

A leading nineteenth century instrument-maker in Norway and his astronomical and geodetic instruments

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Abstract

Christian Holberg Gran Olsen introduced the European continental standards of scientific instrument making into Norway in 1861, following a four-year tenure with A & G Repsold, Hamburg. This paper lists and discusses the major astronomical and geodetic instruments made by Olsen. The geodetic instruments are now in museums or in university storage. The first universal instrument was extensively used to carry out the Norwegian part of the European Geodetic Arc 1863-1878, both as a theodolite and as a transit instrument for astronomical observations at selected geodetic stations. Other instruments contributed to the mapping of Norway. Olsen's last model was used to determine the position of Fridtjof Nansen's polar ship *Fram* during its three-year expedition (1893-1896) in the Polar Sea. It was also used on other Norwegian polar expeditions during the next thirty years. A copy was made for the first winter expedition to Antarctica, with Belgica in 1897-1899. The first astronomical refractor by Olsen (with a 10.8-cm Steinheil objective lens) was made for Bergen Observatory in 1869. Its current whereabouts have been investigated, but the instrument has not been found. Two larger refractors have been successfully searched for. A 13.2-cm Merz refractor with mounting by Olsen, made for the University Observatory in Christiania (Oslo) in 1883, exists in refurbished condition. The largest refractor, with a 36.0-cm objective lens by Olsen (7 metres focal length), was the centrepiece in what appears to be the first astronomical observatory in Europe founded and operated exclusively for the public on a commercial basis. When erected in 1885, the refractor of the Peoples' Observatory in Oslo was unsurpassed in size in Scandinavia, even at professional observatories.

Keywords: *Olsen, refractors, universal instruments, theodolites, equatorial mounting, people's observatory*

1 C H G OLSEN: HIS TRAINING AND PROFESSIONAL LIFE

Christian Holberg Gran Olsen was born into a large family of gifted and creative people in 1835. He grew up at the family farm, Einstapevoll, in Valestrand, north of the city of Haugesund, on the west coast of Norway. His father had done extensive international travelling as a young sailor and many impressions were implemented at the farm in modified forms. He was also innovative in his own right and developed new solutions and machinery to deal with everyday challenges. Music, religion, and hard work were integral elements of life at the farm.

About 1850, C H G Olsen moved to Bergen to become an apprentice at the optical and mechanical workshops of Ulrik Fredrik Krog, the city's Master of Weight and Measures. Krog had been trained by Repsold in Hamburg, and upon realizing Olsen's talent he arranged for his further training at the firm of A & G Repsold, then recognized as one of the world leaders in the development and construction of astronomical and geodetic instruments. Olsen arrived at Hamburg in 1857 April to work for Repsold (Cranner, 2001:44), and he became a valuable and trusted instrument maker. In 1859, Repsold wrote a flattering statement in support of Olsen's application for a stipend from Norway's National Assembly to study mathematical and physical instruments in Paris. Repsold also asked Christopher Hansteen, Professor of Applied Mathematics in Oslo and Director of the University Observatory, to support the application (Cranner 2001: 46). Apparently this application was successful, and in 1861 Olsen spent six months in Paris before returning to Hamburg. On 1861 September 21 he resigned from the Repsold firm, moved to Christiania (now Oslo), the capital of Norway, and established his own company. He gradually expanded and soon dominated the national market for scientific instruments and complex mechanical innovations. He also trained a number of

talented, young men, thus improving the standards and availability of scientific instrument-makers in the country. Some started their own workshops. In 1898 Olsen sold his business to two of his senior staff and in the remaining twenty-three years of his life devoted himself to innovative projects carefully selected to match his personal interests. His company is still active today.

On several occasions, Olsen's innovative and beautifully-handcrafted instruments won him medals and awards at national and international exhibitions (Paris in 1875, 1878, and 1881, and Christiania in 1883), and he obtained several patents. He seems to have been more preoccupied with technical developmental work and less focused on business smartness. He thus ended up taking rather large risks at times, and his annual income varied by orders of magnitude. All his major designs were prototypes or one-of-a-kind units.

Olsen married Pauline Dobbertien in Hamburg in 1859 July when he was still employed at A & G Repsold. After moving to Oslo in 1861, they eventually had six sons and two daughters. The bilingual Olsen residence cultivated a variety of cultural activities, including science, literature, music, religion, and foreign languages. Olsen's children sought professions in music, education, and engineering. The oldest son, Henrik, moved to Munich and became a senior optician with Steinheil. Olsen's youngest daughter assisted him during the second phase of his People's Observatory, from 1911 to 1921.

2 THE INSTRUMENTS AND THEIR PRESENT STATE

Each scientific instrument fabricated by Olsen was custom-made to the buyer's specifications. Some of them are signed and dated, but many were not. Olsen was obliged to acquire some parts and elements from

reputable companies abroad because he lacked the necessary tools and equipment to make them in his own workshop. Thus he obtained objective lenses from Steinheil in Munich and accurately-divided circles from Oertling in Berlin and from England. The latter was a costly solution, and Olsen started to develop his own circle dividing machine in 1865 based on the idea that the primary divisions should be limited to increments of $\frac{1}{2}$ degree. Finer divisions were added by subdividing the primary intervals with special apparatus. This was successfully applied to the production of small theodolites and apparently also to the astronomical refractor for Bergen Observatory. In 1875 Olsen received government funds to construct another machine in order to divide larger circles. Many of his later instruments were delivered with his own graduated circles.

Table 1 lists Olsen's major astronomical and geodetic instruments in chronological order. Their current whereabouts and condition are commented upon in Sections 3 and 4, where we also describe all of the instruments and review their use (as documented in published papers and unpublished archival sources).

Table 1. Instruments by CHG Olsen 1863-1896.

Year	Instrument	Receiving institution	Characteristics
1863	Universal instrument	Geographical Survey of Norway	$\varnothing=54$ mm f/9 25 cm circles
1869	Refractor telescope	Bergen Observatory	$\varnothing=108$ mm Steinheil, equatorial mounting
1869	Theodolite	Geographical Survey of Norway; University Observatory, Oslo	$\varnothing=20$ mm f/9 10 and 6 cm circles
1883	Refractor telescope	University Observatory, Oslo	$\varnothing=132$ mm f/14 Merz, equatorial mounting
1885	Refractor telescope	C.H.G. Olsen's Peoples' Observatory, Oslo	$\varnothing=360$ mm f/19 Olsen, equatorial mounting
1887	Universal instrument	Geographical Survey of Norway	$\varnothing=70$ mm f/10 32 cm circles
1892	Universal instrument	Fridtjof Nansen's Arctic expedition	$\varnothing=50$ mm f/9 21 cm circles
1892	Universal instrument	Fridtjof Nansen's Arctic expedition	$\varnothing=20$ mm f/8 10 cm circles
1896	Universal instrument	Adrien de Gerlache's Antarctic expedition	$\varnothing=50$ mm f/9 21 cm circles

3 THE GEODETIC INSTRUMENTS AND THEIR USE

3.1 A universal instrument for the Norwegian section of the European Geodetic Arc

Norway joined the newly-established Commission for European Geodetic Arc Measurements in 1862, one year after Olsen established his company in Oslo. A major observing programme was planned for a 5° latitudinal arc from the southern point of the Norwegian-Swedish border (Svinesund) to Trondheim. This would be the northern extension of a multinational geodetic arc through Europe with its southern terminal at Palermo, Italy. The intention was to improve the accuracy of the parameters of Earth's

ellipsoid and to establish interconnections between separate national geodetic networks in order to improve the mapping of Europe. Two historical decisions are attached to this project. At the second General Assembly in 1867 the metre was selected as the scale unit. This led to the Metre Convention beginning its meetings in 1870, with national ratification in 1875. At the seventh General Assembly in 1883, Greenwich was selected as the reference meridian.

Due to the challenging project requirements, the Geographical Survey of Norway found itself in need of a new universal instrument for the geodetic and astronomical observations. Olsen delivered the instrument (Figure 1) in late 1863, and each summer from 1864 to 1870 (and then occasionally till 1883) this instrument was taken to selected mountaintops. Theodolite observations were made to determine azimuth directions to other sites in the triangular network. These stations were then successively occupied for further observations. Thus new triangles developed along the geodetic arc as the observing programme progressed.

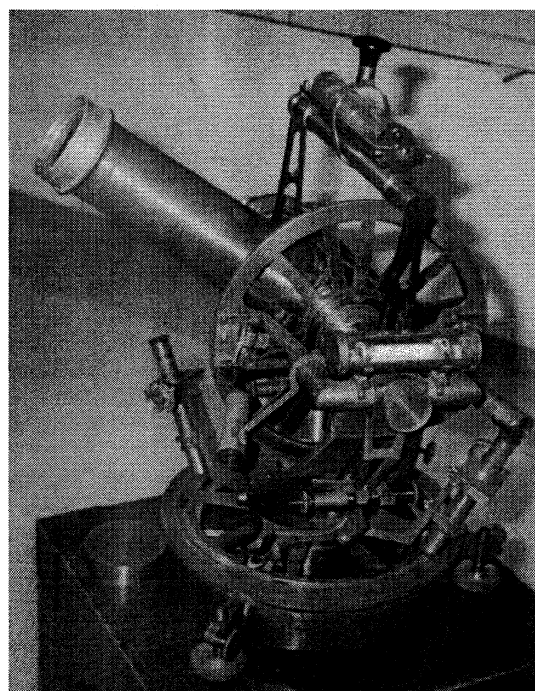


Figure 1. The universal instrument for the European Geodetic Arc, 1863.

The universal instrument was thoroughly tested by Henrik Mohn (1865) in 1864 and 1865. The telescope optics are from Steinheil of Munich. The objective lens has a diameter of 5.4 cm and a focal length of 48 cm. The optical axis is broken orthogonally by a prism into the horizontal axis of the mounting. At f/9 this instrument is well suited for stellar observations during the bright sky background conditions prevailing at daytime and during the Norwegian summer nights. It was used with an eyepiece giving a magnification of $37\times$. For astronomical transit observations the focal plane had one horizontal and six vertical thin wires. The circles were divided by Oertling of Berlin. The horizontal circle (diameter 25 cm) is divided in units of 10 arc minutes and is read by two microscopes. Crosshairs

and micrometer adjustments allow readings to 10 arc seconds and estimates to 1 arc second. A small vertical circle is divided into four quadrants 0° - 90° , in units of 20 arc minutes and can be read to 20 arc seconds from two vernier positions. Technical data for this instrument are given by Ebbesen (1891), Geelmuyden (1895), and Haffner and Mohn (1880).

In Oslo and Levanger (north of Trondheim) permanent baselines were established and measured in 1864 to a precision of 0.7 ppm (Fearnley *et al.*, 1882). They set the linear scale of the geodetic network. These baselines were connected to the triangular net in 1864 and 1865 (Haffner and Mohn, 1880; Haffner *et al.*, 1882) and the remaining stations were measured in 1866-1872 to complete the geodetic arc between latitude 59° at the southern point of the Norwegian-Swedish border and latitude 64° north of Trondheim (Fearnley *et al.*, 1885, 1887; Haffner *et al.*, 1888). Additional measurements were made 1877-1883 to improve results at individual stations and add nine new ones. Olsen's universal instrument was used as a theodolite at 40 of the 49 stations and contributed the great majority of geodetic data for this project. Other observations were made with universal instruments by Reichenbach, Repsold, and Breithaupt. The Olsen and Reichenbach instruments were used for astronomical observations at eleven sites in 1868-1872 and 1877-1881 (Geelmuyden, 1895). Local time was mainly determined from meridian transits of stars. Geographical latitudes (of nine stations) were determined by observations in the prime vertical. The azimuth directions of eleven triangle sides were determined with the Olsen instrument. This was used for the global orientation of the geodetic net. The azimuth angles were determined with typical errors of 2-3 arc seconds (rms), while geographical latitudes have errors of 1-2 arc seconds (rms).

The precision throughout the Norwegian geodetic arc may be assessed by calculating the length of a selected triangle side, starting from each of the two baselines. The length difference is about 0.4 m (Fearnley *et al.*, 1887; Geelmuyden 1895) for the distance between the two mountaintops Spåtind and Neverfjell (44 km), that is a relative error of about 10 ppm.

The Olsen instrument continued to serve the Geographical Survey of Norway on a regular basis until 1913 (i.e. for 50 years). It received an additional vertical circle in 1900 and was also used for trigonometric height determinations. During the 1920s it was used for astronomical positioning of Norwegian dominions in the Arctic. It is now on display at the museum section of the Norwegian Mapping Authority in Hønefoss.

3.2 Miniaturized universal theodolites

For the general surveying purposes in the districts of the country, scientific accuracy was not a requirement. This invited the use of miniaturized theodolites that were much easier to carry. A larger area could thus be surveyed in shorter time than was the case when a heavy, high-precision universal instrument was required. In 1869 Olsen delivered two small theodolites to the Geographical Survey of Norway and one to the University. The latter, a signed copy (Olsen, *Christiania, 1869*) is in storage at the University of Oslo (Figure 2), and an unsigned copy is on display at the museum section of the Norwegian Mapping Authority.

During each summer from 1869 till 1872, Olsen's miniaturized theodolites were used to establish a dense triangular network to support mapping of the County of Troms in Northern Norway. It turned out, despite rather long distances between each surveying site, that the results were better than expected. This was confirmed by re-measuring several sites with the far more accurate universal instrument in 1872. Part of the success was the precision obtained by Olsen when he divided the 10-cm diameter horizontal circle and 6-cm vertical circle on the small circle dividing machine he constructed in 1865.

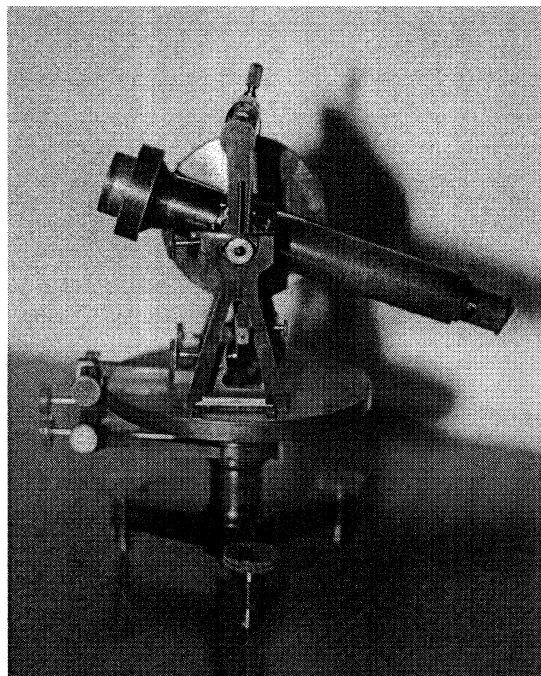


Figure 2. The miniaturised universal theodolite for the Geographical Survey of Norway, 1869.

3.3 A large universal instrument for the Geographical Survey of Norway

In 1886-87 Olsen produced a large universal instrument for the Geographical Survey of Norway (Figure 3). It was accompanied by a box chronometer (made by the clockmaker, Michelet of Oslo, in 1888), and was used until 1894 for astronomical control of the Norwegian first order geodetic net by determination of latitude, longitude, and azimuth in selected stations throughout the country.

The telescope optics were made by Steinheil. The objective lens has a diameter of 7.0 cm and a focal length of 70 cm. The optical axis is broken orthogonally into the horizontal axis of the mounting, leaving the eyepiece and micrometer at a constant height above the floor for all azimuth and altitude directions. The circles were divided in London. The horizontal circle (diameter 32 cm) has two concentric scales, one for full and half values of degrees and another divided in units of 5 arc minutes, which requires microscopes to be read. There are two vertical circles. The small one reads full and half values of degrees. The larger 32-cm diameter circle is divided in units of 5 arc minutes and is read by microscopes. The two large circles are subdivided to 1 arc minute. Mechanical micrometers allow readings to 1 arc second and estimates at the 0.1 arc second level (Ebbesen, 1891). This instrument is in storage at the

University of Oslo.

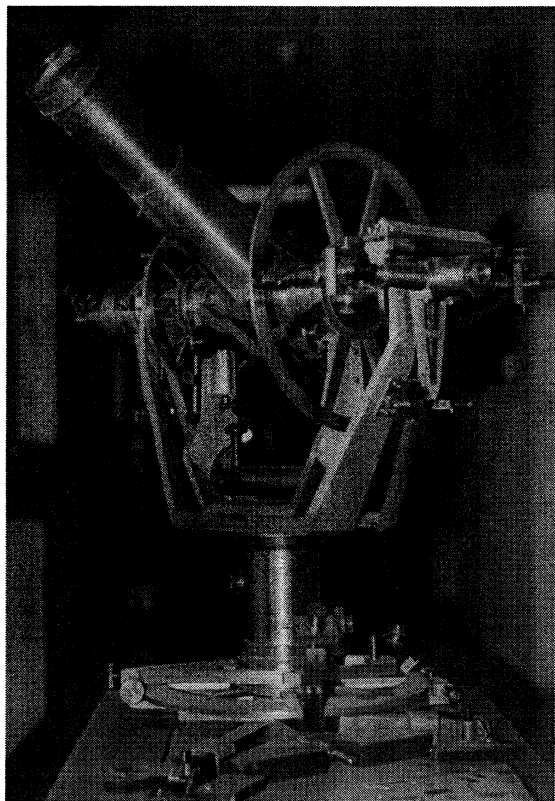


Figure 3. The large universal instrument for the Geographical Survey of Norway, 1887.

3.4 Universal instruments for polar expeditions

In preparation of the Arctic expedition with the polar ship the *Fram*, Olsen delivered two universal instruments (Figure 4) to Professor Fridtjof Nansen in 1892 (Geelmuyden, 1901). One remained on the ship, which was intentionally frozen in from 1893 September until 1896 August to track the currents of the Polar Sea through frequent astronomical determinations of position. The horizontal and vertical circles are both 21 cm in diameter and graduated to 10 arc minutes. Microscopes allow readings to 10 arc seconds and estimation to 1 arc second. The telescope has an objective lens of 5.0 cm diameter and a focal length of 42 cm, and is equipped with thirteen lines engraved on glass. The optical axis is broken orthogonally into the horizontal axis by a reflective prism. This instrument, signed "C.H.G. Olsen, Christiania 1892", accompanied the *Fram* on later polar expeditions, for example by Otto Sverdrup to Greenland in 1898-1902 (Isachsen 1907), and Maud on the North Pole Expedition of 1918-1925 (Sverdrup 1928). Latitudes determined from circum meridian altitudes of the Sun or stars were accurate to a few arc seconds, while longitudes were uncertain to 1 or 2 arc minutes at these high northern latitudes (Sverdrup 1928).

The second universal instrument is miniaturised with circles of 10 cm diameter, graduated to half a degree. Microscopic reading with verniers gave 1 arc minute. The telescope, also with a broken axis, has an aperture of 2 cm and a focal length of 16 cm. The focal plane wires, one horizontal and two vertical, are fine lines engraved on glass. This instrument

accompanied Fridtjof Nansen and Hjalmar Johansen on their ski and sledge expedition of 1895 March – 1896 June.

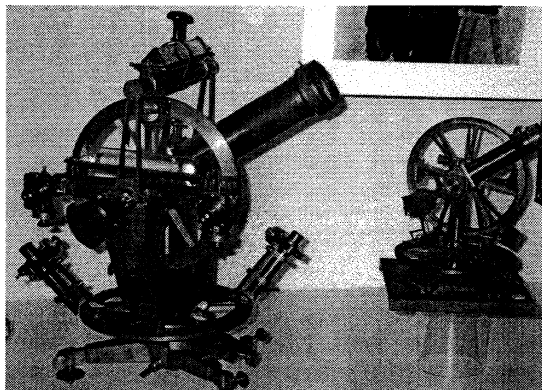


Figure 4. The universal instruments for Fridtjof Nansen, 1892.

Both instruments are illustrated in Nansen (1942:72, 165, and 185) and are now on display at the Fram Museum in Oslo.

A copy of the 21-cm universal instrument was made for Adrien de Gerlache's expedition with *Belgica* (Internal memo, 1898). The Belgian Antarctic Expedition of 1897-1899 was the first scientific winter expedition to Antarctica. It was realized in response to a resolution of the Sixth International Geographical Congress in London in 1895 July, which urged the exploration of that continent before the close of the century. George Leconte of Belgium was Navigation Officer and Expedition Astronomer.

4 THE ASTRONOMICAL INSTRUMENTS AND THEIR USE

4.1 A refractor for Bergen Observatory

Olsen made his first astronomical telescope in 1869 in response to a request from Bergen Observatory. A new observatory building had just been completed and a 10.8-cm refractor by Olsen was mounted in a tower with a revolving conical roof. The brass telescope tube had an objective lens from Steinheil. The equatorial mounting was equipped with a mechanical clockwork to track stars. A selection of eyepieces made it a useful instrument for public viewing of astronomical objects under the supervision by the City Astronomer. Occasionally more than one hundred persons attended such events, according to annual reports (e.g. Åstrand, 1871, 1873). The telescope was also equipped with a micrometer for determination of relative positions of astronomical objects (Åstrand, 1895). Bergen Observatory discontinued its operation in 1902 and the property was taken over by Bergen School of Navigation. Two years later, the refractor was transferred to an astronomical dome at the new school building (Helland, 1916). This dome is empty today, and no further reports on the fate of the telescope have been found.

4.2 A mounting for the University Observatory in Oslo

In early 1883, Olsen completed an equatorial mounting with setting circles and mechanical clock drive for a 13.2-cm Merz refractor that was acquired by the University Observatory in Oslo (see Figure 5). He was invited to display and demonstrate the telescope at the Christiania Exhibition that summer,¹ and it was

mounted in a small observatory where visitors were allowed to view astronomical objects. This proved quite an attraction and won Olsen a silver medal for his craftsmanship. This unexpectedly large public interest made Astronomy Professor Carl Fredrik Fearnley decide that the telescope should remain in its temporary observatory for at least another year. It was used for star parties, but also served science: on 1884 October 4 Henrik Mohn observed occultations of faint stars during a total lunar eclipse (Fearnley, 1885). Later it was mounted in a new pavilion at the University Observatory and was used occasionally for timing lunar occultations, partial solar eclipses, and transits of Mercury (see Fearnley, 1888; Geelmuyden, 1891a, 1891b, 1900, 1905, 1908; Schroeter, 1921). Over a period of more than fifty years, the telescope was made available to the public once per week (weather permitting).

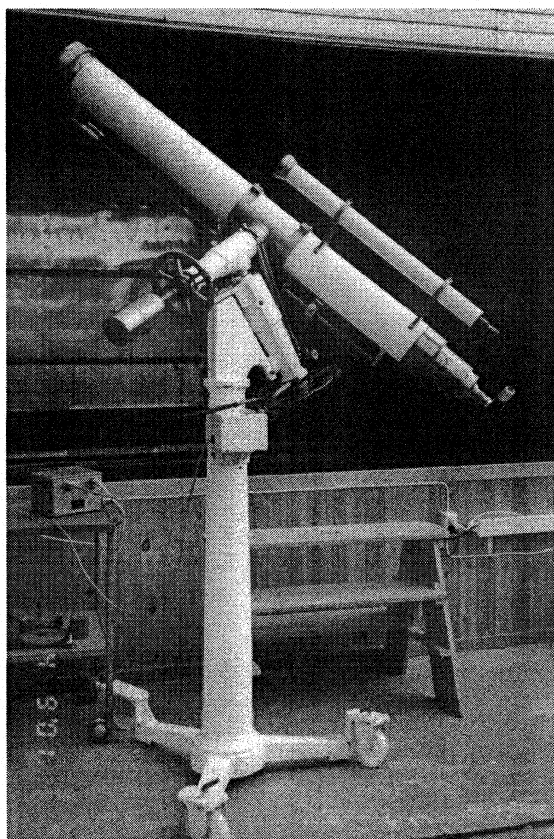


Figure 5. The 13-cm Merz refractor, mounting by Olsen, 1883.

The Merz-Olsen refractor was transferred to nearby Ruseløkka Primary School in 1937 where a teacher with a personal interest in astronomy showed sky objects to his classes. Upon his retirement this activity was discontinued, and after decades of non-service and neglect it was dismantled in 1988 and returned to the University of Oslo. It was then refurbished and set up at their Harestua Observatory (a former solar research observatory; now an excursion centre for school classes and astronomy training of teachers), where it is once again used for star parties.

4.3 The People's Observatory

The public interest shown in astronomy during the Christiania Exhibition was the direct experience that led Olsen to plan, construct, and operate a large

refractor in a public observatory in the centre of the Norwegian capital. Visitors to the Christiania Exhibition willingly paid a small fee to look through the telescope and showed considerable interest in Olsen's entertaining mini-lectures on astronomical objects. He decided that a market existed for an observatory that was open to the public. Although it was not uncommon in other countries for private and university observatories to welcome visitors, sometimes on a regular basis, the People's Observatory in Oslo appears to be the first establishment to be founded and operated exclusively for the astronomical entertainment of the public. It was run on a commercial basis, and was never used by professional or amateur astronomers to collect astronomical data. Olsen's idea attracted attention in other European countries, and he was approached by several individuals and societies wanting to establish similar facilities. In a newspaper interview reported in the 1910 October 16 issue of the *Aftenposten*, Olsen stated that Wilhelm Foerster in Berlin corresponded with him in the late 1880s and that his project became the model for the Urania Observatory. There was a similar story about Antwerp in Holland.

Olsen acquired optical blanks from Charles Feil² in Paris and spent eighteen months grinding and polishing the two-element objective lens for his 36-cm refractor. Astronomer Hans Geelmuyden at the University Observatory in Oslo calculated the theoretical characteristics of each surface of the achromatic lens, upon Olsen's request. This formed the basis for the optical tests during the production process. Further input was received from Carl Lundin, senior optician with Alvan Clark & Sons, USA. With an older brother, Lundin had emigrated from Sweden to Norway and worked in Olsen's company around 1870 (Geelmuyden, 1918). He moved to America in 1873 and began working for Alvan Clark & Sons the following year (Briggs and Osterbrock, 1988). During the summer of 1883 Lundin travelled to St. Petersburg to deliver the 76-cm objective lens for the new giant refractor at Pulkova Observatory (Krisciunas, 1978, Struve, 1889). He also visited his homestead in Sweden and his brother in Christiania before returning to America. In Oslo he met up with Olsen, his old master, who was making money through the refractor at the Christiania Exhibition and was developing the idea of a telescope of his own. Lundin explained to Olsen the unusual techniques of final adjustments of the lens surfaces developed by the Clark firm, by corrective polishing and direct testing of stellar images at the telescope focus, and Olsen adopted this approach for his own objective lens. Family anecdotes report that he was seen polishing the objective lens (while mounted in the telescope tube) on many occasions over the next thirty years. Apparently he challenged himself to continually improve its quality.

The equatorial mounting and other mechanical parts were completed in Olsen's workshop during 1884, and in 1885 March the 7-m long telescope tube was mounted on top of a 4-m high pillar inside the observatory building (Figures 6 and 7) in the southeastern corner of the park surrounding the Royal Castle in Oslo (*Naturen*, 1885). This was the largest telescope in Scandinavia at the time (Figure 8). The 36-cm crown glass front lens was separated from the flint glass lens by an air space of 7 mm. The focal length was 680 cm. The equatorial mounting had a mechanical clock drive to track stars, and was

equipped with 48-cm setting circles that could be read to 2 seconds of time in right ascension and 1 arc minute in declination. A collection of eyepieces allowed magnifications of up to 1200 times.

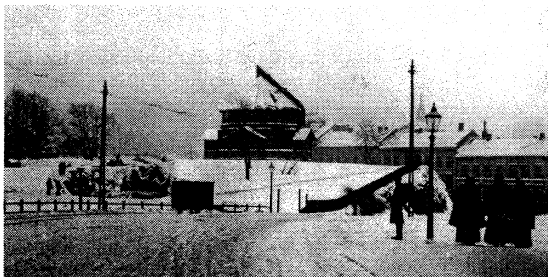


Figure 6. The People's Observatory in Oslo about 1894, viewed from the west.



Figure 7. The People's Observatory viewed from the south.

Olsen named his facility *Folkeobservatoriet*, or the 'People's Observatory',³ and individuals and school classes could view astronomical objects through the telescope and hear Olsen and his assistant lecture on the various objects and other topics. On 1885 August 29, when showing the Andromeda Nebula to a group of visitors, Olsen noticed that the galaxy core had an unusual appearance and he checked his observation several times (Tromholt, 1885). In effect, this was an independent discovery of what today is known as the first supernova in an external galaxy; it had been discovered one and a half week earlier at Dorpat Observatory in Estonia. Olsen operated his People's Observatory until 1894, when it had to be moved to another area of the park because of road construction work by city authorities. During this time it is said to have received 60,000 visitors.

In its new location the foundation for the observatory building was insufficiently set, and some time after re-erecting the telescope, the conical, revolving roof jammed and would not rotate. The People's Observatory was no longer operational. It took more than ten years to raise money for a new observatory building, but by then the observing conditions in downtown Oslo had deteriorated

significantly, and a new location was selected at Holmenkollen, in the hills to the west of Oslo (Figure 9). In 1911, the telescope once again became available to the public (Figure 10). By this time, Olsen was 76 years old, but he was still the driving force and leading personality on the observing floor, although now assisted by his youngest daughter. Many fewer visitors turned up, however, possibly due to the longer travel distance, and the observatory was finally closed soon after Olsen's death in 1921. After being dismantled and removed from the Holmenkollen Observatory, there was a dispute about the ownership of the telescope, and its future use. Finally, parts of the telescope and mounting ended up in various storage locations at the Norwegian Technical Museum in Oslo. Decades later, in 1989, a request to the Museum revealed that the objective, a set of eyepieces, and several small telescope components were still in storage. Subsequently, a search by the author of storage halls containing partially unregistered heavy and large units led to the identification of the major telescope parts, including various pieces of the telescope tube, axes, counter weights, bearings, and the pier. A recent revisit to the new storage premises of the Museum revealed that all major pieces are now identified and collectively stored. This allowed us to measure different features of the telescope and mounting and to reconstruct details of the design.

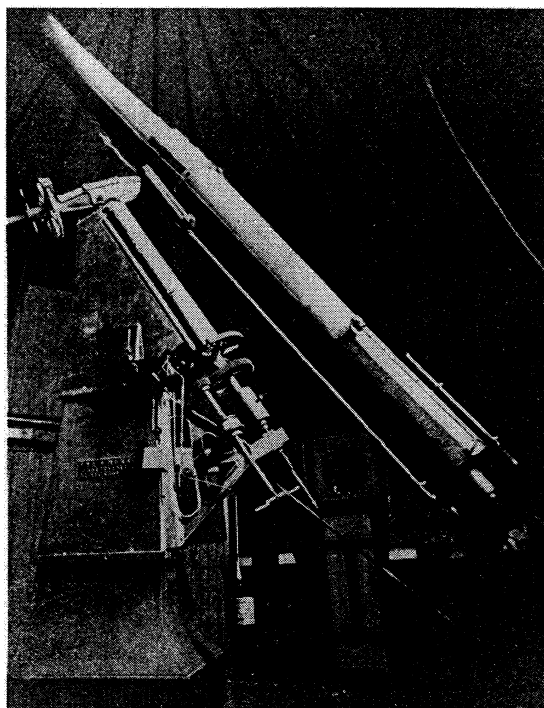


Figure 8. The 36-cm refractor inside the People's Observatory.

5 CONCLUSIONS

After serving both the national surveying community and international geodesy for several decades, the geodetic instruments are in well-preserved conditions in the museum section of the Norwegian Mapping Authority in Hønefoss, the Fram Museum in Oslo, and at the University of Oslo. Two of the astronomical instruments have been 'rediscovered' by tracking printed and hand written sources. The 13.2-cm Merz refractor had already been refurbished by technical

personnel at the University of Oslo when the author accidentally came to know about it and identified it as Olsen's refractor of 1883. The large 36.0-cm Olsen refractor was searched for by the author in unmarked storage areas of the Norwegian Technical Museum, and identified in 1989. A future mounting test is required to determine if all essential parts are present. Hopes are that this large instrument can again be displayed to the public. This study has revealed numerous new and original pieces of information from family sources and the successors of Olsen's company, in handwritten notes, memorabilia, and unpublished family and company photographs.



Figure 9. The observatory at Holmenkollen (recent photograph).

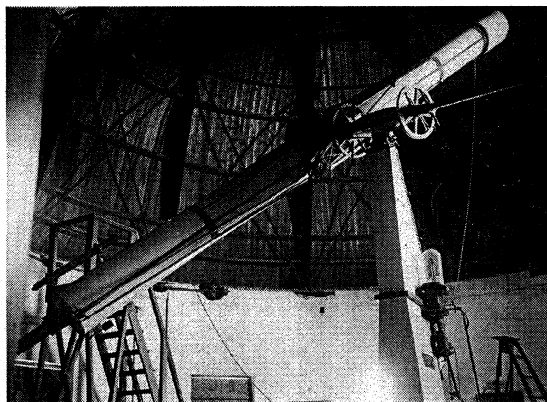


Figure 10. The 36-cm refractor, photographed in 1912 inside Holmenkollen Observatory.

6 ACKNOWLEDGEMENTS

It is a pleasure to thank the staff members of several museums, city and state archives in Norway and Germany, and at the universities of Oslo and Bergen for expertise and assistance in locating documents and other source material. Mr Karl E Ljungmann, Director and owner of the company started by C H G Olsen in 1861, has shared information and photographic material about Olsen, his projects and company, as have a number of Olsen descendants, but notably Mr Alf Cranner.

7 NOTES

1. The 1883 Christiania Exhibition was open from June 16 to October 14 and attracted 238,000 visitors, twice the population of the city at that time!
2. Charles Feil was the son-in-law and business partner of Henri Guinand (1771–1851), a son of

Pierre Louis Guinand (1748–1824) who improved the techniques for producing homogeneous optical glass blanks. This led to Henri's employment with Reichenbach, Utzschneider & Liebherr in Munich from 1805 to 1813, where he collaborated with Fraunhofer for a number of years. Guinand returned to his homeland, Switzerland, in 1813 to start his own glass factory. Upon his father's death, the son brought their optical techniques to France and trained C Feil, who made blanks for the 76-cm refractor at Pulkova Observatory (Strömgren, 1945). Impressed by the quality of the Pulkova blank, Lundin possibly recommended Feil's company to Olsen when he visited Oslo in 1883. Thus, Lundin may have played a key role in the choice of glass for the 36-cm Oslo refractor.

3. A comparable term, *Volksternwarte*, was later in common usage in Germany.

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