, double star camera. In 1965, the objective was disassembled for cleaning and reassembled with new spacers. The most recent maintenance included re-wiring and replacing several motors and the hand paddles.

Originally designed as a visual instrument, the USNO telescope now hosts a speckle interferometer for nightly observations of double stars, weather permitting. Despite continuing modifications, the refractor remains a fine example of the optician's art.

## HALL MODIFICATIONS

- May 1876 Alvan Clark & Sons refigure flint lens
- "After having been in use two years the figure of the lenses seemed to have undergone a slight change ..." (Hall 1881)
- Jul. 1876 Gardiner, USNO instrument shop, modifies clock drive
- Aug. 1877 Hall discovers moons of Mars
- Jan. 1879 Gardiner replaces setting circles to reduce positional errors

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## FOR MORE INFORMATION

- Contact authors at [jennifer.bartlett@usno.navy.mil](mailto:jennifer.bartlett@usno.navy.mil)
- Visit Double Star Astronomy at the U.S. Naval Observatory webpage at [http://ad.usno.navy.mil/wds/ds\\_history\\_text.html](http://ad.usno.navy.mil/wds/ds_history_text.html)
- Visit Gillis Library historical images collection on-line at <http://www.usno.navy.mil/USNO/library/historical/historical-images-search>

## GREAT EQUATORIAL c1990



Initial Speckle Interferometry Team: (left to right) R. Hindsley, G. Douglass, C. Worley, and R. Harrington

The 26" Clark refractor at the US Naval Observatory continues to be used for research. Of the instrument installed by Alvan Clark in 1873, only the objective remains; even it has been slightly modified.

## GREAT EQUATORIAL c1961



## MORE MODERNIZATION

- 1958 Mikesall updates telescope
- Warner & Swasey pier platform and access stairs removed to increase range of motion
- little-used microscopes for reading setting circles discarded
- Warner & Swasey clock drive replaced with reliable electric motor
- mechanical controls and shafts replaced with cables and control circuits
- Warner & Swasey tailpiece replaced with draw tube capable of accommodating Clark micrometer and other instruments
- Aperture-reducing diaphragm and grating-mounting disk added
- 1958 Photographic Double Star Program begins, continues to 1973
- 1965 lens cleaning
- Clark tin foil separating lens replaced with aluminum spacers
- Teflon pads added to the front retaining ring
- Silicon grease added to tighten seal
- 1973 Photographic Planetary Satellite Astrometry Program begins
- Observations continue to 1999, analysis continues today
- 1990 Double Star Program transitions
- Micrometry, begun in 1873, ends
- Speckle interferometry program begins, continues tonight (weather permitting)
- 2004 Rafferty updates telescope controls
- Out-of-date electronics removed from inside tube and each end
- Right ascension clamp replaced by USNO instrument shop
- Control console rebuilt