APPENDIX

THE MELBOURNE OBSERVATORY.

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The Melbourne Observatory was founded in the year 1853, and placed in charge of Mr. Ellery, who has remained its director up to the present time (1875). The site first chosen was at Gellibrand's Point, not far from the old lighthouse; in 1856, however, when Mr. Ellery held also the appointment of manager of the Electric Telegraph at Williamstown, it was removed to a spot in the rear of the Telegraph Office, about 800 feet to the eastward of its first position. The latitude and longitude of this spot, as represented by the place of the transit circle, were subsequently determined to be 37° 52′ 7·2″ S. and 9h. 39m. 38·8s. E. of Greenwich. In the middle of 1863 the Observatory was removed to its present site, in the Government Domain, at Melbourne; and, shortly after, the Magnetical Observatory, which had been established at the Flagstaff Hill in 1858, and presided over by Dr. Neumayer, was amalgamated with it. The Observatory reserve contains an area of rather more than 5½ acres. The height of the floor of the main building is 92 feet above the level of the sea; and the position of the transit circle is latitude 37° 49′ 53·3″ S., and longitude 9h. 39m. 54·8s. E.

The main building, which is in the Italian style of architecture, contains the following rooms:—On the basement, two rooms, one of which is occupied by the standard measures of length and weight, and the meteorological instruments in stock; the other contains the barograph. The ground floor consists of the library, which is also the official room of the director, and the place of meeting of the Board of Visitors. The principal instrument contained in this room is a fine astronomical clock by Frodsham; this is known as the zone clock, from its having been used in the observations of the southern zones. The strong room, which is fireproof, is filled with books and records. The messenger's room is occupied by that official, who sleeps on the premises. The transit room contains the transit circle, a tape, and a barrel chronograph, the batteries for working the different instruments which register by electricity, and the transit clock; this last was made by Frodsham, and is one of the finest astronomical clocks in existence. The jury appointed to report upon the horological instruments at the Paris exhibition of 1867, after an examination of the rates of this clock, pronounced it to be the most remarkable for accuracy on record. The ante-room is occupied by the fourth assistant, and contains the commercial books, &c., of the establishment. The assistant astronomer's room contains two astronomical clocks, one by Frodsham, keeping sidereal time, the other by Evans, keeping mean time; this latter also controls, by means of electricity, a clock in the hall of the Observatory, and the clocks of the Melbourne railway stations, Houses of Parliament, several private watchmakers, &c.; the principal working astronomical books are also in this room. The prime vertical room contains the piers and portions of the large Ertel transit instrument, which was intended for observing the passages of stars over the east and west verticals, but which was afterwards adapted for observing the zone transits in the meridian; most of the unbound books of the establishment are also stored in this room. The chronometer room contains the chronometers whilst being rated; it is also filled up with large cases for holding the various small optical and physical instruments when not in use. The spectroscope room contains the large Steinheil spectroscope and subsidiary apparatus. The laboratory contains the chemical apparatus, &c. The east transit room is occupied by the zone transit and two barrel chronographs. The workshop is occupied by the Observatory mechanic, and contains two lathes, a planing machine, besides the usual tools of a mathematical instrument maker. On the upper story is situated the meteorological room, occupied by the second assistant, containing also the air pump apparatus for testing aneroid barometers, various meteorological instruments, and the machine for co-ordinating the curves of the self-recording instruments. Leading from the roof is the north equatorial room, a circular chamber, covered with a revolving dome, containing the small equatorial, of 4½ inches aperture.

The great telescope house is situated about 280 feet to the north-west of the main building, and presents a somewhat singular appearance, owing to the difference in height of the two roofs with which it is covered. The roof that covers the great telescope room, when the instrument is not in use, is of a very steep pitch, and is carried by a railway over the other half of the house (which has a nearly flat roof), when it is desired to open up the instrument for celestial observation. The building contains, besides the telescope room, an office for the observer, a large store room, the polishing room, containing the steam-engine and polishing machines, a photographic room, and the boiler house.

The other buildings are distributed over the grounds, and consist of the absolute house, where absolute values of the magnetic elements are determined once a month ; the differential house, containing the self-registering magnetic instruments ; the thermograph house, containing the self-registering photographic thermometers ; the photoheliograph house, a circular chamber, with a revolving hemispherical roof, containing the Dallmeyer photoheliograph ; and the south equatorial house, a circular chamber, with a revolving polygonal roof, which contains the equatorial of 8 inches aperture. In the eastern portions of the grounds the various meteorological stands are kept.

Instruments.

The transit circle, constructed by Troughton and Simms, and first brought into use at the Observatory in 1861, has an object-glass of 5 inches aperture, and 6 feet focal length ; the circle has a diameter of 4 feet, and is read by means of four microscopes, whose micrometer heads are divided into sixty parts, each of which corresponds to a second of arc. The transits are all registered by means of the electric chronograph, and are observed on seven wires, at a mean distance from each other of 1·34s., or in linear measurement, seven thousandths of an inch. The two collimating telescopes have object-glasses of 2¾ inches aperture, and 33 inches focal length. The error of horizontality of the axis is found by measuring with the micrometer the distance between the middle transit wire and its image as reflected from a surface of quicksilver, a Bohnenberger eye-piece being always used for this purpose. This has proved itself a first-class instrument ; with it are made all the observations for time, position of the Observatory, and absolute places of the heavenly bodies. The work done with this instrument up to the end of 1870 has been published in five volumes, the first two of which were subjected to a rigid scrutiny by the celebrated astronomer, Mr. Gylden, of the Pulkowa Observatory, and the results declared to be such as to entitle them to be placed alongside the best observations obtained in Europe.

The great Melbourne telescope, constructed by Grubb, of Dublin, is a very fine instrument ; it was received at the Observatory near the end of the year 1868, and was finally erected in the present house early in the following year. As a piece of mechanism, it has always excited the greatest admiration, the facility of working being something marvellous for so ponderous an instrument ; and although at first some disappointment was felt here as to its optical performance, caused probably by some strain to which the speculum then in use had been subjected during its transmission from the maker ; yet since the polishing of this mirror by Mr. Le Sueur, in the middle of the year 1870, the telescope has proved itself well adapted for the work for which it was originally constructed, viz., the observation of nebulæ and faint clusters of stars.

The telescope is on the Cassegrain construction ; the large mirror has a diameter of 4 feet, with a focal length of 30½ feet ; the small mirror is convex, with a diameter of 8 inches, and focal length of 74·7 inches, the effect of the combined mirrors being such that when the rays come to a focus, near the lower end of the tube, they form an image as if they had come from a single mirror of 166 feet focus ; an average image of the moon would therefore at this place have a linear diameter of a little over 18 inches. The telescope is furnished with nine eye-pieces, whose magnifying powers range from 220 up to 1,000.

The equatorial mounting, being on the Fraunhofer plan, allows of an uninterrupted view of the sky, and the whole is moved during observations by a small clock governed by a conical pendulum, which has a differential gearing, so that the telescope, which ordinarily follows the motions of the stars, may be readily made to move with the average motion of the moon. The weight of the whole instrument amounts to more than 8 tons, according to the following detailed statement:—

	lbs.
Speculum and box	3,500
Tube, boiler plate, and lattice	2,670
Polar axis	3,200
Declination axis	1,500
Cradle	1,100
Counterpoises	4,700
Smaller portions	1,500
Total	18,170

The cost of the instrument, including spectroscope, photographic apparatus, &c., has been about £5,500, and the building and piers have cost about £2,000, making a total cost of £7,500. Some photographs of the moon taken with a temporary apparatus while the telescope was in Ireland, were so promising that it was resolved to construct an apparatus specially adapted for the purpose; this was made, and sent out in 1871, and the result fully justifies the anticipations, for some of the photographs of the moon taken with this telescope are considered to surpass those produced by any other instrument.

The south equatorial has a refracting telescope of 8 inches aperture and 9 feet focal length; it is mounted in the Fraunhofer style. The hour and declination circles are read by means of microscope micrometers, which are arranged for this purpose in a manner at once ingenious and convenient. This instrument was constructed by Troughton and Simms; it was received at the Observatory in 1874, just in time to be used for observing the transit of Venus, soon after which some of the parts were returned to the makers for slight alterations; it has therefore not been thoroughly tested yet, but it appears to be a very fine instrument.

The north equatorial, also by Troughton and Simms, was received at the Observatory in 1862; it is a refractor of 4½ inches aperture and 5 feet focal length. This instrument has been extensively used in observations of comets, &c., and has proved itself in every particular to be of first-class quality.

The Newtonian reflector has a mirror of 12 inches diameter and 8 feet focal length; it is mounted equatorially, without clockwork. It has not been much used hitherto for celestial observation, but has served principally as an instrument for obtaining experience in the grinding and polishing of its mirror.

The east transit instrument, called also the zone transit, has a telescope by Ertel and Son, of Munich, the object-glass of which has a diameter of 6¼ inches and focal length of 8½ feet; the other parts of the instrument were made in Melbourne. This transit has been generally employed in observing the southern stars in zones three-quarters of a degree wide. The telescope is of first-rate quality; it was received at the Observatory in 1863.

The altazimuth was constructed by Troughton and Simms; it was received at the Observatory in 1857. The telescope has an aperture of 2⅝ inches with a focal length of 29 inches. The circles are of 18 inches diameter, and are read by microscope micrometers to seconds of arc. This is a first-class instrument, and in the early days of the Observatory was the only one that could be depended upon for absolute measurements. It has of late years been principally employed in the trigonometrical survey of the colony.

The zenith sector, received at the Observatory in the beginning of 1861, is constructed on Airy's principle. It has not been much used since the acquisition of the transit circle, as it is principally intended as a field instrument, for use at the principal stations of the Geodetic Survey.

The photoheliograph, by Dallmeyer, of London, was received at the Observatory in 1874, in time to be used for the observation of the transit of Venus. It photographs an image of the sun of about 4 inches diameter, and one of these is generally taken every fine day.

The time-keeping instruments consist of five astronomical clocks, showing sidereal time, and two for mean time; besides these there are seven box chronometers, four barrel chronographs, and one tape chronograph.

The magnetic instruments are divided into two classes: the absolute instruments, which measure the real values of the magnetic elements, and the differential instruments, which measure the periodic variations of the absolute values. The first consist of a magnetic theodolite, for determining the absolute amount of the declination (variation of the compass) and of the horizontal force, and a dip circle, for the measurement of the absolute inclination. The differential instruments are three: one registers the variations of the declination, another the inclination, and the third the horizontal force. All the differential instruments record their measures by means of photography on a sheet of sensitized paper, wrapped round a cylinder which revolves by means of clockwork once in 24 hours. In connection with these instruments is also an apparatus for measuring the ordinates of the photographic curves. All these instruments have been in use at the Observatory since the year 1867.

Besides the usual barometers, thermometers, rain gauges, &c., for measuring the pressure of the atmosphere, the temperature of the air, soil at various depths, solar radiation, minimum radiation, surface water, evaporation, &c., and the amount of rainfall, the principal meteorological instruments are as follows:—

The anemograph, received at the Observatory in 1865, for recording the velocity and direction of the wind. The velocity is measured by the revolutions of four hemispherical cups on Dr. Robinson's principle, while the direction is indicated by an arrow-head, moved by a couple of fans. Both these elements are recorded continuously on a sheet of metallic paper, by the edges of brass helices moved by the force of the wind, the paper being wrapped on a horizontal cylinder which revolves, by means of clockwork, once in 24 hours.

The barograph, in use since the middle of 1869, records photographically the height of the barometer on a sheet of sensitized paper attached to an upright cylinder, which revolves by clockwork once in 48 hours. The correction for temperature is ingeniously managed by means of the expansion of a bar of metal, which acts on the abscissa of the recorded curve so as to prevent its being straight, except in the case of invariable temperature.

The thermographs, in use since the beginning of 1870, record the temperatures of the dry and wet bulb thermometers, photographically, in precisely the same manner as the barograph.

The electrograph records, in the same manner as the magnetic instruments, the fluctuations of the electrical state of the atmosphere.