THE GRUBB ASTROGRAPHIC TELESCOPES, 1887-1896

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Thomas and Howard Grubb, father and son, made telescopes in Dublin from c.1830 to 1925. The elder Grubb's first telescopes of some size were the 1835 equatorial mounting of a 34-cm Cauchoix objective for E. J. Cooper of Markree Castle, Co. Sligo, Ireland, and a 15-inch reflector for Armagh Observatory (1840), which employed a centrifugal governor and the first mirror-cell with rocking support pads. The firm continued in Newcastle-upon-Tyne in England as Sir Howard Grubb, Parsons and Co.

Of the products of the Irish firm, two large telescopes, built within a few years of each other, marked the transition from father to son. Both were, in their time, the largest of their type. These were the 1.2-m Melbourne reflector of 1870 (Robinson and Grubb, 1869) and the the 68-cm refractor of the Vienna observatory of 1880 (H. Grubb, 1881). During this period, Howard Grubb was experimenting with control of telescope drives by pendulum. It was intended that both of these large instruments would be equipped for photography and for use of a visual spectroscope. William Huggins in London had experimented with a pendulum control of the friction-controlled governor of a Grubb telescope and such a system was provided by H. Grubb for the Vienna telescope.

Up to 1880 most photography in astronomy had been directed towards the planets or the gaseous nebulae in a desire to replace the tedious draughtsmanship required to register details seen visually, but by 1882 it was realised that stellar photography would be a powerful method of carrying out astrometry. This interest, stimulated especially by Sir David Gill, H. M. Astronomer at the Cape, resulted in the Congres Astrographique International being convened in Paris in April 1887. Gill was closely in touch with Howard Grubb of Dublin during this period and Grubb was examining the problems that would have to be solved if a satisfactory astrographic telescope were to be constructed.

The first decade of work by the Astrographic Congress is represented by two series of publications. The proceedings and 80 resolutions of the Congresses, held in April 1887, September 1889, March 1891, and May 1896,

S. Débarbat et al. (eds.), Mapping the Sky, 139–142.

include resolutions which were intended to define the project. Eleven were related to the instruments to be used and it is these that formed the basis of the Grubb design of astrographic telescope, built as closely as possible to the requirements. They specified (inter alia), following the lenses of the brothers Henry in Paris, that the instruments are to be refractors, that the aperture is to be 33 cm., that the focal length is to be 3.43 m. (for scale 1 arcminute = 1 mm.) and that aplanatism and achromatism is to be defined at 430.8 nm.

The second series of publications was the Bulletin of the International Committee. It contained detailed accounts by astronomers and others concerned with the project. David Gill contributed many articles and notes to this series and in some cases he was clearly reporting Howard Grubb's opinion. Grubb himself contributed only a few notes and he is not listed as having attended any of the congresses in Paris.

In Dublin Grubb considered every aspect of the design of his intended instruments most carefully. Between 1889 and 1896 he made seven astrographic lenses for the observatories of Tacubaya (Mexico), Greenwich, The Cape, Oxford, Melbourne, Sydney and Perth and mountings for all except that of Sydney. In Paris the Henrys supplied nine of the remaining lenses used for the Carte du Ciel and the Astrographic Catalogue, the mountings being by Gautier, while two instruments (Potsdam and Helsinki) were made by Repsold. At the onset of the period of construction, Grubb had a 20-inch reflector in progress for Isaac Roberts (King, 1955; Roberts, 1886, 1893). Roberts started a photographic survey of his own using small camera lenses on the same mounting. He wrote (1893):

> "On May 1st 1885, the charting was commenced, and continued till some time after the late Admiral Mouchez, director of the Paris Observatory, in a letter addressed to the President of the Royal Astronomical Society, and read at the meeting held in November 1885, proposed that the charting should be done by the astronomers of all nations, on a uniform plan to be agreed upon between them.....How admirably this was arranged and brought to maturity, under the guidance of Admiral Mouchez and Dr Gill, is now a matter of history, and the work which I had previously begun was consequently superseded."

Roberts' telescope provided only a starting point for Grubb's design. Every mechanical feature seems to have been carefully considered, modified where necessary, and re-designed to give a thoroughly workmanlike final appearance. (The Grubb astrographic telescopes could observe the polar regions, which the Gautier mountings prevented.) Apart from the many details, there were two main areas that exercised the resources and ingenuity of H. Grubb. These were the design of the lens and the arrangements for controlling the telescope driving clock by means of pendulum contacts.

The Congress resolutions specified an "aplanatic" and "achromatic" design for the objective lens. It is probable that the first of these terms was understood to mean freedom from spherical aberration and coma (King, 1955, p.156). Grubb was accustomed to providing lenses to any required wavelength specification but was not thoroughly familiar with coma-free design. A short article (Grubb, 1891) describes an unsure path that he followed in arriving at two coma-free designs, one flint-in-front and the other normally arranged. It was unfortunate that he seemed to find it necessary to use a small amount of non-spherical figuring on one of the surfaces. In general the four radii can be chosen to satisfy achromatism, zero coma, and zero spherical aberration for a particular focal length, if the refractive indices are within an appropriate range, but Grubb does not appear to have been aware of this 'theoretical' solution. He certainly understood the practical need for absence of coma at the edge of the 1-degree field angle and in practice his lenses were very satisfactory. However, the Cape lens had to be returned to Dublin, delaying its installation and the Sydney lens took three years to deliver. At a relatively late stage in constructing the Greenwich instrument, W. H. M. Christie, Astronomer Royal, wrote (Christie, 1890, translated from French):

> "For three months the Greenwich photographic equatorial has been provisionally erected in Dublin. Sir H. Grubb has made use of it to test the objective lenses that he has made. In the middle of December (1889), I went to Dublin to inspect the instrument and to spend time, also, on certain secondary matters. I am very satisfied with the instrument and I doubt that it leaves anything to be desired. I have examined a photograph of the Pleiades, taken with an exposure of 20 minutes, the instrument being completely left to itself.... At the edge of the field (80-90 arcminutes from the centre) the images are very symmetrical with respect to both axes in the plate, radial and transverse."

From the time of the Melbourne telescope, up to the production of the astrographic instruments, Howard Grubb was successively improving the clock-drives of the firm's telescopes. The pendulum-controlled governor of the Vienna refractor, originating with Huggins, possessed an escapement that controlled a friction-pad on the mechanical drive, but the force imposed back on the pendulum tended to interfere with its isochronism. The culmination of Grubb's work by 1888 was the production of a system of electrical control that used one-second signals from a mercury contact on a pendulum to produce a worm shaft turning at a very constant speed. The system (H. Grubb, 1888) was very ingenious and was the basis of the Grubb telescope drive control into the 1930's.

The principle of the clock-control incorporated in the astrographic instruments was to interpose between the governor-controlled motive power and the worm shaft three devices:

1. An epicyclic train capable of accelerating the drive by the action of

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an electromagnet by a ratio 41:40

2. An epicyclic train capable of slowing the drive by the action of an electromagnet by a ratio of 40:41

3. A contact wheel capable of giving electrical contacts to produce pulses on three wipers that would indicate the position of the driving shaft accurately. The centre pulse would correspond to a series of one-second pulses and the two just before and after the centre pulse would correspond to the drive 'leading slightly and 'lagging' slightly.

The pulses operated a kind of two-way relay with a central null position. The pulses originated with the mercury contact of a pendulum of 2-second period: the 'centre' pulse would put the relay into the null position, but if 'early' or late' pulses were produced, an error-signal would be indicated and the appropriate slowing or accelerating electromagnet would be energised. The brushes of the main contact wheel could be finely adjusted to give close control limits, if required.

CONCLUSION

The Grubb astrographic equatorial telescopes were widely used and generally very successful even though the execution of the Carte du Ciel and the Astrographic Catalogue was very prolonged. The Greenwich instrument was provided with a new Grubb Parsons mounting in 1969 after re-erection at Herstmonceux in 1958. The work done by Howard Grubb on the astrographic telescopes made it possible for him to improve on his early Vienna 27-inch refractor so that the Oxford 24-inch refractor, the Greenwich 26-inch instrument, the Cape 26-inch Victoria telescope and other later instruments were capable of being regarded as large astrographic telescopes suitable for parallax work rather than telescopes suitable for single images. The principle of the pendulum 'Grubb Control' developed for the Carte du Ciel astrographs was retained, where required, for over forty years.

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