Smithsonian

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Once Upon a Bear
A Century of Teddies

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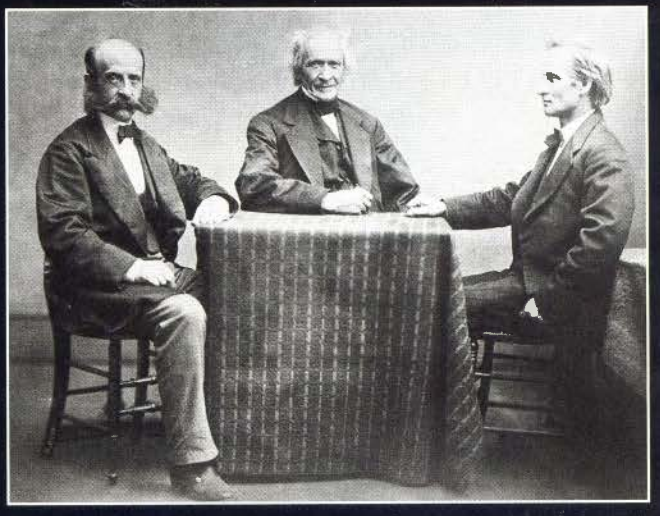
STARS IN THEIR EYES

THE EXQUISITE TELESCOPES CRAFTED BY ALVAN CLARK AND HIS SONS HELPED MAKE THE LAST HALF OF THE 19TH CENTURY A GOLDEN AGE OF ASTRONOMY ◆ BY MICHAEL TENNESEN

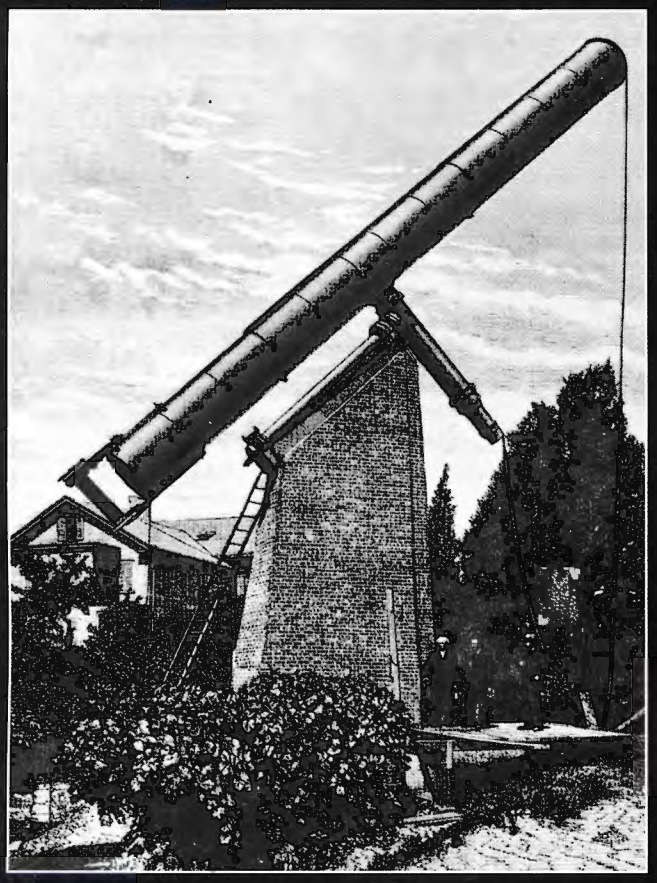
ASTRONOMER KYLE CUDWORTH ENTERS THE great dome of the Yerkes Observatory in Williams Bay, Wisconsin, an hour after sunset. A storm blew through these rolling hills last night and another is on its way. Cudworth wants to use this brief window of clear skies to take a look through the great 40-inch Clark refracting telescope.

The dome looks like a cathedral. In the middle of the cavernous room, balanced on a giant metal pier, is the telescope. It is 63 feet long with a light-gathering power about 30,000 times that of the unaided eye. The telescope looks regal, as well it should, this aged but elegant former king of astronomy.

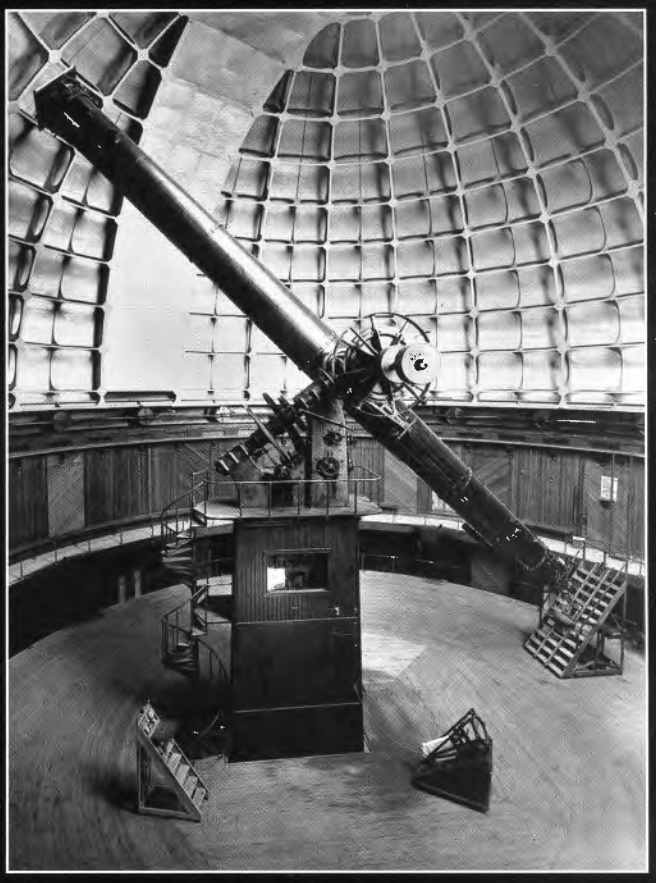
Cudworth runs around the dome, unlocking



The Clark factory in Cambridge, Massachusetts (opposite, top left), boasted a tall telescope tube and mount that Alvan Clark (above, center, with sons Alvan Graham, left, and George Bassett, c. 1880) used to test the lenses he made. It was Alvan Graham, with his father at his side, who discovered the faint companion to Sirius, the brightest star in the sky.

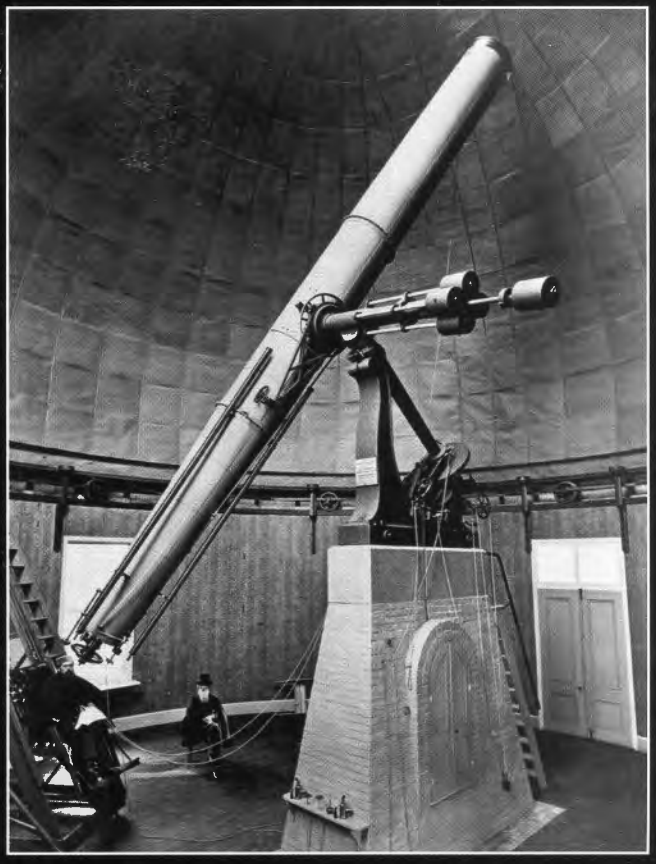


Clark Factory, Cambridge, Massachusetts (in 1883)

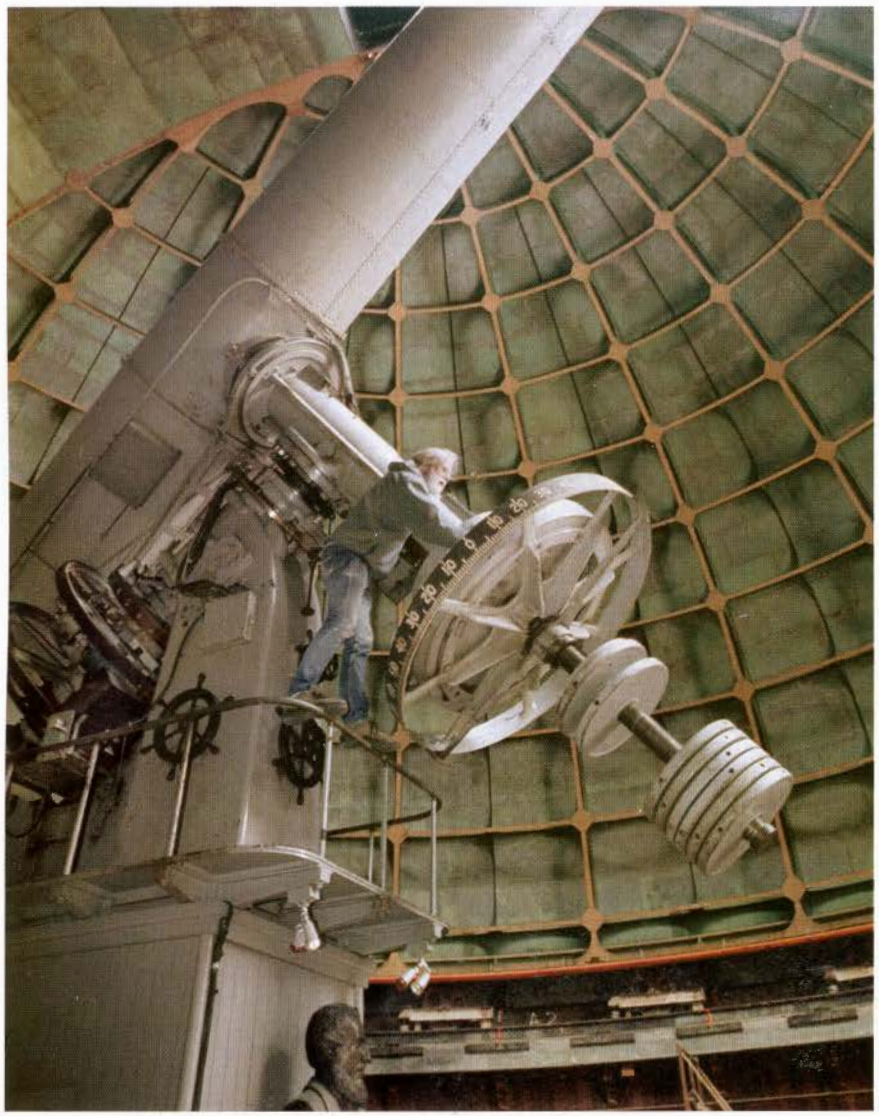


Lick Observatory, Mount Hamilton, California (installed 1887)

Yerkes Observatory, Williams Bay, Wisconsin (installed 1897)



U.S. Naval Observatory, Washington, D.C. (installed 1873)



The 36-inch refracting telescope at Lick Observatory—getting a polish from astronomer Remington Stone—had its Clark-crafted lenses refigured in 1987, after a century of use.

doors on all sides so the temperature inside will match that outside. Unless he does so, heat waves, escaping the room, could distort the viewing. The room temperature quickly drops to 15 degrees Fahrenheit. Modern astronomers have warm control rooms; earlier astronomers had wool.

The telescope and the moving parts of the mount weigh 20 tons. Yet the telescope is balanced so well that Cudworth has no trouble moving it by hand. He turns some dials attached to the mount, then steps back and says, "Take a look."

I walk across a floor where Albert Einstein and Edwin Hubble once walked. Through the eyepiece I see M15, a globular star cluster that orbits our galaxy. The weather sends waves of turbulence in front of the lens, but in brief spaces of stillness, I see the stars bunched together.

I am looking through the end of an era in astronomy: the largest of the great refracting telescopes. From 1610, when Galileo first observed Jupiter and four of its moons through a telescope, until after this one was completed in 1897, refractors were thought to be best for astronomical research. They pass light through a set of lenses to focus it, and look like what we think of as the classic telescope. Reflector telescopes—the kind more often used today—are shaped more like barrels and use mirrors to focus light.

Though the refractor has been eclipsed for research use, not so the reputation of the largest lens makers, Alvan Clark & Sons of Cambridge, Massachusetts. For the last half of the 19th century, their instruments dominated astronomy. Five times the Clarks made the lenses for the largest refracting telescopes in the world, often breaking their own records. Through the lenses of the Yerkes instrument, in 1951, astronomers discovered the spiral arms of our own galaxy.

Astronomers looking through Clark telescopes also discovered the moons of Mars (U.S. Naval Observatory, 1877) and the fifth moon of Jupiter (Lick Observatory, 1892), and found that other galaxies are moving away from us, the first evidence of an expanding universe (Lowell Observatory, 1912).

The Clark family was uniquely suited to its craft. Alvan Clark's sense of touch was so precise that he could feel a lens and find imperfections not visible to the naked eye. For its final polish he used his bare thumbs. Only then, he felt, might he detect the finest particles of grit.

Astronomers appreciated his dedication and that of his firm. In 1892 astronomer George Ellery Hale persuaded Chicago railroad and streetcar financier Charles T. Yerkes to build an observatory that would bear his name and to commission the Clark 40-inch refractor. Meanwhile, Hale went out and rounded up some of the best astronomers of the day, with the promise of that telescope as bait.

Today more than 100 years old, it is still used for research. Cudworth takes out one of the original glass photographic plates of M15, the globular star cluster we've just been viewing. The date of the photograph is 1916. He lays a recent negative over the plate, and we see how various stars have moved in the past 85 years. He says that having a photographic record taken through the same telescope is invaluable. "The comparison gives us a couple of things,"

LAURIE HATCH; P. 78 SCIENTIFIC AMERICAN, VOL. 48 (1883); MARY LEA SHANE ARCHIVES/LICK OBSERVATORY; UNDERWOOD & UNDERWOOD/CORBIS; CORBIS; P. 79 MARY LEA SHANE ARCHIVES/LICK OBSERVATORY

The Clarks made more than 400 smaller telescopes. Collectors such as engineer John Briggs (with an 1884 six-inch) consider them the most elegant.

says Cudworth. "It shows us which stars are actually a part of the cluster and which are not. And it shows us the movement of the stars within the cluster."

ALVAN CLARK WAS BORN IN 1804 IN ASHFIELD, MASSAchusetts. As a young man, he worked as an engraver, producing patterns on the cylinders used to print textiles. In 1836 he gave up engraving and turned his attention to painting portraits and miniatures. He was known for exquisite detail. He moved his wife, two sons and two daughters to Cambridge and opened a studio in Boston. His reputation as a painter was substantial, and he has several pieces in major collections, including the Smithsonian's.

The Clarks' first telescope was built in 1844 when eldest son, George, brought home a broken dinner bell from his prep school, Phillips Academy in Andover, and melted the metal down to make a mirror for a reflecting telescope. George's father joined in and soon had a new hobby.

Clark Sr.'s obsession with telescopes grew, and two years later he abandoned reflectors and started making lenses for refractors. His eye was remarkable. When he visited Harvard to look through their 15-inch telescope, he noted imperfections in the lenses. Learning that the lenses had cost the school $12,000, Clark decided to get into the business. He felt he could do better.

His two sons would end up helping immeasurably. George Bassett, a retiring sort, was drawn to mechanical work and managing the business; the younger son, Alvan Graham, was an optician and, also like his father, a born salesman.

In those days American telescope makers were taking a backseat to Europeans. But the elder Clark struck up a friendship with English astronomer William Dawes, whose interest was double stars. (Scientists currently believe that about two-thirds of all stars have a companion.) In letters to Dawes, Clark told him about various double stars that the Englishman couldn't distinguish with his telescope. Soon Dawes was ordering Clark's telescopes and introducing him to European astronomers. Americans began knocking on his door as well.

Astronomy was then an important part of the popular culture. In the second half of the 19th century, rich industrialists were endowing college campuses with observatories bearing their names. Harvard, West Point, Princeton, Cornell and Columbia all purchased Clark telescopes. "America was proud of this upstart American firm, which, with no background or training, made the largest and best telescopes in the world," says Deborah Jean Warner, curator at the National Museum of American History and coauthor of *Alvan Clark and Sons, Artists in Optics*.

The first of the firm's big telescopes was an 18½-inch, the largest refractor ever made until that time, now at Dearborn Observatory at Northwestern University, Chicago. After completing that telescope in 1864, the Clarks continued setting records for large lenses. In 1873 they made the 26-inch refractor for the U.S. Naval Observatory in Washington, D.C. They bested that in 1883 with 30-inch lenses for the Imperial Russian Observatory at Pulkowa, and in 1887 with 36-inch lenses for the Lick Observatory at Mount Hamilton, California. In 1897 they completed the 40-inch lenses for the Yerkes Observatory.

Though the larger telescopes captured most of the attention, the company's smaller telescopes were its bread and butter, made for clients ranging from schools to wealthy hobbyists and astronomy clubs.

At his home in southern New Mexico, John W. Briggs, president of the Antique Telescope Society and an astronomical engineer at the National Solar Observatory nearby, shows off a five-inch Clark refractor from his private collection. The telescope was built for the much-anticipated

DOUGLAS MERRIAM

transit of Venus of 1874, when that planet moved across the face of the Sun. Briggs beams as he points out the fine detail in this instrument. The telescope and much of its mount are made of shiny brass. The movement of the scope is flawlessly fluid. Tiny fractions of a degree are finely engraved in silver on the setting circles, which, like a mariner's sextant, allow astronomers to point a telescope at celestial objects with great precision.

It was only in 1860, with the order for their first large refractor, that Alvan Clark finally gave up his portrait studio and started making telescopes full-time. He and his sons bought an acre and a half near the Charles River in Cambridge, and built homes for their families, an observatory and a modest two-story brick workshop.

The Clarks' assistant, Carl Lundin (right, with Alvan Graham in the 1890s) would keep the shop going for 30 more years after the Clarks had all died.

Rough grinding, on a horizontal turntable powered by steam, was accomplished with emery or cast-iron sand. Then the Clarks polished a lens with rouge embedded in pitch. After the polish, they went searching for tiny imperfections in the lens, which they marked with red powder, then painstakingly corrected with cloth or thumb.

Alvan and Alvan Graham were the principal opticians for the factory, and George Bassett, the principal machinist. When around 1880, George's health began to decline, the Clarks started to pass the construction of the mounts and tubes for large lenses to others. The dome, mount and tube for the 36-inch lenses at Lick Observatory, which overlooks San Francisco Bay, were contracted to Warner & Swasey of Cleveland, Ohio.

For three days after the 36-inch telescope was first installed on December 31, 1887, Northern California was hit by one of the worst storms in decades. But on the fourth night, the sky cleared. Though ice had frozen the dome in its tracks, the astronomers decided to see what they could see. But when the star Aldebaran appeared, they found to their horror that the telescope wouldn't focus. The eyepiece holder was too long. They had to saw six inches off the tube to see the star clearly.

When I visit the Lick Observatory at Mount Hamilton, a fog forms around the hill as dusk approaches. After about an hour, a clear sky emerges. Remington Stone, director of Mount Hamilton operations, says he can't open the dome's shutters for the Clark telescope when the humidity is high, as it is now. "It could damage the glass."

After an hour, Stone and I go outside and climb the stairs to the dome to check its surface. It's dry. Stone looks at the advancing clouds. "If we are going to do it, we'd better do it quick," he says.

We go back inside. Stone moves the scope by hand before motors turn the dome and open its shutter door. At first, all we see is a cloudy sky, but after a moment the cloud cover breaks. Stone uses the finder to look in on Saturn. "Quick," he says, "before the clouds reappear."

The light is dazzling, almost like staring right into a flashlight. My eye adjusts to the brilliance, and I study the gaps in the rings. I see detail I have never seen before. Next we look at Jupiter. I see a multitude of patterns in the swirling clouds on the surface. We stare, speechless, for about 20 minutes before the clouds roll in again.

ALVAN CLARK DIED IN 1887 AT THE AGE OF 83, GEORGE four years later at age 64. Alvan Graham followed in 1897 at age 65, just a few months after the installation of the 40-inch at the Yerkes Observatory.

In Cambridge, one can find a few scattered plaques about Alvan Clark and his sons. But the real monuments to their craftsmanship are the telescopes they made, many of which are still used more than 100 years later.

It had been a rarefied world. In 1916 George C. Blakslee was interviewed for the job of staff photographer at Yerkes, where the Clark 40-inch was still the primary research telescope. "This job, I see, must be accurate to a hair's breadth," said Blakslee. "No sir, no sir," said the interviewer. And then after a long pause for his contradiction to soak in, he leaned forward, tapped Blakslee on the shoulder, and added, "To a half a hair's breadth."

Writer and amateur astronomer Michael Tennesen says his late father, a machinist, taught him to appreciate fine craftsmanship.

YERKES OBSERVATORY, WISCONSIN