

# **12-Inch Alvan Clark Telescope Restoration:**

## **Summary of Research and Final Recommendations**

**Deborah Culmer and Hannah Johnson**  
**September, 2011**

### **Introduction**

The first telescope installed at Lick Observatory was a second-hand purchase, with the telescope and its optic made by the premier telescope makers of the time, Alvan Clark and Sons of Cambridge, MA. The dome that housed it was the first structure built on Mt. Hamilton, from bricks fired in a kiln on location. That dome still stands; and until the 1970's, the 12-inch refracting telescope was in operation, but without its original driver clock and gears (replaced with an electronic drive, perhaps in the 1950's).

Since it was decommissioned, the 12-inch has been in storage. The Lick Instrument Lab has retrieved it, and it is currently on location at UC Santa Cruz in anticipation of total restoration. In the summer of 2011, a research project was launched to determine to what era and condition the telescope should be restored.

In recent years, there has been great interest in historical restoration of Alvan Clark telescopes (and others, to be sure). As a result of that interest, we had a pool of organizations and institutions from which to glean information. Two we visited in person; many more we contacted via email and conference calls. Based on our research and interviews, we offer our recommendations on the restoration of this historically important telescope.

### **1. Research**

In beginning this project, it was very important to understand the history of the 12-inch Alvan Clark, especially since it was the first telescope set up on Mt. Hamilton. Reading books surrounding the history of the Lick Observatory, such as Eye on the Sky and James Lick's Monument, helped us understand the history behind the telescope and the importance of preserving the history. At this point we did not even know where all the parts were: we had a POD storage unit which contained most of the big parts, but other than that, it was quite a mystery. Hannah Johnson started looking into historical archive holdings for information about the clock drive, since no one could remember having seen it in the crates that the Instrument Lab received in 2008. Due to the McHenry Library Special Collections (which houses the Lick Archives) being moved over the summer, our research was slightly limited. We felt the closure

of the Lick Archives most keenly when it came to the engineering aspects of the telescope. We were not *sure* there were no drawings extant, but we suspected not, due in part to the age of the telescope and it being a second-hand purchase.

Another important part of Hannah's research was learning how the telescope worked, as she was tasked with building a solid model of the telescope in SolidWorks. Before the parts were unloaded from the storage POD, the only references she had were archival photographs. One way to gain understanding of the engineering was by looking into historical books: Alvan Clark & Sons: Artists in Optics, Victorian Telescope Makers, and A History of Control Engineering.

Victorian Telescope Makers looked, in part, into the lives of Thomas and Howard Grubb, who were originally commissioned to build the 36" equatorial stand (eventually built by Alvan Clark and Sons); there are a few letters between them and Richard S. Floyd, the President of the Lick Trust and the person responsible for building the Observatory. Hannah found snippets describing how telescopes of that time were built. Fortunately, in Artist in Optics, she found specific information about Alvan Clark telescopes and their general style. Hannah also learned about clock governors and equatorial stands and how they work. In A History of Control Engineering, she learned about classic mechanical engineering that employed physics and gravity; but Hannah did not fully understand how the telescope worked until our visit to Lick Observatory to view the Alvan Clark Great 36-inch Telescope, and then seeing the parts of the 12-inch as we uncrated them at the Lab.

The bulk of the research involved studying renovated Alvan Clark telescopes in the United States. We were able to contact quite a few institutions, and were fortunate enough to get detailed information from Cincinnati Observatory, USNO, and the Antique Telescope Society past President John Briggs; along with invaluable help from Lick Historians Tony Misch and Shiloh Unruh.

## **2. Field Trips: Lick Observatory, Chabot Space Center, Santa Clara University**

**Lick Observatory:** Just before the visit to Lick Observatory on June 28, 2011, Hannah accessed Tony Misch's online Lick Observatory Historical Collections Project database. Tony was staff astronomer at Lick Observatory, since retired and actively involved in archiving instruments, miscellaneous parts, and documents that are on-site at the Observatory. The database clearly showed parts of 12-inch telescope, including the clock drive and governor, which we had thought was missing. Tony had it safely in his Archives, and turned it over to us, along with its gearbox and other related parts. We saw the original 12-inch pier, the top of which was destroyed when the dome was refitted for the 40-inch Anna Nickel reflector. We also inspected the Great 36-inch Alvan Clark refractor; the equatorial stand was of particular interest to Hannah, from an engineering perspective. We also got a suggestion from Tony on our project, as he strongly emphasized that the telescope should not be polished to a high degree, in order to preserve the history.

**Chabot Space Center:** On July 1, 2011, we visited Chabot Space Center in the Oakland hills to see the 8-inch Alvan Clark they call “Leah.” We met with Conrad Jung, historian and staff astronomer, and Ken Swagerty, the lead technician restoring the telescope. Both gave us a lot of advice for the restoration process, including the importance of documentation and photographing the project. We need to take photos of each part from every angle, document each step of the process, keep a log of activities, and classify each part. Dr. Jung told us to beware of small abuses or corrosion that may already exist, or could occur during the renovation. For example, there is a silver inlay on the rim of the axis which could have easily corroded due to excess cleaning. It was noted that parts and screws were custom made, and they alerted us that we might need to make our own parts to replace missing ones. Regarding the color of their telescope, it was both serendipity and history: the CEO of Chabot instructed them to try and match the wall panel color of the original dome. They also mixed colors to determine which ones made the mechanical parts of the telescope stand out. They used enamel/lacquer automotive paint, an expensive but beautiful and long-lasting process. Since their telescope is being used currently for extensive public viewing, they replaced their clock mechanism with a motor; the original drive is housed in a viewing port in the pier. Other details of the renovation include cutting down the tube for astrophotography use; and polishing the brass to a high shine. Dr. Jung referred us to the 16-inch Alvan Clark telescope that at Santa Clara, and another 12-inch owned by the US Naval Observatory, mentioned in [Artists in Optics](#).

**Santa Clara University:** July 20, 2011, we visited Santa Clara University to see their 16-inch Alvan Clark, “Swift,” only to find that it has been out of commission for about 10 years. Still, we met astrophysicist and professor, Phil Kesten, who has been trying to get the refractor back in working order. He took us on a tour of the dome, which currently houses the SCU Archaeology Department offices and part of its collection. The telescope was last refurbished in 1990 after a 25-year decommission; they replaced the original drive with electronics because the clock drive was missing; the view finder was replaced with a modern model because of its age. In addition to these upgrades, the original eyepieces and other optics were not made by Alvan Clark, but by another optics maker and matched to the original 16-inch Alvan Clark optic. For its brief starlight period, the telescope was primarily used by Astrophysics students. The SCU administration closed the observatory in 2000 and sealed the dome, ostensibly due to the high cost of operation. The telescope lives in its dome, untouched and gathering dust, but Phil has hopes to reopen it in the future. Although it was a sad story to hear, it was nice to see another Alvan Clark telescope in person and study its engineering. One important point to note about the SCU renovation was that they were NOT striving for historical accuracy, but for utilization of the telescope for Astronomy and Astrophysics students.

### **3. Possible Directions for Lick 12-Inch Alvan Clark**

Among the Alvan Clark refractors we researched, there are three directions that renovations seem to go, mechanically. First, the telescope mechanics can be replaced completely and a GOTO motor added, which can move the telescope with a remote control. Unfortunately, this

takes a lot of time and money because we would have to change the mechanics of the telescopes completely. Second, we can use an older motor which does not require changing the internal mechanics of the telescope, like the motor that was installed on the 12-inch in the 1950s. Finally, we can keep the original clockwork and restore it to its original state. This would require learning the antique mechanics, of which much information is extant.

**Mechanical Restoration:** After an interview with John Briggs, past President of the Antique Telescope Society, we concluded that using the original clock drive would be the best way to go. We have all the parts, and the clock works substantially well, as far as we can tell. We interviewed John Ventre, the historian at Cincinnati Observatory, to whom we sent an email inquiry about their renovation process (see Appendix 2). We learned that their 16-inch is primarily used for educational purposes, and rarely for research. We believe that our 12-inch telescope would be similarly used. As it is an old piece of equipment that would take a bit of knowledge to operate, it may be wise to dedicate it to educational and historical purposes, with a cadre of volunteers and staff to protect its integrity. Since it is possible for us to restore the telescope back into its original condition, there should be no reason not to do so.

The SolidWorks model of the telescope that Hannah created will assist in understanding the mechanical construction of the telescope. The primary purpose of creating the solid model was to confirm that we have most (if not all) of the parts of the telescope.

**Brass Restoration:** The brass should be cleaned, carefully, in order to preserve any historical markings or silver inlay (possible on the declination and right ascension wheels). It is especially important that any lacquer that exists on the brass be removed, which can be a laborious process; a fresh coat of lacquer should be applied after thorough cleaning. One point of view is that the degree of polishing should be subdued, which will lend the telescope an aged and not overly "steampunk" look. Another point of view is that a highly-polished instrument might be more attractive to the public. More research needs to be done before making a final decision.

**Paint Restoration:** The other parts of the telescope that have been painted must be stripped down to the original metal. When considering repainting, the color should not be too bold, but should accentuate the details of the telescope. John Briggs recommended earth tones, but other renovations have varied widely in color choices, from bright primaries to subdued neutrals. As for the type of paint, there have been many suggestions, including automotive paint to Rustoleum and a fish oil based primer. To get additional information, we can inquire with coatings engineers at paint companies when the time approaches for such decisions to be made.

**Restoration Best Practices:** During the renovation process, it is important to take a lot of pictures - of each object at every angle, and of every single step along the way. It is also essential to note the name of each and every product we use in our efforts. When discussing the renovation of the 16-inch Alvan Clark at the Cincinnati Observatory, we were told that their PI not only did not take many photos of the process, he neglected to note what type or brand of paint they used. This sort of information is essential, not only for those tasked with maintaining

the telescope through the years, but also to other institutions that may be researching renovating telescopes, as we have been doing this past summer.

Another valuable piece of information we received from Briggs and Ventre was this: If you do not have an original part and must make a replacement, do NOT try to make it look "antique." In fact, quite the opposite – make it obvious that it is a modern replacement part. This transparency will be important in future maintenance of the telescope, and valuable for anyone researching the details of our restoration.

We are grateful for the accurate record-keeping of those institutions whom we have contacted, and their willingness to share information.

**Final Thoughts:** Everyone we spoke to regarding restoration emphasized that great care be taken at every step to preserve the historical integrity of the instrument, that the process be gentle, and each decision be made in the interest of historical accuracy for our own and future generations. The Lick 12-inch Alvan Clark represents the great legacy of astronomical science upon which our modern observatories have been built. It should be restored in that spirit.

**Color Samples:** Before his death, Shiloh Unruh showed us some color samples he had found for the telescope. His desires are pretty clear: teal, cream, and black.





## **Appendix 1. Other Alvan Clark restoration projects: Approaches and Practices**

Author: Hannah Johnson

### A Survey of Alvan Clark Telescopes Still in Use Today

For our project to restore Lick's 12-inch Alvan Clark Telescope, we have been looking at other Alvan Clark-made telescopes still in use today and asking for their opinions.

This document is a survey of Alvan Clark Telescopes at working observatories and discussing such things as

- Condition and renovation techniques
- Colors
- Use (Science or public or both)

#### **Allegheny Observatory - 13-inch**

*University of Pittsburgh; Pittsburgh, PA*



As many of these telescopes, this 13-inch was originally made by Dr. Henry Fitz in 1861, but the lens was reconditioned 11 years later by Alvan Clark due to a scratch across the lens. Today the telescope is “primarily used for the tour program and on occasion used to test instruments for the bigger telescopes” according to their website (<http://www.pitt.edu/~aobsvtry/fitzclark.html>). It is also used for astronomy classes.

From this picture we can see that new electronics replaced the clock drive. The tube, when it the telescope was built was originally wood, and was replaced in 1893 with steel and the clock drive was replaced in 2000 for an electronic slip clutch drive. It also has a new view finder and LED circle lights.

#### Assessment:

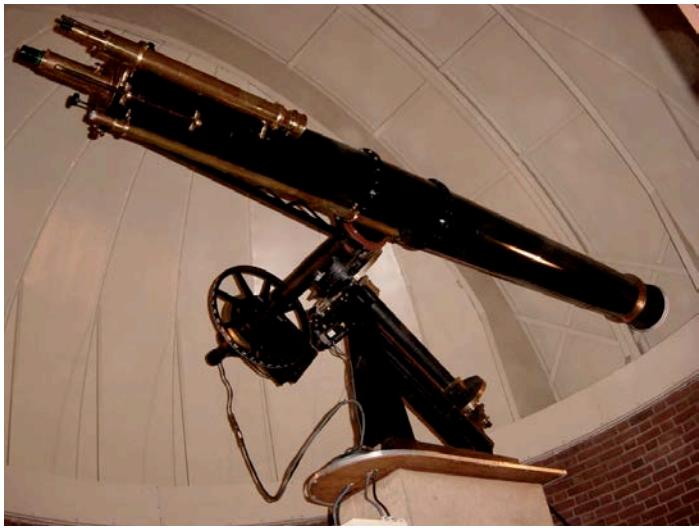
The green color looks really nice with the gold, but otherwise the telescope looks too new. The equatorial stand looks to brand new, almost like a telescope you could buy on today's market.

#### Website:

<http://www.pitt.edu/~aobsvtry/fitzclark.html>

Special thanks to Louis Coban and David Turnshek

**Bucknell University**  
*Lewisburg, PA*



The renovation of this telescope took place in 2008 by Chris Ray and Fred Orthlieb. Everything is original except the drive system, which is a GOTO motor. Since the telescope is primarily used for Bucknell University's Astrophysics introductory class and for public observing nights - which is the primary reason why they use the GOTO motor - because it is easy to operate. The telescope itself was painted black with polished brass. According to a historical description of the telescope in 1887, this was the original color, as well as a confirmation from Chris Ray, who has experience with Alvan Clark telescopes of similar vintage.

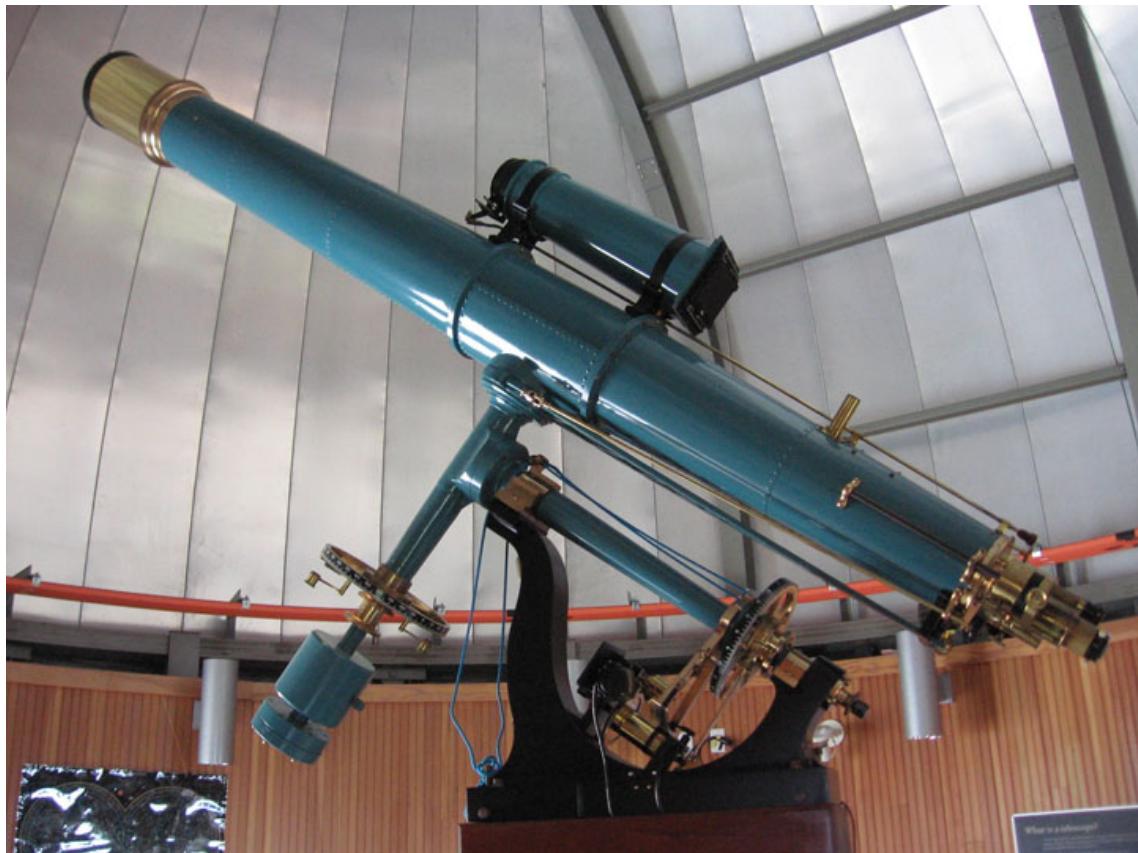
## Assessment:

This telescope uses a GOTO motor, which is pretty common among the Alvan Clark telescopes I have researched. It seems to be the least incriminating of the motors used for 19th century telescopes today as it does not interfere with the original equipment all too well.

Special thanks to Fred Orthleib and Ned Ladd.

### **Chabot Observatory - 8-inch, Leah**

*Oakland, CA - VISITED 6/31/2011*



Leah was Chabot's first telescope, circa 1883. Upon Chabot last move to their current observatory in 2000, there was room for renovation of both telescopes (the other, Rachel, the 20-inch Alvan Clark). On June 31st, we visited Chabot and talked to astronomer Conrad Jung and Ken Swagerty, who led the renovation team. The renovation was purely based on making it look good as well as making sure it could be put into use. A lot of part were missing, including the clock drive, thus, most of the telescope is electronic. The moving of the telescope itself is still slightly original as it is pulled with strings to rotate and tilt it. This is possible due to the telescope being a smaller, more manageable size. The colors of the telescope were chosen based off of the wall panels in the original dome, which took a series of mixing, testing, and serendipity to choose. Overall they chose colors that would make the feature of the telescope stand out, keeping the brass mechanics original, but polished to look nice.

#### **Assessment:**

The telescope does look beautiful polished, but as Tony Misch had said, it has the threat of looking "steam punk" (Example - [http://platypusart.com/wetherell/sculpture\\_greatwetherellrefractor.html](http://platypusart.com/wetherell/sculpture_greatwetherellrefractor.html)) and losing some of its history. Looking at this telescope, without knowing its history, I would have no idea that it was made in 1883.

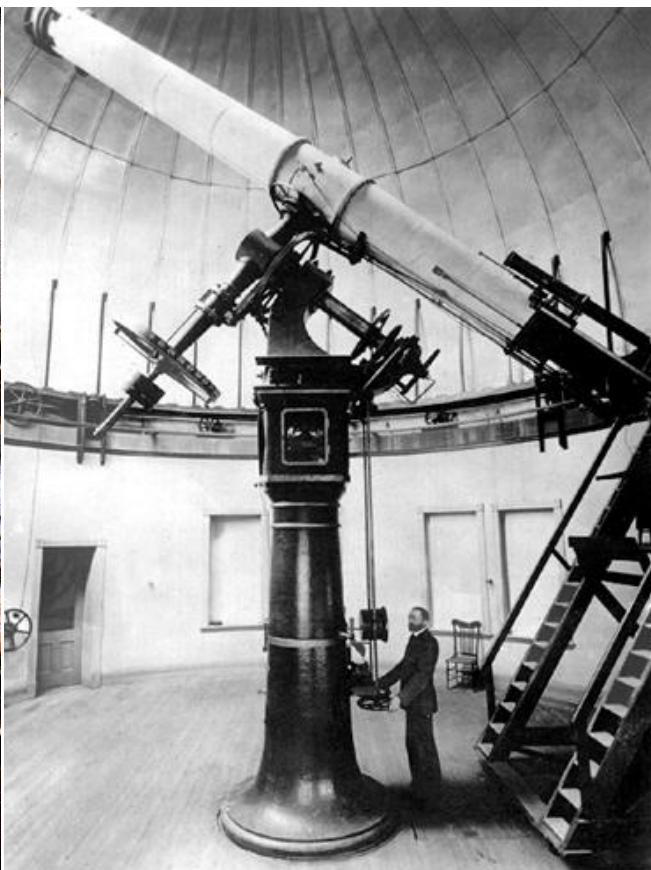
Website:

<http://www.chabotspace.org/leah.htm>

Special thanks to Conrad Jung and Ken Swagerty

### **Chamberlain Observatory - 20-inch**

*University of Denver; Denver, CO*



This telescope was renovated recently by Chris Ray, Fred Orthleib, and Robert Stencil, in May 2011. A lot of the parts had to be replaced due to misalignment and wear and tear. Only a 110ac motor has replaced the clock work, but from the looks of the blurry, dark photos on the website, it seems that this telescope still holds its original clock drive and mechanics. Professor Stencil has hopes of getting a GoTo motor, which remotely controls the movement of the telescope with motors, which ultimately would replace the clock work. According to Professor Orthleib, the renovation was more of a “rehabilitation” - as in “cleaned what needed cleaning, found and corrected accumulated faults and damage, minimized excessive effects of wear, and improved mount lubrication and adjustment capabilities” according to his email.

By confirmation of Professor Stencil and comparing the two photographs, the colors of the telescope have not changed, just merely been repainted.

### Assessment:

The fact that the telescope today looks exactly like the original shows the fierce influence of history on this telescope. The color certainly accentuates the details of the telescope and since it kept its original color, it certainly emphasizes the historical value. If we are able to find the original color of the 12-inch, that color should certainly be taken into account.

As mentioned before, they are thinking of adding a GoTo motor, which can move the telescope without having to seriously change any of the mechanics of the original telescope. This might be something to consider, especially if we decide to make the telescope functional.

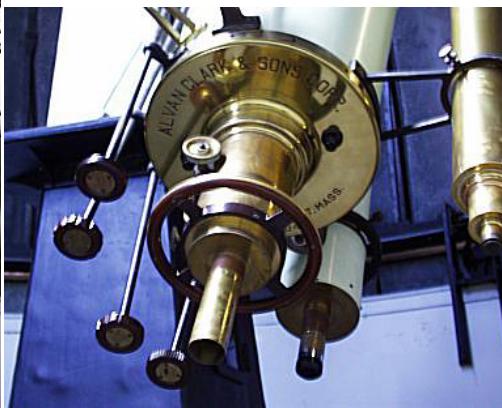
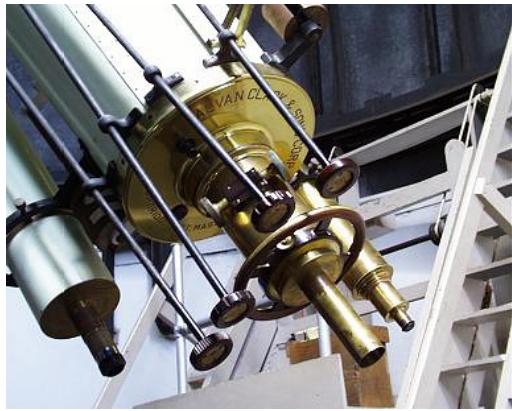
Overall, as Prof. Orthleib had mentioned, we need to decide the “balance between preservation of appearance and improvement of function” - or the decision to make it a working telescope or a historical museum piece.

Website: <http://mysite.du.edu/~rstencel/Chamberlin/cham12.html>

Special thanks to Robert Stencil, Fred Orthlieb, and Chris Ray

### Cincinnati Observatory - 16-inch

*Cincinnati, OH*



As proudly announced on the website, this Alvan Clark still holds its clock drive. Looking at the other pictures, it looks like all the classic mechanics are still there too. The brass is polished to look new and the tube color is white, which effectively highlights the brass. The telescope was last renovated in the early 1980s. Since the telescope had deteriorated into terrible condition, there was a severe amount of renovation on the telescope -including stripping all the metal to its original state, using many chemicals to clean and extensively polish the brass and metal parts. The telescope was originally installed in 1904 and has not had an electrical element added to it since. It was out of order in the 1930s until it was renovated in the 1980s, in which the original clock drive was reinstalled and the telescope reconditioned. This telescope is primarily used for education purposes such as showing it to public schools, and in the future, using it for graduate students. Currently a small group of volunteers are using the 16" to discover exoplanets.

#### Assessment:

I definitely admire the use of the clock governor in this telescope. By seeing that this is possible to do, it would be good to think about putting the clock governor back in order and maybe finding some sort of device that can reset the clock by pulling the weights. This of course might be the end of the spectrum of electronic interference.



Another Telescope to note at the Cincinnati Observatory is their Merz and Mahler 11-inch refractor. It has a “Brazilian Mahogany veneer tube that overlays a hollow wooden tube” as historian John Ventre told

me in his email. When I first saw it, I thought it was really beautiful. I know that we cannot add a wood veneer to the tube, but this does have a beautiful color:

Website: 16" - <http://www.cincinnatiobservatory.org/alvanclarksonsre.html>

Merz and Mahler - <http://www.cincinnatiobservatory.org/merzundmahlerref.html>

Special thanks to Craig Niemi and John Ventre

**United States Naval Observatory - 12-inch**

*Washington D.C.*



The 12-inch telescope held at USNO has an Alvan Clark lens but a Geo. Saegmuller equatorial stand. According to astronomer Richard Schmidt, the renovation was merely the task of getting it in working order. They had to replace the tube due to a crack and as the clockwork was missing, they replaced it with new gears and electric motors. To fine tune the image from the telescope, they replaced the eye pieces. They also replaced the setting circles with plastic ones due to the numbers being large and metal.

For the paint job, they followed closely to the original, although they painted it white rather than the original light green.

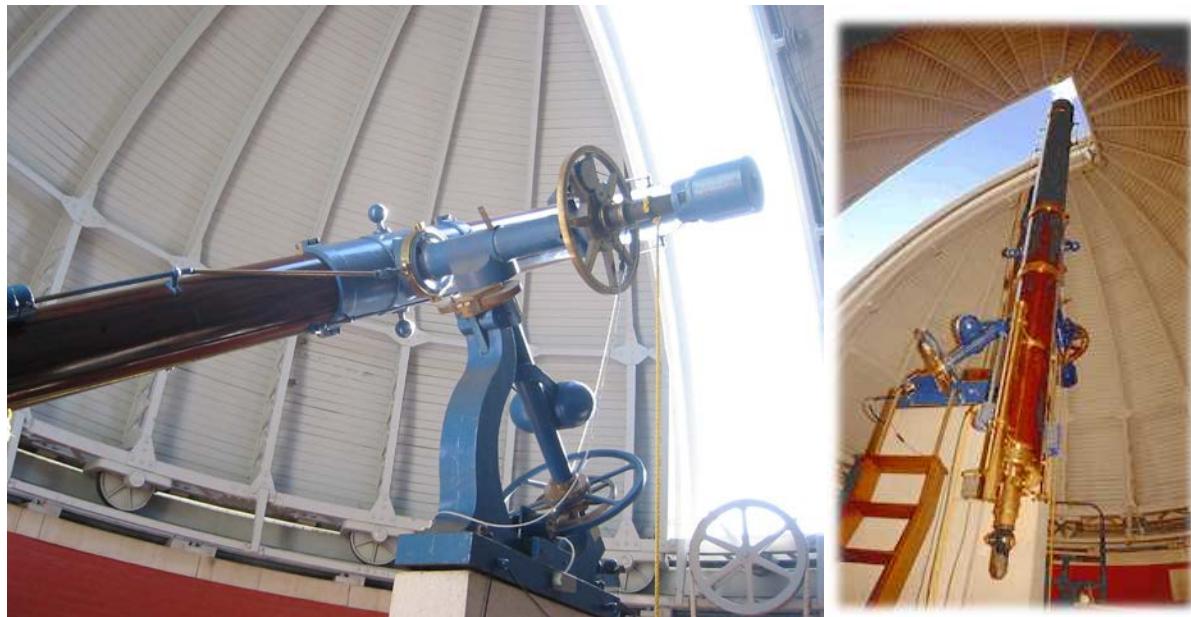
Assessment:

The white and black looks really nice with this telescope but I dislike the fact that they painted over the bronze. It definitely loses its age. Since they did not have the original clockwork, there is no blame on adding electrical equipment. Still this is a nice telescope to look at for reference since it is the same size.

Website: <http://www.usno.navy.mil/USNO/about-us/the-usno-12-inch-refractor>

Special thanks to Richard Schmidt

**Whitin Observatory - 12-inch**  
*Wellesley College, Wellesley, MA*



This telescope is yet another that was originally built by Henry Fitz in 1852, but again remodeled by 1867 by Alvan Clark and Sons. The last time the telescope was renovated was in the 1980s by John Richardson. Looking at the pictures (they have both of the telescope and from restoration - <http://www.wellesley.edu/Astronomy/gallery04.html#restoration>), it seems that it has a wooden tube that has been refurnished, and metal tube is there to support the tube. The telescope seems to be using electronic controls as far as I can tell, but the movement of the telescope still looks like it is controlled by ropes. The brass looks to be polished well and the base and part of the tube are painted blue. This telescope is primarily used for introductory astronomy classes at the university.

Assessment:

Although the telescope is not very close to ours in style, as it was built originally by another telescope maker, the rope movement would be something to look into. It may be possible to use the same original control movement on our telescope and still have it be safe to use.

Website: <http://www.wellesley.edu/Astronomy/facilities02.html#12>

## **Appendix 2: Detailed Accounts of Renovations from USNO, Chamberlin Observatory, and Cincinnati Observatory**

Hannah addressed the following questions to a number of institutions at the outset of our research.

1. When was the last time the telescope was renovated?
2. How did you decide what level of renovation - like the amount of polishing and so on? And why?
3. How much of the telescope is original, such as any electronics added, etc?
4. How did you decide on the colors for the telescope?
5. What is your telescope primarily used for and did that influence any of the decisions made in the renovation process?

She received detailed answers from several of the institutions queried.

### **USNO:**

I would say that we did not "restore" the 12-inch as much as put it back in operating condition. It had been left outside for a number of years when I discovered it back in '84. We were very fortunate that the major parts, tube, equatorial, pier, objective, tailpiece, etc. were not discarded as was intended.

Our tube had a crack in the center piece which is of cast iron, and we had to have it repaired by specialists. The tube is rolled and riveted sheet steel much like that of the 26-inch Clark.

I think there was a 12-inch Clark at a Missouri college sometime ago.

As the attached images show, the Lick 12-inch was not in fact a twin of ours, as your mount was by Clark and ours by Geo. Saegmuller. Only our lens is by Clark. There are two other Saegmuller 12-inch refractors, at Brown Univ. in Providence and at Georgetown Univ. at Georgetown Univ., DC. Ted Rafferty did restoration work on the Georgetown refractor, which is more original than the USNO refractor.

See the attached images. We have many historical images of the 12-inch, and I took quite a number during the disassembly and restoration back in '85 which are in the USNO Library. In addition there were journal articles that showed views of our telescope when it was new, as it had some of the first indicator dials for RA and Dec (which have since been lost). We have photos of the telescope in use from the 1910's. Not much is digitized but could be...

There must be historical images of the Lick 12-inch that would be helpful to you. The attached one is from The Century magazine May 1886. I will check the Library to see if we have any here.

When we set about putting the 12-inch back in shape we were constrained in budget. We had the steel and iron parts stripped at an auto stripping place and we repainted to look similar to the original photos, though we chose white rather than the light green that I believe Saegmuller used on the tube.

We kept the brass parts unpainted (finder, microscope tubes, tailpiece). The original clockwork drive was long lost, as were the various gears for slewing the telescope by hand wheels. Rafferty constructed a sidereal gear train and used what electrical motors were available for the drive and the R.A. clamp.

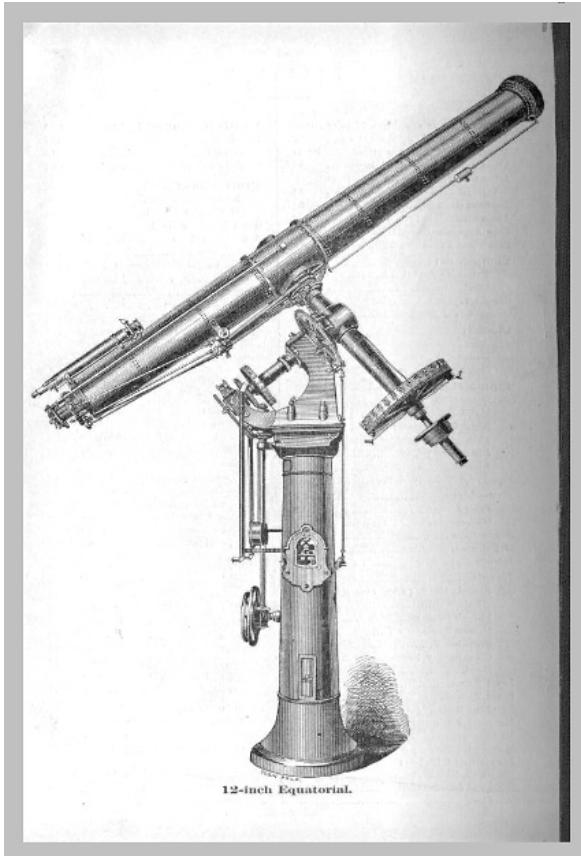
Our original setting circles had large metal raised numbers, though it looks like yours did not. We used plastic ones on the restoration.

We added a standard 2-inch eyepiece adapter to the tailpiece, as the original eyepieces were all heavy threaded pieces not as fine as modern eyepieces.

An article on the restoration of our 12-inch was published in an amateur telescope making journal back in those days. I have not seen it in a while.

Lick also had a nice Brashear Comet Seeker; I would love to know what became of that instrument.

Well, keep us informed as to your progress; I don't know what all you have to work with, but preserving astronomical history is important. I will obtain Rafferty's address for you.



Regards, Rich Schmidt

**Chamberlin Observatory:**

Hannah, I'm forwarding your message to Chris Ray - and taking a crack at your questions myself. Copying Chris on my reply will give him the opportunity to comment on it for your benefit as he might wish.

1. As far as I know, the last significant renovation of the Chamberlin 20 inch was in 1917, and the observatory logs contain quite a bit of information about what was done at that time. Sometime in the 60s or so, an electric motor drive was installed within the pier just above the clockworks and coupled to the tracking drive; records for that are also available at Chamberlin, but I did not review them as our contracted rehab tasks explicitly excluded any clock drive or new tracking drive work.
2. Chris is our man for optics - assessment, cleaning, and alignment. I think it's fair to say that we (certainly I) do no polishing of anything, glass or otherwise, except in rare instances involving mechanical components where it's necessary to prevent excessive friction or galling wear.

Level of renovation is set by budgetary resources and existing level of degradation. We don't propose rehab work until we've surveyed the scope and mount in person in the company of its

owner/operator and reported on what we've found amiss or nearly so.

Then there's the issue of function in the present and near-term future. Some old scopes are strictly museum pieces - and questions of renovation are strongly balanced by a desire for preservation of original features and respect for the makers design and craftsmanship.

Others are in working observatories with significant ongoing educational and/or research missions. Here issues of rehab most often involve tension between preservationist impulses and needs to effectively support current educational (curricular and public) and research activities. Fortunately, modern GoTo functionality can be provided at reasonable cost, and usually without doing violence to original or existing mechanical details of the mount, or doing anything at all to the telescope optics.

Mechanical changes are typically minor and go virtually unnoticed by the casual observer. But that does not mean that they are welcomed by full-bore preservationists in the community of users and supporters. The balance between preservation of appearance and improvement of function must always be considered and understood, if sometimes not fully accepted, by all stakeholders.

3. In the Chamberlin first-stage rehab we just completed, no electronics were added, and some outdated and increasingly decrepit electrical wiring was removed and replaced by more and better insulated conductors to support existing digital encoders and anticipated digital cameras - and to "clean up" the external appearance of the mount to something more like original conditions.

New and improved gears and bearings replaced worn and damaged originals at several points - all of which improved tracking accuracy and precision. But not all drive-critical bearings were replaced - the remaining tracking-worm shaft support bearings were retained, albeit with improved lubrication and closer-tolerance positioning shims. If and when servomotor drives for Dec and RA are added to support GoTo operation, all new and much more precise (but not much larger) shaft supports and drive train elements will be necessary.

4. Colors are always the owner's choice - although we do try to discover what the original colors were, and advise the owner accordingly. But exterior color scheme doesn't matter with long-focus refractors, as long as the interior finish is flat black. At Chamberlin, we did almost no finish painting and left all accessible rehabbed mount components scraped clean (if bronze) or in red primer for others to paint in colors and gloss levels of their choosing.

5. The 20" Clark/Saegmuller at Chamberlin now has, in my own view, a primarily educational function at both the institutional-academic and public levels. But I would readily defer to the opinion of Professor Bob Stencel in his capacity as Director - the person who has constantly to balance the needs and desires of his many Observatory stakeholders.

The work done in situ at Chamberlin last fall by Chris Ray and by myself this spring was in my view strictly rehabilitative in character. We cleaned what needed cleaning, found and corrected accumulated faults and damage, minimized excessive effects of wear, and improved mount

lubrication and adjustment capabilities - only those last two involved adding some very minor mechanical components that in no way changed the appearance of the scope or mount.

Hope some of this helps. I find it fascinating to delve into old mounts and comprehend their makers' intent, then try to preserve that intent as much as possible while countering the effects of a century's passage, finally permitting the scopes and mounts to continue to serve educational and research purposes with modern pointing capabilities and more explicit lubrication and maintenance routines.

FYI, Chris Ray and I completely disassembled, stripped, rehabbed and upgraded the 10 inch Clark refractor and mount at Bucknell University two years ago, and I suggest that you contact astronomy Professor Ned Ladd there, as his situation and desiderata may be much closer to your own than those at Chamberlin Observatory. His scope changed color from dirty-white to gloss black - image attached (taken a few days before job completion).

Cheers.

- Fred Orthlieb

#### **Cincinnati Observatory:**

Because of the horrible state of deterioration of the telescope the person who restored the 16" Clark, Paul Nohr, had to take all of the metal down to original metal and the brass had to be cleaned with chemicals and then highly polished. Had the condition of the telescope not been so deteriorated he would not have taken these extreme measures. The telescope was encrusted with pigeon dung and the two element lens contained a puddle of water.

3. How much of the telescope is original, such as any electronics added, etc?

This telescope never was electrified, motorized or computerized. When it was installed in 1904, there was not electricity at the Cincinnati Observatory. The telescope went off line in the 1930s. Hence when Paul Nohr restored it, he restored it to its original condition, including the weight driven governor clock drive. Although somehow the periscope tubes that were used to read the fine engravings on the silver inlay on the Right Ascension and Declination wheels were lost.

4. How did you decide on the colors for the telescope?

Paul selected a neutral cream color with a little dash of green added to the paint. Paul worked for the Physics department, and when the department head saw the color that Paul selected, he was greatly agitated about it, and told Paul never to do anything like that again. So much for artistic creativity.

5. What is your telescope primarily used for and did that influence any of the decisions made in the renovation process?

At the time that it was restored, it was not used since the mid-1930s. In the late 1970s the University of Cincinnati Physics Department acquired control of the Observatory. They sent Paul Nohr to the Observatory to restore the two principal telescopes, the 1845, 11" Merz & Mahler and the 1904, 16" Alvan Clark and Sons. The M&M was restored over a year and a half in the late 1970s and the 16" was restored in the early 1980s in about a year. The Physics department had planned on using the telescopes to do graduate student projects.

The Cincinnati Observatory Center was formed as a 501(c)(3) not-for-profit organization in 1998 to save the Observatory. UC was planning on bulldozing the Observatory facility, sell the 14 acres of land, and then erect some high rise apartment buildings. We had it declared a National Historic Landmark and then raised 2-1/2 million dollars to restore the facility. It currently is used for educational outreach programs and for public education. A small group of volunteers who are associated with the Observatory are using the 16" Clark telescope for exoplanet searches.

The 1845, 11" Merz and Mahler has a Brazilian Mahogany veneer tube that overlays a hollow wooden tube.

I could recommend that if you have not contacted the Antique Telescope Society as a consultant on this project that you consider it. Their members have been involved with many of the antique telescope restorations around the world. <http://oldscope.org>

In Memory of Shiloh Unruh.

