

# The English equatorial mounting and the history of the Fletcher Telescope

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## Abstract

The first all-metal English equatorial Mounting of the 'Cross Axis' type was constructed in 1859 for a 9.5-in (24.1 cm) Cooke refractor owned by Isaac Fletcher of Carlisle, northern England. Over the next ten years Fletcher used this telescope for systematic observations of known double stars, and after his death it was acquired by S Chatwood of Manchester. In 1902 the telescope was purchased by J T Ward for the newly-formed Wanganui Astronomical Society in New Zealand. Ward used the telescope to discover new southern double stars, and it was also the mainstay of public viewing nights. This educational function has remained through to the present day, and during the 1980s and 90s O Warren reactivated a micrometric double star programme involving the re-measurement of the Ward and other southern double stars. After nearly 150 years, the 'Fletcher Telescope' remains New Zealand's largest operational refractor, and has been maintained in excellent mechanical and optical condition.

**Keywords:** *double stars, English Equatorial Mounting, I. Fletcher, J.F. Miller, Ward (Wanganui) Observatory*

## 1 INTRODUCTION

The English equatorial mounting has a long and distinguished history (see Gingerich, 1967; King, 1979). There are two principal varieties:

- the 'Through Axis' type, where the tube of the telescope "... passes between, and is pivoted from, two or more structural elements of the polar axis ..." Hingley (n.d.), and
- the 'Cross Axis' type, where the telescope "... is pivoted to one side of the single polar axis and thus needs a counterweight on the other side." (ibid.).

The Palomar 'Horseshoe Mounting' should be regarded as a special variant of the 'Through Axis' type that permits direct access to the celestial pole, and its origins have recently been traced back to nineteenth century Australia (Orchiston, 2000).

Hingley (op. cit.) discusses the history of both types of English equatorial mounting, and shows that an important advance took place when a cast-iron 'Cross Axis' mounting was manufactured for a 9.5-in (24.1 cm) f/15.2 Cooke refractor owned by Isaac Fletcher. This was the first time that metal (rather than wood) had been used in the overall construction of an English equatorial mounting. As such, Fletcher's telescope serves, in zoological parlance, as a *type specimen*, and it is of interest to trace its chain of ownership and use. After discussing its English affiliations, this paper focuses on the circumstances leading to the relocation of the telescope to New Zealand in 1902, and its subsequent use for research and for the popularization of astronomy.

## 2 THE ENGLISH HISTORY OF THE TELESCOPE

There is some confusion surrounding the early history of the 9.5-in refractor, and it is only possible to unravel the facts of the matter by critically examining various publications that specifically mention this telescope. At the root of the problem is King's claim (1979:251) that in about 1851 Thomas Cooke manufactured a 9.5-in refractor for a John Fletcher Miller (1816-1856), who lived at Whitehaven on the south-western shore of Solway Firth. One of Miller's astronomical contemporaries in far north-western England was Isaac Fletcher (1827-1879), who lived at Greysouthen, near Carlisle, and it is clear from their publications that the two men knew each other (e.g. see Miller, 1853). Miller died in 1856, and it is a reasonable assumption that

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the 9.5-in Cooke refractor then passed to Fletcher, as he is known to have been in possession of just such an instrument during the 1860s. This is a plausible story, but what is the truth of the matter?

Published papers by Fletcher (1853) and Miller (1852) indicate that Cooke did indeed make a refracting telescope for Miller, and in 1851, but the aperture was actually 4.14 inches (10.5 cm) not 9.5 inches, and it is clear from Miller's obituary that he never acquired a larger instrument (Obituary, 1857). Meanwhile, Fletcher had a refractor of identical aperture, which Cooke had made for him in 1847 (Fletcher, 1850), and the only difference between the two instruments was in their mountings: Fletcher's featured a wooden English equatorial and Miller's a German equatorial (Miller, 1853). Both men used their telescopes for micrometric observations of double stars and published their results in the *Monthly Notices* and the *Memoirs* of the Royal Astronomical Society. Where the same stars were involved, they included each other's measures in some of their publications (e.g. see Fletcher, 1853, 1855; Miller, 1852). Furthermore, both astronomers were elected to Fellowships of the Royal Astronomical Society in 1849, and each subsequently became an FRS (see Obituary, 1857; Obituary, 1880).

Miller died in 1856 at the youthful age of 40 (Obituary, 1857), and on April 24 in the following year Fletcher placed an order with Cooke for a 9-in refractor costing £400 (Orders ..., n.d.) in order to dramatically increase his available light grasp (see W.H. Smyth, 1860). The actual aperture of the completed telescope was 9.5 inches, and delivery took place towards the very end of 1859 (Jacob, 1860; W.H. Smyth, 1860; cf. Crossley, Gledhill and Wilson, 1879). Regardless of the precise date, this was a new telescope that was specifically made for Fletcher by Cooke, and it was in no way associated with Miller. The parallels between the two men in relation to their instruments, observations, publications and FRAS election, and the common 'Fletcher' element in both their names, may go some way towards explaining King's version of events. He may also have been misled by the statement that Miller's Cooke telescope was "... of the same size as Mr. Fletcher's instrument." (Crossley, Gledhill and Wilson, 1879:49). Crossley *et al.* were, of course, referring to Fletcher's smaller refractor.

Captain Jacob (Director of the Madras Observatory) provides an account of Fletcher's new acquisition in an 1860 issue of *Monthly Notices*:

The telescope in question is the property of our worthy Fellow, J. Fletcher, Esq., of Tarnbank, where it has been but recently erected by him; the optical portion by Cooke, of York; but the mounting, a long polar axis of cast-iron ... has been executed under Mr. Fletcher's direction at an engineering foundry at Whitehaven, belonging to one of his brothers....

The mounting seemed remarkably firm, and so smooth in its movement, that, with the telescope slightly under-counter-poised, a star could be well followed and kept pretty near the centre of the field by gentle pressure with the finger. On the whole, I should say it was creditable both to the designer and the maker, and that in such able hands it is likely to prove a most efficient instrument ... (Jacob, 1860: 248-249).

Accompanying the telescope were "... a double-image micrometer of varying powers, a wire micrometer with positive magnifiers to 1,000, and a battery of negative eye-pieces ranging from 25 to 1,500." (W.H. Smyth, 1860:304).

W H Smyth's son (see Brück and Brück, 1988) was a friend of Isaac Fletcher, and the Piazzzi Smyth Collection in the Royal Observatory Edinburgh (Brück, 1988) includes a diary documenting his visit to Greysouthen in 1860 April:

Isaac Fletcher describes his new equatorial. Object glass by Cooke, 9.5 sees 7 Satellites of Saturn and perhaps an 8<sup>th</sup> at least as much as Sir W. Herschel with a four foot reflector.

Polar axis of home make i.e. at his brother's foundry. of English form with telescope on one side; cast in iron in one piece – 15ft long ... (C.P. Smyth, 1860).

Of particular interest is the mounting, for this was the very first time that an all-metal English equatorial mounting had been used in telescope design and construction.<sup>1</sup> It was manufactured "... expressly at the Lowca Engine Works belonging to Messrs. Fletcher, Jennings, and Co. near Whitehaven. " (W.H. Smyth, 1860:302-305); as we have seen, Henry A Fletcher was Isaac Fletcher's brother. This innovative design, which was in part inspired by the smaller wooden mounting used by W H Smyth at his Hartwell Observatory (Smyth, 1860), is described in an 1865 issue of *Monthly Notices*:

The middle portion of the axis, which is pierced for the declination axis, is a tube of 17 inches, the metal being one inch thick. From the central cube to each extremity the axis is circular in section, and tapers from 16 inches diameter at the cube to 8 inches near the ends, where it spreads out as a moulded flange to give sufficient strength to carry the pivots. The thickness of the metal in the conical portions diminishes gradually from  $\frac{3}{4}$  inch to  $\frac{3}{8}$  inch. The cube is planed accurately, and the rest of the axis very carefully turned. The declination axis is of hammered iron,  $4\frac{1}{2}$  inches diameter; it is carried *direct* by the polar axis without the intervention of either bushes or friction rollers; a boss is cast on the *inside* of the cube on the telescope side, of sufficient depth to give a bearing  $4\frac{1}{2}$  inches long, and a similar boss is cast on the *outside* of the cube, on the counterpoise side, which gives a similar length of bearing. As there are no means of adjusting the declination axis, great pains were taken to bore out the bearings at right angles with the polar axis ... One end of the declination axis carries a strong cradle of cast-iron, to which the tube is fixed by means of four very strong clasps; the opposite end carries the counterpoise. The pivots of the polar axis are of wrought-iron,  $2\frac{1}{2}$  inches diameter; they work in brass bearings without friction rollers, but have the necessary adjustments. The hour-circle is of gun metal, 42 inches diameter; the declination circle is cast from the same pattern, and reads off by opposite microscopes to single seconds...

The total weight of the *moveable* portion of the mounting is upwards of  $1\frac{1}{2}$  tons, yet the instrument may be moved either in hour-angle or declination with a finger, and a clock-weight of 45 lbs. (acting on the clock of  $22\frac{1}{2}$  lbs.) is sufficient to drive it with the greatest regularity. (Fletcher, 1865a: 242-243; c.f. W.H. Smyth, 1860: 303-304).

C P Smyth (1860) also includes a number of interesting sketches in his diary. Fletcher (1865a:243) was proud of this newfangled mounting, and was quick to proclaim that "In regard to *firmness*, I do not think this instrument is surpassed by any ..." It was this 1865 paper which led Harper (1992; see also Harper, Warren and Austin, 1990) to erroneously associate this date with the actual manufacture of the telescope.

Although we have stressed the unique nature of the mounting, the telescope itself was an achievement as it was "... one of the largest telescopes yet made in England ... and may serve to show that it is not now needful to go abroad in order to procure a first-rate instrument." (Jacob, 1860:247-248). Cooke only opened the Buckingham Works at Bishopshill in 1855, and the telescope was important for his burgeoning reputation (see King, 1979; McConnell, 1992; Smiles 1884). More specifically, an examination of the firm's first order book reveals that at the time it was made the Fletcher telescope ranked as Cooke's largest refractor, surpassing two 8-in (20.3 cm) instruments (for J Nasmyth and W Hartree) ordered in 1857 (Orders ..., n.d; cf. Smiles, 1884). Fletcher's telescope also rated highly on an international scale (see Table 1 below, after Crossley, Gledhill and Wilson, 1879; Howse, 1986; Krisciunas, 1988; Welther, 1984; Whitesell, 1998), the equal largest operational refractors in the world at that time being the 15-in Merz & Mahler instruments at the Pulkovo and Harvard College Observatories (see van Helden, 1984).

Table 1. Some operational refractors with apertures exceeding 9.5 inches in 1859.<sup>2</sup>

Aperture	Manufacturer	Observatory
15.5-in (39.4 cm)	Merz & Mahler	Harvard College
14.93-in (37.9 cm)	Merz & Mahler	Pulkovo
13.3-in (33.8 cm)	Cauchois	Colonel E.J. Cooper
12.8-in (32.5 cm)	Merz & Mahler	Royal, Greenwich
12-in (32.5 cm)	Merz & Mahler	Cincinnati
12-in (30.5 cm)	Fitz	Detroit
11.6-in (29.5 cm)	Cauchois	Cambridge University
11-in (27.9 cm)	Ross	Mr J.W. Grant
11-in (27.9 cm)	Amici	Royal, Florence
10-in (25.4 cm)	Merz & Mahler	Kazan University
9.75-in (24.8 cm)	Fitz	West Point
9.6-in (24.4 cm)	Fraunhofer	Dorpat
9.6-in (24.4 cm)	Merz & Mahler	U.S. Naval
9.6-in (24.4 cm)	Fraunhofer	Royal, Berlin

In order to house his new telescope Fletcher built a commodious new Tarn Bank Observatory (Figure 1), with an 18-ft (5.5 m) diameter dome that revolved on eight railway wheels of 12-in diameter (W.H. Smyth, 1860). C P Smyth's diary (1860) contains details and sketches of the dome, and a plan of the Observatory, which housed a number of other instruments including a transit telescope by Simms and an astronomical clock by Frodsham. Fletcher believed this facility was one of "... the best and most complete observatories in private hands in existence." (Mr. Fletcher's Observatory ..., 1866).

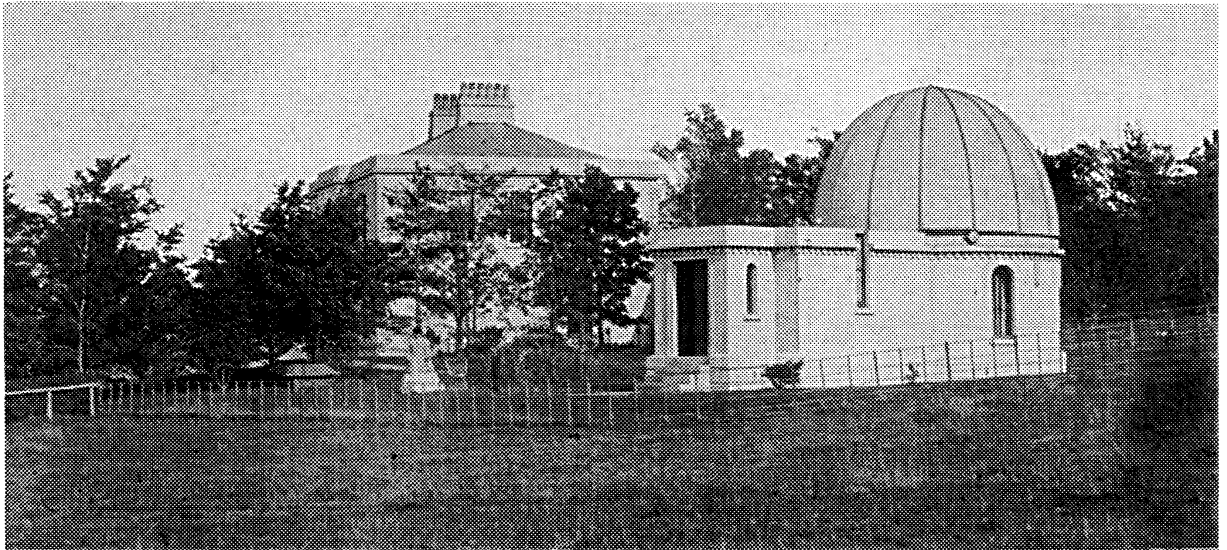


Figure 1. Fletcher's residence and his Tarn Bank Observatory (Courtesy: Royal Astronomical Society).

Initially, Fletcher used the Cooke telescope to examine the double star,  $\zeta$  Herculis (Fletcher, 1865b), and his observations of solar granulation clarified the controversy over their true nature by reinforcing the views of Sir William Herschel and W R Dawes and conflicting with the explanation put forward by J Nasmyth (see Fletcher, 1865c, 1865d). But he had much grander plans for the Tarn Bank Observatory, which he believed boasted "... one of the finest telescopes in this country ..." (Fletcher, 1865d:25). He intended to re-observe the objects in Smyth's Bedford Catalogue, and

... when that is done, it is his intention to bring out a new edition of Admiral Smyth's *Cycle of Celestial Objects*, for which purpose the Admiral, some time ago, made over to him his entire interest in that work. (Mr. Fletcher's Observatory ..., 1866; cf. W H Smyth, 1860).

W H Smyth died in 1865, and Fletcher was left with what can only be described as a mammoth undertaking. After all, Smyth's two-volume book, published in 1844, ran to a little over 1100 pages of text, more than half of which comprised the remarkable 'Bedford Catalogue'. Chapman (1998:80) has written an excellent evaluation of this indispensable tool of the nineteenth century observational astronomer:

The *Cycle* provides a wealth of information about the equipping of observatories and an evaluation of instruments ... But it is in the second volume of the 1844 *Cycle*, known as the *Bedford Catalogue*, that we see the celestial 'harvest' of which Smyth spoke. Here is a detailed description and analysis, occupying some 543 pages, of hundreds of binary, variable, and coloured stars in 70 constellations. No one can read these pages without appreciating the thousands of hours of sheer hard observing, undertaken purely for the 'love' of astronomy, that lay behind Smyth's book.

Smyth based his 'Bedford Catalogue' upon observations carried out with a 5.9-in (15 cm) Tully refractor (see the diagram in Smyth, 1844, I:338), a much smaller instrument than Fletcher's 9.5-in Cooke, so different field sizes and limiting magnitudes were involved, particularly

important factors for nebulae and star clusters. Moreover, all of the double stars needed to be re-measured as their position angles and separations would, in most instances, have changed since Smyth's initial observations of the 1830s.

Fletcher responded to the challenge and for several years he "... systematically collected materials for the revision of the work." (Smyth and Chambers, 1881:vii, cf. Mr. Fletcher's Observatory, 1867), although one cannot help but wonder if he completely understood the magnitude of the task before him. As it turned out, a non-astronomical factor put paid to this ambitious project once and for all, for in 1868 Fletcher "... exchanged in great part his scientific career for a political one by becoming Member of Parliament for Cockermouth." (Smyth and Chambers, 1881:vii). One consequence of this was that no further papers in Fletcher's name were to appear in *Monthly Notices* or in the *Memoirs* of the Royal Astronomical Society.

Fletcher finally took his own life in 1879, at the age of 52 (Obituary, 1880), and by that time the 'Bedford Catalogue Project' had passed to George Chambers. The 'Revised, Condensed, and Greatly Enlarged' Second Edition emerged from the Clarendon Press at Oxford in 1881. As a single weighty tome of about 700 pages (see Smyth and Chambers, 1881), this was a worthy successor to Smyth's original Volume II.

After Fletcher's death, the 9.5-in Cooke refractor passed to Samuel Chatwood, the successful and "... well-known bankers' engineer ..." (Baker, 1902) who owned the Chatwood Lock and Safe Company (Beaumont, 1963b). Chatwood does not disclose whether he acquired the telescope from the estate immediately after Fletcher's death or at a later date, but we do know that he installed it in a new observatory adjacent to his home at Worsley, near Manchester (see Figures 2 and 3). If the singular lack of published papers in the *Journal of the British Astronomical Association*, *Monthly Notices of the Royal Astronomical Society* and *The Observatory* is anything to go by, we must assume that Chatwood made little if any attempt to use this excellent telescope for serious research before selling it, in 1902, to the Wanganui Astronomical Society in New Zealand.

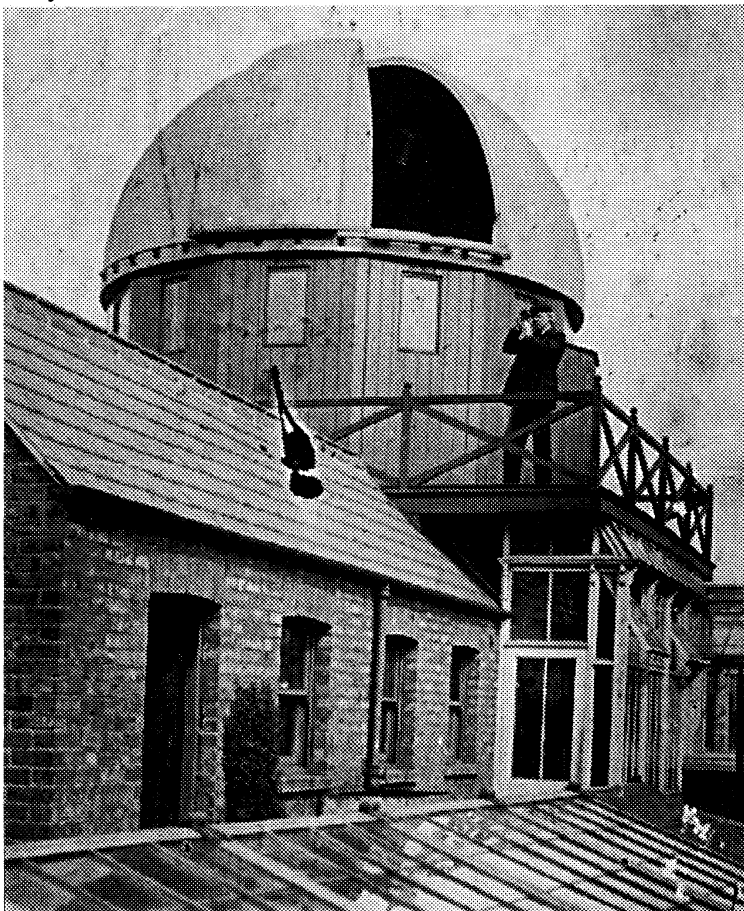


Figure 2. Mr Chatwood's Observatory; the man with the sextant is Dr Fison (Courtesy: Ward (Wanganui) Observatory Archives).

### 3 THE NEW ZEALAND HISTORY OF THE TELESCOPE

In this Section, we shall discuss separately the transfer of the telescope to New Zealand and its subsequent role and function.

#### 3.1 Transfer to New Zealand

The transfer of the telescope to New Zealand was effected by Joseph Thomas Ward (see Figure 4), a prominent New Zealand amateur astronomer during the first three decades of the twentieth century and a member of the British Astronomical Association (see Beaumont, 1963a; Calder, 1978a; Orchiston, 1996b). Born in England on 1862 April 7, Ward migrated to New Zealand in about 1880 and in 1896 he and his wife settled in the North Island coastal town of Wanganui (which is about 150 km due north of the capital, Wellington). There he opened a bookshop and stationery business, and also taught the violin. From an early age he had been interested in astronomy, and in about 1899 he purchased a 4.5-in (11.4 cm) refracting telescope. When the Great Comet of 1901 (C/1901 G1) appeared, townsfolk flocked to view it through this instrument.

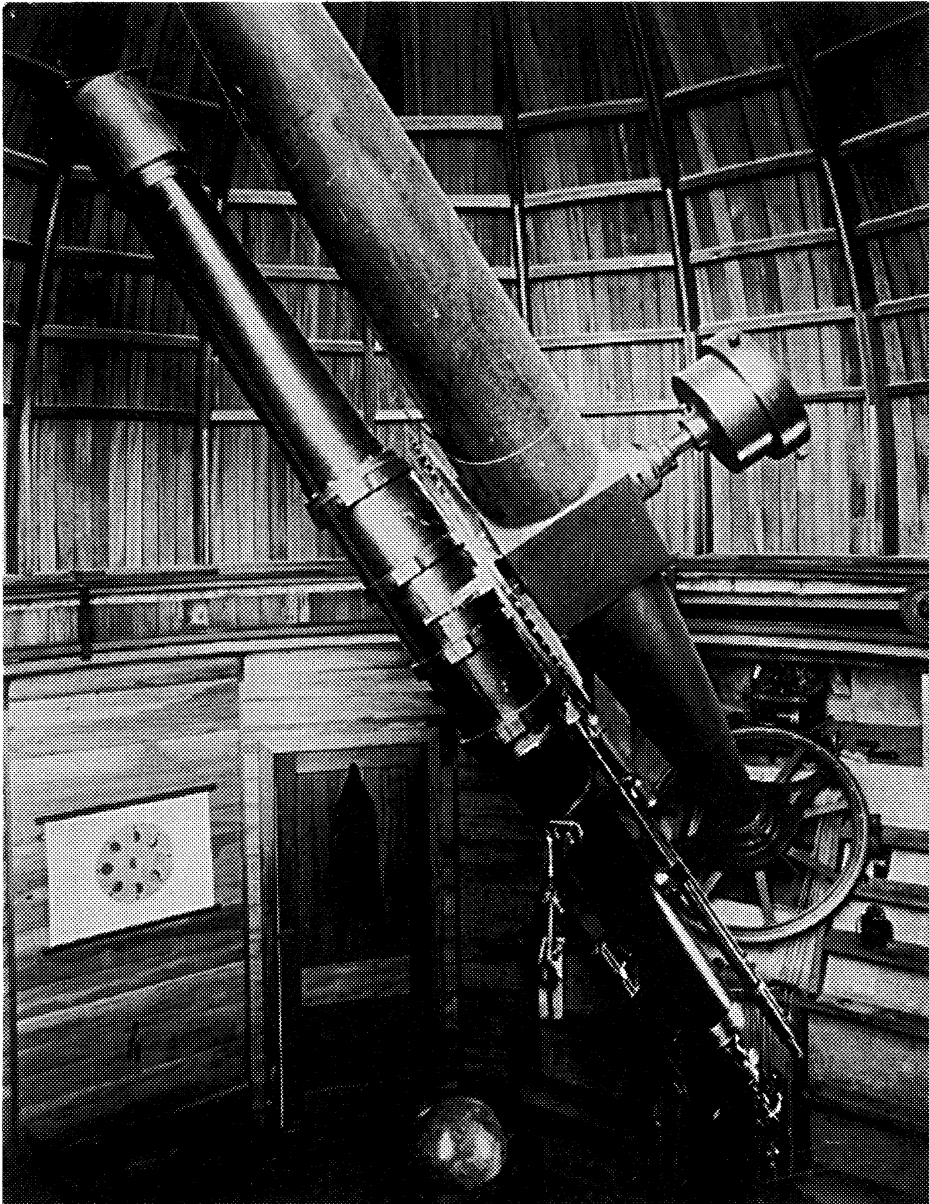


Figure 3. A view of the Cooke Telescope and mounting at Mr Chatwood's Observatory (Courtesy: Ward (Wanganui) Observatory Archives).

In this same year Professor R C Maclaurin from Wellington gave a public lecture on astronomy in Wanganui, and Ward used this as the catalyst to form the Wanganui Astronomical Society. As might be expected, Ward was elected to the Presidency, a post that he was to occupy until his death in 1927. One of the first decisions made by the new Society was to establish an observatory, and the committee set about fund-raising. They also obtained a suitable site in suburban Cook's Gardens from the Borough Council. Ward, meanwhile, was busy searching for "... a very large telescope capable of research as well as public observation ..." (Beaumont, 1963b:6).



Figure 4. Joseph Ward, 1862-1927  
(Orchiston Collection).

Thrush (1963) recounts how Ward succeeded in tracking down three suitable instruments in England: 8-in (20.3 cm) Grubb and Clark refractors and a 20.5-in (52.1 cm) Calver reflector, and by 1901 October the Society had decided to purchase this last instrument. After part of the purchase price of £400 had been dispatched to the Bolton firm of Banks & Co., a cable arrived from a Mr Chatwood advising that the payment should be stopped as he was the owner of the reflector and Banks & Co. had not been authorized to sell it!

Fortuitously, Chatwood also owned the ex-Fletcher 9.5-in Cooke refractor with the prototype metal English equatorial mounting, and he decided to make that instrument available to the Society. Negotiations on his behalf were entered into by Charles Baker of London, and in a letter dated 1902 March 27 Baker stressed the telescope's optical quality:

I have had consultations with Mr. Maunder, and with Mr W.H. Maw, Treasurer of the B.A.A. who express themselves satisfied with the instrument; and Mr Chatwood informs me that Dr Fison, Mr Antoniadi and Sir Robert Ball, who have used his instrument, all say that the object glass in a beauty. (Baker, 1902).

As an added incentive, Baker offered an extremely attractive purchase price of just £400, but when the cost of constructing an observatory was added to this the Society was facing a

daunting task for a city with a population of just 6,000 since "The [total] amount needed would be at least the equivalent of two years salary for the average citizen." (Venimore, n.d.:12). In fact, the price soon proved to be even higher, for the Society agreed to pay an additional £50 to Mr Chatwood for some improvements he made to the telescope and for some extra equipment that he added to the consignment.

Yet the all-up cost did not deter Ward and his colleagues, and at their meeting on 1902 May 2 the Committee voted to accept Baker's offer. Mr Chatwood (1902) was quick to point out that the Society had got itself a bargain, for "Under other circumstances ... I would not have sold the instrument for less than £750. It could not be replaced [today] for less than £1250 ...". The instrument was then dismantled and packed ready for shipping on *S.S. Indravedi*. In 1902 December the vessel reached New Zealand, and the telescope was placed in storage pending the construction of an observatory.

The Society's 20-ft (6.1 m) diameter 16-sided wooden observatory was designed by a local architect named Atkins from drawings and a model provided by Ward, and its construction was completed in early 1903 May (Figure 5) at a cost of £277-12-6. The massive supports for the telescope mounting were a special feature, and weighed heavily on the mind of a 4-year old boy who 75 years later was to recall how he "... clearly remembers the day the heavy cast-iron pillar of the mounting was erected. His father provided the lifting gear the foundry used ... and a gang of willing helpers provided the manpower that lifted the pillar into place." (Calder, 1978b:4). This pillar and the 40 ton concrete foundation made to support the lower end of the polar axis are shown in Figure 6, along with the outline of the observatory building.

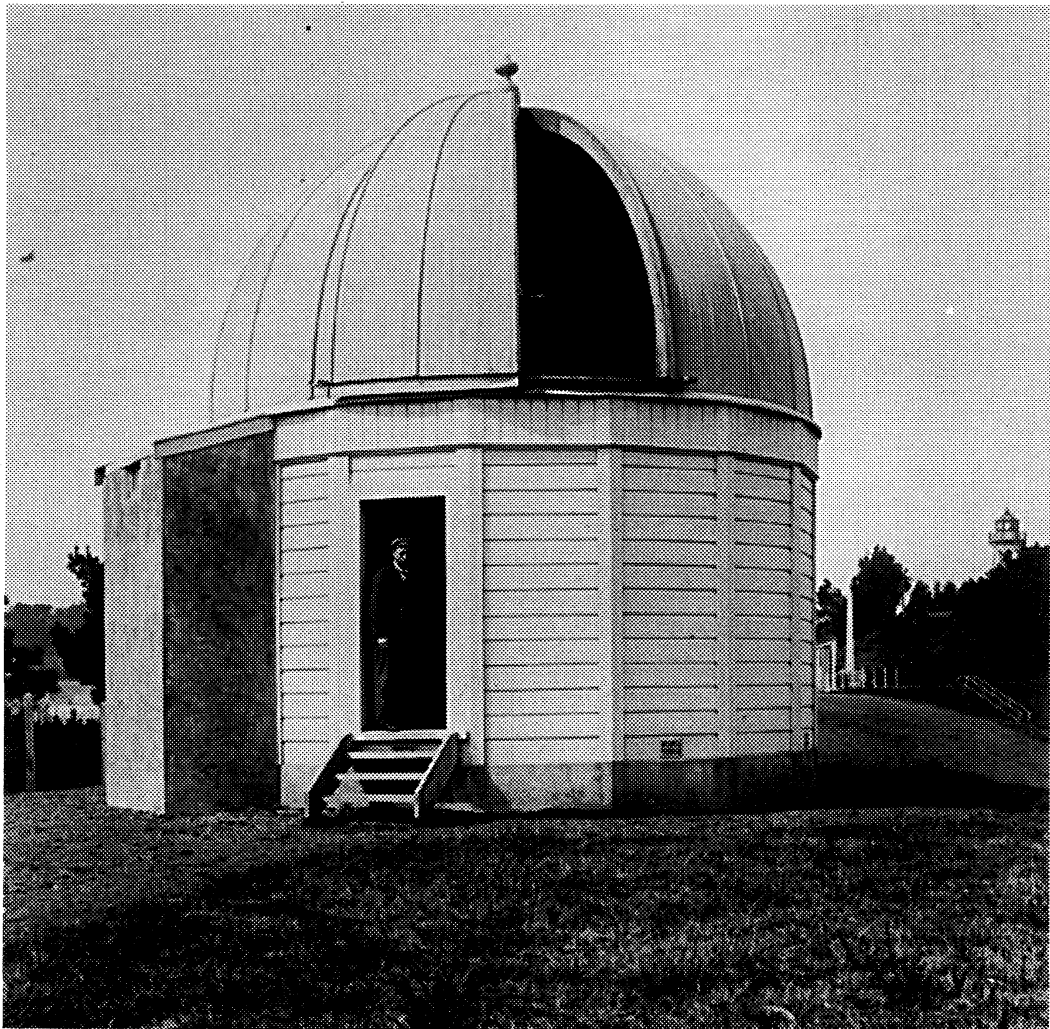


Figure 5. The completed Ward (Wanganui) Observatory  
(Courtesy: Ward (Wanganui) Observatory Archives).



Now came the installation of the telescope and mounting, in good time for the official opening of the observatory by the Premier of New Zealand, the Right Honourable Richard Seddon, on 1903 May 25. Beaumont (1963b:7) describes what a perceptive Seddon would have seen:

The 9½-inch refractor has a 12-ft. focus and is equipped with a 2½-inch finder. There is a battery of eyepieces magnifying from 32 to 750 diameters; filar and position micrometer with divided heads in silver, position circle on silver, reading by opposite verniers; Cooke's two-movement adaptor for centring an object; solar and stellar diagonal eyepieces; Dawes eyepiece for observing the Sun; aluminium shutter to object glass. The telescope is mounted on what is known as the English form of equatorial. It is supported on a massive axis, weighing nearly two tons, which rests at one end on a large iron bracket, which is fastened to a cast-iron column 12 ft. high of architectural proportions. The lower support for the axis is [an] adjustable stopping-piece of brass resting on iron bearings, and moved by set screws in azimuth... A powerful driving clock is attached to the edge of the circle at the lower edge of the large axis, which is kept in motion by a weight attached to a steel cord, and working on the clock at a pressure of 22½ lbs. By this manner an object can be kept in the telescope in the centre of its field for purposes of photography, drawing or measurement.

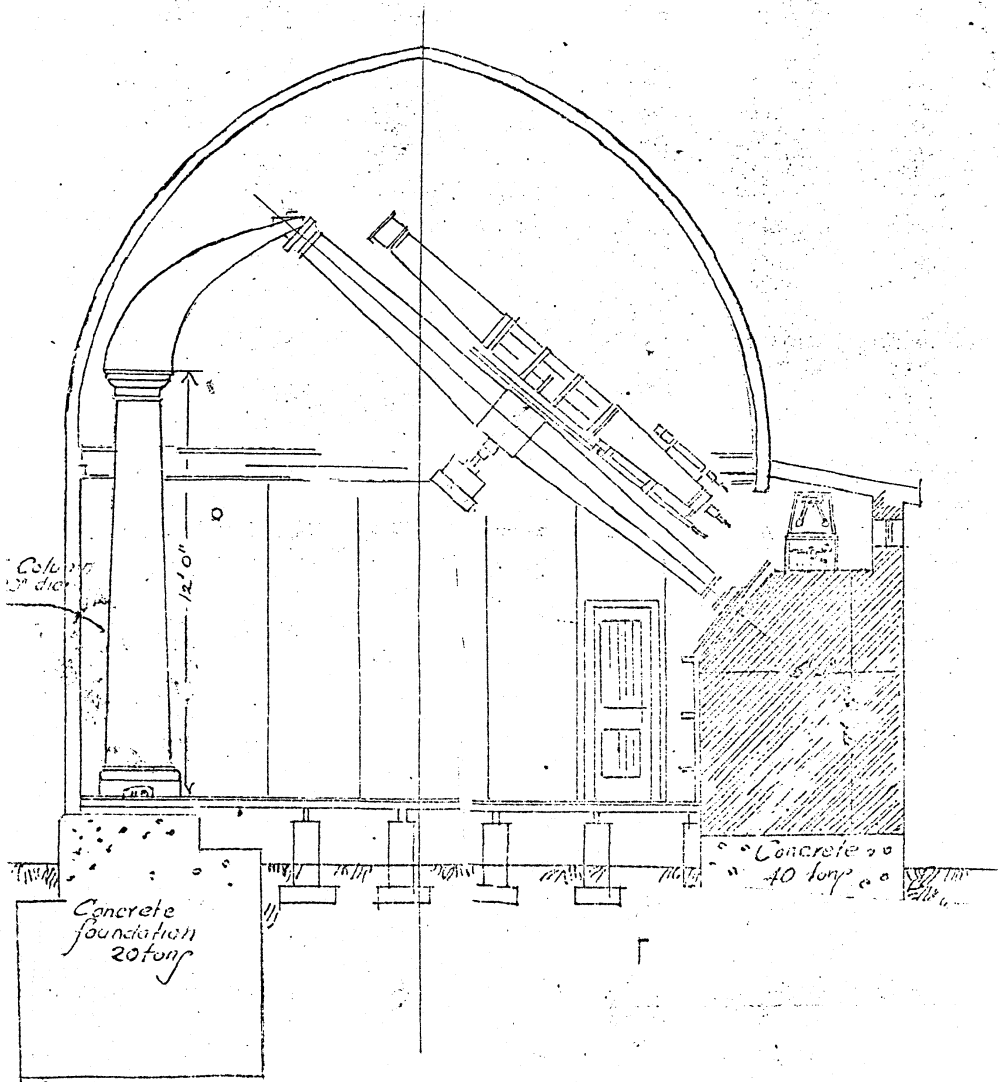


Figure 6 Section drawing showing the Ward (Wanganui) Observatory, telescope and mounting, and supports for the mounting (Courtesy: Ward (Wanganui) Observatory Archives).

Figure 7 shows a close-up view of the lower end of the polar axis, the oversized 42-in (1.07 m) diameter RA circle, and the eyepiece end of the main telescope tube and finder, complete with RA and declination clamps and slow motion controls.

Ward was appointed Honorary Director of the Observatory, a post that he was to retain until his sudden and unexpected death on 1927 January 4 at the age of 65. Nine months earlier, ownership of the Observatory had been transferred from the Astronomical Society to the Borough Council. One of Joseph Ward's sons who happened to inherit a passion for astronomy was prophetically named William Herschel Ward, and in 1927 the local Council arranged for him to succeed his father as Honorary Director of the Observatory, a role that he fulfilled with distinction until 1959 (W.S.T., 1975).

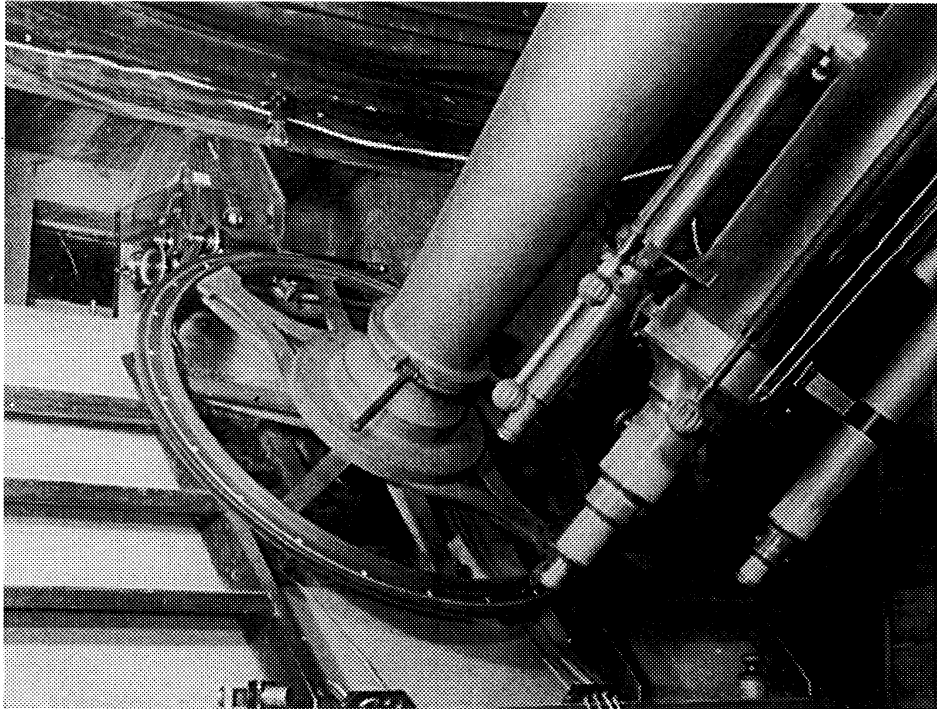


Figure 7. View of the lower end of the polar axis and main telescope tube (Orchiston Collection).

The Observatory is nowadays known officially as the 'Ward (Wanganui) Observatory' in honour of its founder (Beaumont, 1963b), and in spite of its antiquity the historic Cooke telescope remains the largest operational refractor in New Zealand marginally surpassing the better-known 23 cm Cooke at the National Observatory of New Zealand in Wellington (see Orchiston, n.d. (a), 1996a).

### 3.2 Role of the Telescope in Recreation and Research

Joseph Ward was quick to recognize the potential of what was then by far the largest refractor in New Zealand, and he was keen to find a suitable research programme for it. He began by canvassing the views of Australia's leading astronomer, John Tebbutt (Ward, 1903), and in 1904 he and his assistant, local lawyer Thomas Allison, commenced a search for new double stars in selected areas of the southern sky, mainly "... along the southernmost sections of the Milky Way among the constellations Triangulum Australe, Centaurus and Musca, between  $-50^\circ$  and  $-80^\circ$  south declination." (Harper, Warren and Austin, 1990:283). In the course of the next six years they made 212 discoveries (see Warren, 1991), although unbeknown to Ward many of these had previously been detected by others (Innes, 1911). Today, 88 of these stars are recognized as 'Ward doubles' (Harper, Warren and Austin, 1990) and appear with NZO (New Zealand Observatory) listings in international double star catalogues, thereby serving as a memorial to Ward's international contribution in this specialized field of astronomy.

In addition to double stars, Ward also observed sunspots (Venimore, 1988), and 15 drawings of Mars that he made in 1905 were forwarded to the British Astronomical Association

(see Antoniadi, 1910). He also used the Cooke refractor to carry out numerous observations of Comet 1P/Halley in 1910 (see Mackrell, 1985).

It should be mentioned that in addition to using telescopes Ward was one of that rare breed that also enjoys manufacturing them, and over the years he made many refractors and reflectors of modest aperture. Undoubtedly his crowning achievement was a 20.5-in (52.1 cm) equatorially-mounted Newtonian reflector completed in 1924 (Venimore, 1988), which for 40 years remained the largest reflecting telescope manufactured by a New Zealand amateur astronomer. Further information on Ward's pioneering efforts in telescope-making is provided in Orchiston (n.d. (b)).

Another of Ward's important contributions to New Zealand astronomy was in popularizing the wonders of the southern sky, and two evenings a week he ran 'public viewing nights' at the Wanganui Observatory (Venimore, 1988) where he used the old Cooke telescope to eagerly share his love and knowledge of astronomy with visitors. As one writer so aptly put it, "... he loved the telescope to read the open volume of the sky." (cited by Beaumont, 1963a:14). Meanwhile, through his monthly column, 'Astronomical Notes', which appeared in the *Wanganui Herald* newspaper for twenty-two consecutive years from 1904, he was able to bring astronomy to a much wider audience, and help raise the level of astronomical literacy in the general population.

Despite these various achievements, some have painted an even more glowing picture of Ward, suggesting that he proposed "... several theories concerning the movement and nature of heavenly bodies, which were accepted by leading authorities." (Beaumont, 1963a:13); that "In his time he was considered one of the world's foremost astronomers." (Beaumont, 1963b:7); and that "His writings were more widely known abroad than in New Zealand due to their publication in many British and French astronomical journals." (Rice, 1982:272). In reality, there is no basis for these exaggerated claims. Although Ward did indeed discover a number of new double stars (as, also, did other astronomers at about this time), he actually published nothing of substance in international journals (but see Venimore, 1988:156; Ward, 1906, 1910). He was not even destined to publish his own double star discoveries. In 1907 he sent a list of these to the British Astronomical Association but they decided not to publish this (Harper, Warren and Austin, 1990), and his catalogue was eventually published in South Africa by Innes in 1911 (although Ward did manage a half-page note about it in the *Journal of the British Astronomical Association* in 1908)! Yet these comments should not blind us to Ward's notable contribution to Wanganui and New Zealand astronomy.

What of the Ward (Wanganui) Observatory today? It is only fitting justice that the observing tradition begun by Fletcher in the 1860s and followed by Ward has in more recent times been perpetuated by Ormond Warren. During the 1980s and 1990s, he used the historic Cooke telescope and its original Cooke Type-A bifilar micrometer to carry out a re-examination of the 'Ward doubles' (e.g. see Warren, 1991, 1995) and to measure the position angles and separations of other southern double stars (e.g. Warren, 1992a, 1992b, 2000). Furthermore, the dedication to astronomical education espoused by Joseph Ward and his son (Thrush, 1963) also is a current priority with the Wanganui Astronomical Society (see Harper, 1992), and the Cooke refractor remains the focal point of their regular public viewing nights.

As to the telescope itself, a recent critical examination of the 9.5-in achromatic objective has confirmed the earlier evaluations of Ball and Antoniadi as to its performance. Nankivell (1994:9) found that in spite of the passage of the years it

... is in a very good state of preservation. The crown lens shows some slight incipient smearing of the front surface ... [but] There are very few scratches of any consequence. The flint lens is free of any obvious tarnish patches. There are one or two "lead spots" about 2-3 mm diameter. Some localised water stains were noted close to the edge...

With the provision of reasonable care, this objective should perform well for another 100 years.

The present appearance of the telescope is impressive, with the cast-iron polar axis painted an attractive shade of blue and the declination axis (plus counterweight) and tube of the main telescope a pale grey. The natural brass finish of the eyepiece assembly and of the finder has been retained.

#### 4 CONCLUDING REMARKS

New Zealand's largest operational refractor is the 9.5-in f/15 Cooke telescope at the Ward (Wanganui) Observatory, which has some claim to fame as the first telescope in the world to be furnished with a cast-iron (as opposed to wooden) English equatorial mounting of the 'Cross Axis' type.

This instrument was manufactured in 1859 for I Fletcher of Carlisle, and was later owned by S Chatwood of Manchester before transferring to New Zealand and the observatory of the Wanganui Astronomical Society in 1902-03. Fletcher and Ward (at Wanganui) both used the telescope for serious positional astronomy (including the observation of known double stars and the search for new ones) and published a number of papers on their work, while at Wanganui the telescope also was the focal point of a popular 'public viewing' programme.

After a heritage of nearly 150 years this historic telescope is in remarkably fine condition, and it continues to contribute to serious observational astronomy and to the popularization of astronomy.

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#### 6. NOTES

- 1 However, the Fletcher refractor was not the first astronomical instrument with a part-iron English equatorial mounting. In 1775 Bird made an equatorial sector for the Radcliffe Observatory, and this featured a plywood laminated single iron axis, 7½ feet long, 3 inches square in the middle and tapering to about 2 inches at the ends (Chapman, 1995). In 1993 the remains of this historic instrument were discovered by Allan Chapman and Tony Simcock in a 'store hole' at Oxford (A. Chapman, pers. comm., August 2000).
- 2 Compiling this table was a challenge as different authors sometimes give differing apertures for the same instrument, depending upon their sources of documentation, the effects of rounding (e.g. 9.6-in becomes 9.5-in and 14.93-in and 15.5-in both become 15-in), and whether total or clear apertures were involved. Where such variations occurred, I generally (but not always) opted for the dimensions given in Howse (1986).

#### 7. REFERENCES

- Antoniadi, E.M., 1910. Section for the observation of Mars. Report of the Section, 1905. *Memoirs of the British Astronomical Association*, **17**(2):35-64.
- Baker, C., 1902. Letter to J.T. Ward, dated 27 March. Original in Ward (Wanganui) Observatory Archives.
- Beaumont, L.R.H., 1963a. J.T. Ward, founder of Wanganui's Observatory, made important contributions to science. *Journal of the Auckland Astronomical Society*, **21**(2):13-14.
- Beaumont, L.R.H., 1963b. Wanganui Observatory: the story of its foundation. *Journal of the Auckland Astronomical Society*, **21**(2):6-7 & 12.
- Brück, M.T., 1988. The Piazzzi Smyth collection of sketches, photographs and manuscripts at the Royal Observatory Edinburgh. *Vistas in Astronomy* **32**:371-408.
- Brück, H.A., and Brück, M.T., 1988. *The Peripatetic Astronomer: The Life of Charles Piazzzi Smyth*. Adam Hilger, Bristol.
- Calder, D., 1978a. Joseph Ward: pioneer astronomer and telescope maker. *Southern Stars*, **27**:104-108.
- Calder, D., 1978b. Seventy-five years of astronomy: Ward Observatory, 1903-1978. Lecture given to the Wanganui Astronomical Society, 24 May 1978.

- Chapman, A., 1995. Out of the meridian: John Bird's equatorial sector and the new technology of astronomical measurement. *Annals of Science*, **52**:431-463.
- Chapman, A., 1998. *The Victorian Amateur Astronomer. Independent Astronomical Research in Britain 1820-1920*. Wiley, Chichester.
- Chatwood, S., 1902. Letter to J. Ward, dated 16 August. Copy in Ward (Wanganui) Observatory Archives.
- Crossley, E., Gledhill, J. and Wilson, J.M., 1879. *A Handbook of Double Stars ...* Macmillan, London.
- Fletcher, I., 1850. Brief description of a small equatoreal and dome at Tarn Bank, near Cockermonth. *Monthly Notices of the Royal Astronomical Society*, **10**:137-139.
- Fletcher, I., 1853. Results of micrometrical measures of double stars made at Tarn Bank, Cumberland, from 1850.2 to 1853.4. *Monthly Notices of the Royal Astronomical Society*, **13**:256-259.
- Fletcher, I., 1855. Remarks on Mr. Powell's elements of the orbit of 70 Ophiuchi. *Monthly Notices of the Royal Astronomical Society*, **5**:161-162.
- Fletcher, I., 1865a. Description of an equatorial mounting. *Monthly Notices of the Royal Astronomical Society*, **25**:241-243.
- Fletcher, I., 1865b. Note on  $\zeta$  Herculis. *Monthly Notices of the Royal Astronomical Society*, **25**:275.
- Fletcher, I., 1865c. On the photosphere of the Sun. *Monthly Notices of the Royal Astronomical Society*, **25**:231-233.
- Fletcher, I., 1865d. Some remarks on the solar photosphere. *Monthly Notices of the Royal Astronomical Society*, **26**:23-26.
- Gingerich, O., 1967. What is an English mounting? *Sky and Telescope*, **34**(4):293-295.
- Harper, C.T., 1992. Teaching astronomy in New Zealand: the Ward Observatory. In J.M. Pasachoff and J.R. Percy (eds.), *The Teaching of Astronomy*. Cambridge University Press, Cambridge, pp. 354-357.
- Harper, C.T., Warren, O. and Austin, R., 1990. J.T. Ward and the NZO double stars. *Southern Stars*, **33**:281-294.
- Hingley, P.D., n.d. The Shuckburghs of Shuckburgh, Isaac Fletcher, and the history of the English mounting. Unpublished manuscript.
- Howse, D., 1986. The Greenwich list of observatories: a world list of astronomical observatories, instruments and clocks, 1670-1850. *Journal for the History of Astronomy*, **17**.
- Innes, R.T.A., 1911. Observations of southern double stars. *Transvaal Observatory Circular*, **6**:61-72.
- Jacob, W.S., 1860. Account of the performance of Mr. Fletcher's new equatoreal. *Monthly Notices of the Royal Astronomical Society*, **20**:247-249.
- King, H.C., 1979. *The History of the Telescope*. Dover, New York.
- Krisciunas, K., 1988. *Astronomical Centers of the World*. Cambridge University Press, Cambridge.
- McConnell, A., 1992. *Instrument Makers to the World. A History of Cooke, Troughton & Simms*. William Sessions, York.
- Mackrell, B., 1985. *Halley's Comet Over New Zealand*. Reed Methuen, Auckland.
- Miller, J.F., 1852. Micrometrical measurements of the binary star  $\xi$  Ursae Majoris, and the double star Struve 1263, made at the Observatory, Whitehaven. *Monthly Notices of the Royal Astronomical Society*, **12**:170-172.
- Miller, J.F., 1853. Micrometrical measurements of double stars made at the Observatory, Whitehaven, in the years 1851, 1852 and 1853. *Memoirs of the Royal Astronomical Society*, **22**:187-188.
- Mr. Fletcher's Observatory. *Monthly Notices of the Royal Astronomical Society*, **27**:131 (1867).
- Mr. Fletcher's Observatory at Tarnbank. *Monthly Notices of the Royal Astronomical Society*, **26**:143-144 (1866).
- Nankivell, G.R., 1994. The 9.5 inch Cooke objective of the Wanganui Observatory. *Southern Stars*, **36**:1-9.
- Obituary: Isaac Fletcher. *Monthly Notices of the Royal Astronomical Society*, **40**:194 (1880).
- Obituary: John Fletcher Miller. *Monthly Notices of the Royal Astronomical Society*, **17**:99-100 (1857).
- Orchiston, W., n.d. (a). From Crossley to Carter: the life and times of an historic 22.9cm Cooke refractor. Submitted to *Journal of the Antique Telescope Society*.
- Orchiston, W., n.d. (b) Joseph Ward: pioneer New Zealand telescope-maker. Submitted to *Amateur Telescope Making Journal*.
- Orchiston, W., 1996a. The historic 23-cm refracting telescope at the Carter Observatory. In W. Orchiston and B. Carter (eds.), *Astronomical Handbook for 1997*. Carter Observatory, Wellington, pp. 59-69.
- Orchiston, W., 1996b. Ward, Joseph Thomas 1862-1927. In C. Orange (ed.), *The Dictionary of New Zealand Biography. Volume Three 1901-1920*. Auckland University Press and Department of Internal Affairs, Auckland, p. 555.
- Orchiston, W., 2000. Illuminating incidents in Antipodean astronomy: H.C. Russell and the origin of the Palomar-type mounting. *Journal of the Antique Telescope Society*, **19**:13-15.

- Orders. Astronomical & Mathematical Instruments. Order Book, Borthwick Institute, York (Cooke Archives).
- Rice, P., 1982. The story of Ward Observatory. *Southern Stars*, **29**:271-274.
- Smiles, S., 1884. *Men of Invention and Industry*. Murray, London.
- Smyth, C.P., 1860. Unpublished diary. Royal Edinburgh Observatory.
- Smyth, W.H., 1844. *A Cycle of Celestial Objects, for the Use of Naval, Military, and Private Astronomers*. Two Volumes. Parker, London.
- Smyth, W.H., 1860. *The Cycle of Celestial Objects Continued at the Hartwell Observatory to 1859 ...* Nichols and Sons, London.
- Smyth, W.H., and Chambers, G.F., 1881. *A Cycle of Celestial Objects*. Clarendon Press, Oxford.
- Thrush, W.S., 1963. Astronomy in Wanganui. *Southern Stars*, **20**:73-76.
- Van Helden, A., 1984. Telescope building, 1850-1900. In O. Gingerich (ed.), *The General History of Astronomy. Volume 4. Astrophysics and Twentieth-century Astronomy to 1950: Part A*. Cambridge University Press, Cambridge, pp. 40-58.
- Venimore, C., 1988. Good Viewing. (A History of the First Wanganui Astronomical Society and the Ward Observatory). Unpublished manuscript.
- Ward, J.T., 1903. Letter to John Tebbutt, dated 20 November. Original in *Letters to J. Tebbutt 1903*, Mitchell Library, Sydney (A 3715).
- Ward, J.T., 1906. The lunar eclipse of August 4. *Journal of the British Astronomical Association*, **17**:32-33.
- Ward, J.T., 1908. The Wanganui Observatory . Observations of two hundred and twelve new double stars. *Journal of the British Astronomical Association*, **18**:122.
- Ward, J.T., 1910. The total eclipse of the Moon, 1909, November 26. *Journal of the British Astronomical Association*, **20**:205-206.
- Warren, O.C.R., 1991. The NZO double stars. *The Web Society Quarterly Journal*, **85**:1-7.
- Warren, O.C.R., 1992a. Micrometrical measurements of visual double stars. *Southern Stars*, **35**:373-380.
- Warren, O.C.R., 1992b. Micrometrical observations of southern double stars. *Southern Stars*, **35**:12-14.
- Warren, O.C.R., 1995. Survey of NZO double star measures from 1989 to 1995. Paper presented at the Annual Conference of the Royal Astronomical Society of New Zealand.
- Warren, O.C.R., 2000. Micrometric measures of southern double stars. *Southern Stars*, **38**:217- 222.
- Welther, B.L., 1984. The world's largest telescopes, 1850-1950. In O. Gingerich (ed.), *The General History of Astronomy. Volume 4. Astrophysics and Twentieth-century Astronomy to 1950: Part A*. Cambridge University Press, Cambridge, pp. Ai-Avi.
- Whitesell, P.S., 1998. *A Creation of His Own: Tappan's Detroit Observatory*. University of Michigan, Ann Arbor.
- W.S.T., 1975. Obituary. William Herschel Ward (1900-73). *Southern Stars*, **26**: 93-94.



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