THE 25-INCH NEWALL REFRACTOR

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Robert Stirling Newall (1812-1889) was a wealthy Scottish engineer and amateur astronomer. Newall commissioned Thomas Cooke (1807-1868) to build a telescope for his private observatory at Ferndene (Gateshead). The discs for a 25-inch (640 mm) refractor were ordered from the Chance Brothers Company in 1862. The lens had a focal length of 9.1 m and a combined weight of 66 kg. The Newall refractor took seven years to build (it was for a few years the largest in the world). It was erected in 1870 on Newall’s estate, a very unfavorable site: during a period of fifteen years Newall had only one night in which he could use its full aperture (Figure 1 and Figure 2).

The Newall telescope was described in detail in an article that appeared in *Nature* (February 17, 1870). The full text of this article in transcribed below:

The 25-inch Equatorial Telescope, commenced several years ago by T. Cooke and Sons, of York, for R. S. Newall, Esq. of Gateshead, is now so far completed that it has been removed from the works at York into its observatory in Mr. Newall's grounds, at Ferndene.

The completion of a telescope with an object glass of 25 inches aperture, marks an epoch in astronomy, and its completion in England again places us in the front rank in the matter of the optical art, as we were in Dolland's time.

The history of the progress of the manufacture of telescopes since the time referred to shows very clearly the long-lasting effects of bad legislation; for it is not too much to say that the duty on glass stifled, if indeed it did not kill, the optical art in England. Hence we depended for many years upon France and Germany for our telescopes to such an extent indeed that the largest object-glasses at Greenwich, Oxford, and Cambridge are all of foreign make. The labors of the Germans culminated in the two magnificent instruments of 15 inches aperture in the observatories of Pulkowa and Cambridge, U.S. And then for a time America, thanks to the genius of Alvan Clarke, took the lead with the 18-inch glass now beginning to do good work in the observatory of Chicago. This instrument is at last eclipsed by the magnificent one now being erected at Gateshead.

In what we have said we have purposely omitted to touch upon reflecting telescopes, in the construction of which, since the time of Newton, England has always been pre-eminent, because we shall take occasion to refer to the reflector of four feet aperture, completed last year by Mr. Grubb, of Dublin, and now erected at Melbourne when it is fairly at work.

The general design and appearance of this monster among telescopes, which will be gathered from the accompanying woodcut (Figure 3), is the same as that of the well-known Cooke equatorials; but the extraordinary size of all the parts has necessitated the special arrangements of most of them.

The length of the tube, including dew-cap and eye-end, is 32 feet, and it is of cigar shape; the diameter at the object-end being 27 inches, and at the centre of the tube 34 inches. The cast-iron pillar supporting the whole is 29 feet in height from the ground to the centre of the declination axis, when horizontal; and the base of it is 5 feet 9 inches in diameter. The trough for the polar axis alone weighs 24 cwt., the weight of the whole instrument being nearly 9 tons.

The tube is constructed of steel plates riveted together, and is made in five lengths, screwed together with bolts and flanges. The plates of the central length are one-eighth of an inch thick, and those of each end one-sixteenth thick, so as to reduce the weight of the ends as much as possible, and avoid flexure.

Inside the outer tube are five other tubes of zinc, increasing in diameter from the eye to the object-end; the wide end of each zinc tube overlapping the narrow end of the following tube, and leaving an annular space of about an inch in width round the end of each for the purpose of ventilating the tube, and preventing, as much as possible, all interference by currents of warm air, with the cone of rays. The zinc tubes are also made to act as diaphragms.

The object-glass has an aperture of 25 inches (nearly), and in order as much as possible to avoid flexure from unequal pressure on the cell, it is made to rest upon three fixed points in its cell, and between each of these points are arranged three levers and counterpoises round a counter-cell, which act through the cell direct on to the glass, so that its weight in all positions is equally distributed among the 12 points of support, with a slight excess upon the three fixed ones. The focal length of the lens is 29 feet. A Barlow lens is arranged to slide on a brass framework within the tube. The hand is passed through an opening in the side of the tube, and by means of a handle attached to the cell the lens may be pushed into or out of the cone of rays.

Attached to the eye-end of the tube are two finders, each 4 inches aperture; they are fixed above and below the eye-end of the main tube, so that one may be readily accessible in all positions of the instrument. It is also supplied with a telescope having an O. G. of 6 ". This is fixed between the two finders, and is for the purpose of assisting in the observations of comets and other objects for which the large instrument is not suitable. This assistant telescope is provided with a rough position circle and micrometer eye-pieces, and is illuminated by new apparatus lately described in NATURE.

Two reading microscopes for the declination circle are brought down to the eye-end of the main tube; the circle-38 inches in diameter-is divided on its face, and read by means of the microscopes and prisms.

The slow motions in declination and R. A. are given by means of tangent screws, carrying grooved pulleys, over which pass endless cords brought to the eye-end. The declination clamping handle is also at the eye-end.

The clock for driving this monster telescope is in the upper part of the pillar, and is of comparatively small proportions, the instrument being so nicely counterpoised that a very slight power is required to be exerted by the clock, through the tangent screw, on the driving wheel (seven feet diameter), in order to give the necessary equatorial motion.

The declination axis is of peculiar construction, necessitated by the weight of the tubes and their fittings, and corresponding counterpoises on the other end, tending to cause flexure of the axis. This difficulty is entirely overcome by making the axis hollow, and passing a strong iron lever through it, having its fulcrum immediately over the bearing of the axis near the main tube, and acting upon a strong iron plate rigidly fixed as near the centre of the tube as possible, clear of the cone of rays. This lever, taking nearly the whole weight of the tubes, &c., off the axis, frees it from all liability to bend.

The weight of the polar axis on its upper bearing is relieved by friction rollers and weighted levers; the lower end of the axis is conical, and there is a corresponding conical surface on the lower end of the trough; between these two surfaces and three conical rollers carried by a loose or "live" ring, which adjust themselves to equalize the pressure.

The hour circle on the bottom of the polar axis is 26 inches in diameter, and is divided on the edge, and read roughly from the floor by means of a small diagonal telescope attached to the pillar; a rough motion in R. A. by hand is also arranged for by a system of cog-wheels moved by a grooved wheel and endless cord at the lower end of the polar axis, so as to enable the observer to set the instrument roughly in R. A. by the aid of the diagonal telescope.

The declination and hour circles will probably be illuminated by means of Geissler tubes, and the dark and bright field illuminations for the micrometers will be effected by the same means.

Mr. Newall, after the preliminary testing of this magnificent instrument at his own residence, purposes to erect it in some climate favorable for astronomical observation. It is very unfortunate that this means in other words that the telescope cannot remain in England. It is or should be among the things generally known that every increase in the size of an object-glass or mirror increases the perturbating effects of the atmosphere, so that the larger the telescope, the purer must be the air. In the absence of this latter condition, a "big" telescope is a "big evil," and skilled observers, mindful of this, reduce the apertures of their instruments when the air is not good.

We may regard this telescope as a clear gain to English science, for Mr. Newall with princely liberality has expressed his intention of allowing observes with a special research on hand to have the use of the instrument during certain regulated hours.

The observatory, of which we also give a sketch, is nearly 50 feet in diameter, and notwithstanding the enormous weight of the dome, like the telescope, it is easily moved into any required position.

When completed it will have attached to it a transit-room. And this reminds us that Mr. Marth, so well known for his great work done at Malta with the Lassell Reflector and elsewhere will have charge of this noble instrument of research.

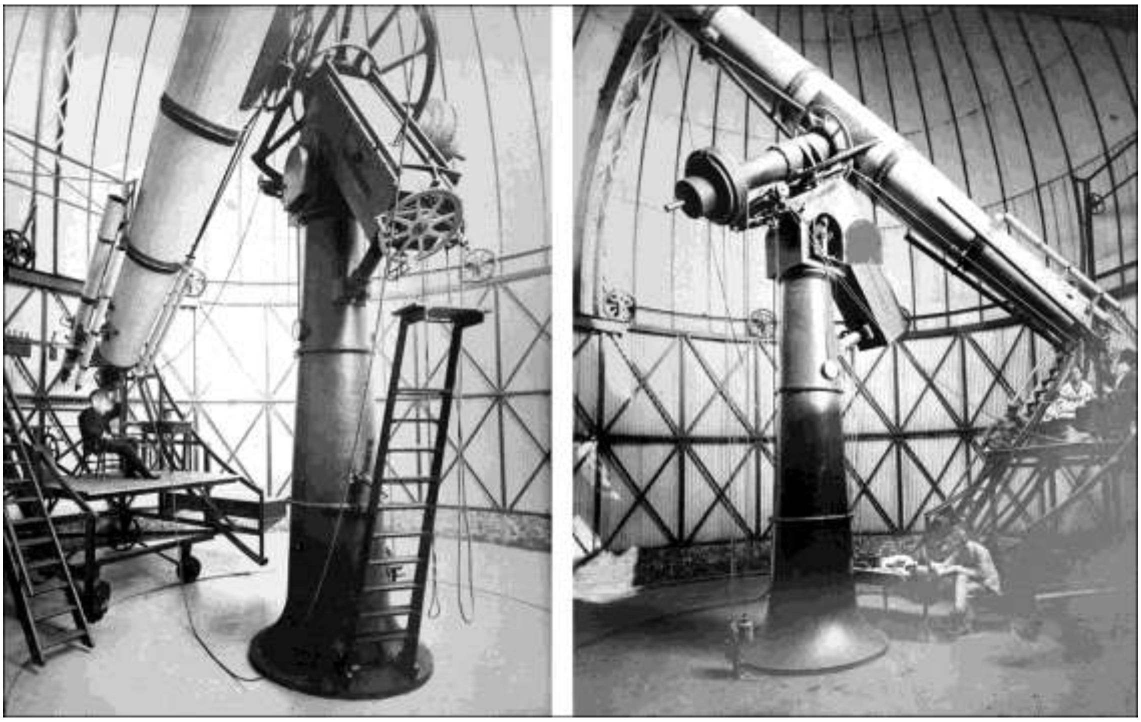

Figure 1- Photographs of the 25-inch Newall refractor and equatorial mount by Cooke of York (1872).

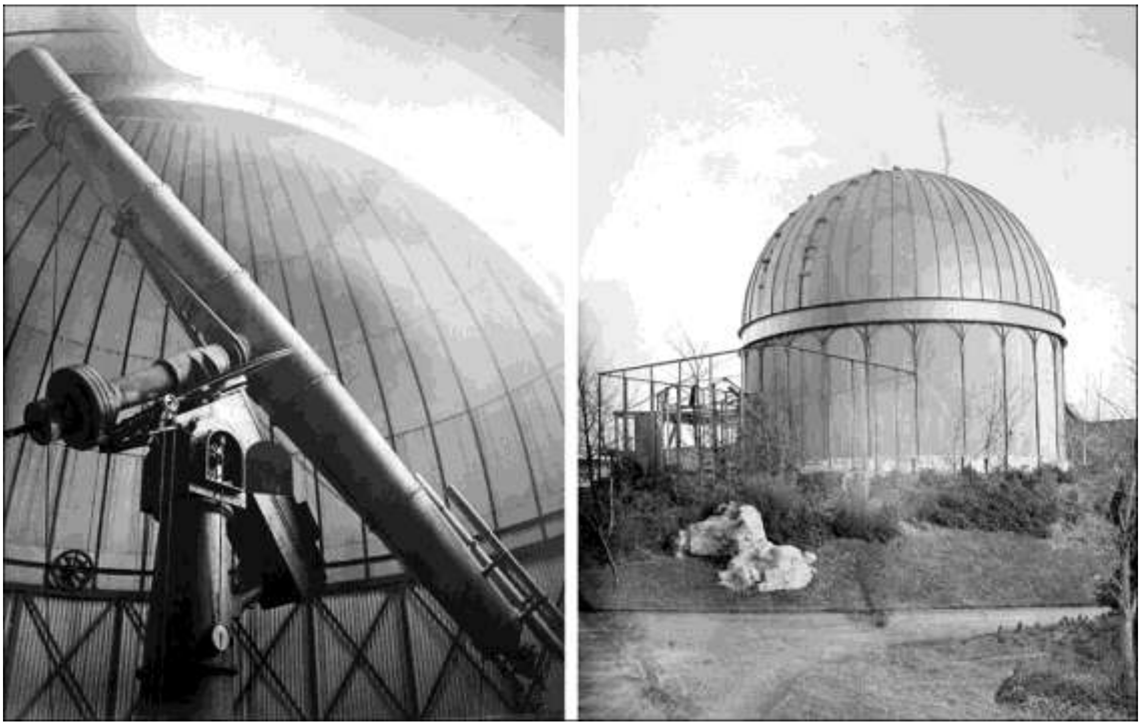

Figure 2- 25-inch Newall refractor and dome (1872).

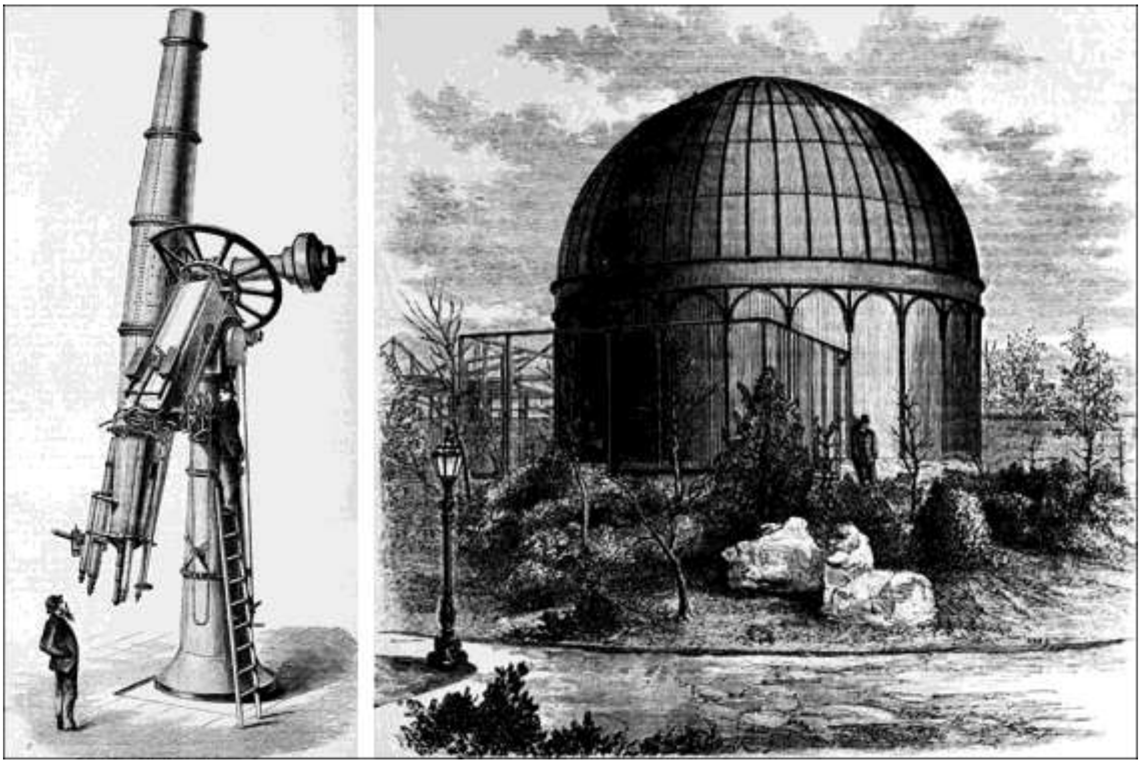

Figure 3- Figures from the *Nature* article. Captions: The great Newall telescope of 25 inches aperture, now being erected at Gaterhead (left); The observatory for the Newall Telescope (right).

After years of bad weather and sporadic use, Newall offered to loan the instrument to the Cape Observatory. David Gill (1834-1914), director of the observatory was eager to determine the parallax of alpha Centauri. The cost of dismounting and transporting the telescope to South Africa was considered prohibitive and the whole matter was put to rest.

Figure 4- Newall telescope at the University of Cambridge: spectroscope (left); telescope and dome (center); dome (*ca.* 1906).

In 1890 the 25-inch refractor was offered to the University of Cambridge (the telescope was moved in 1891). Newall's son, Hugh Frank Newall, worked for five years without any payment as the main observer responsible for the telescope. From 1891 to 1911, H.F. Newall conducted a huge series of spectroscopic observations with excellent results. The work continued until 1930 when the telescope became gradually outdated (Figure 4 and Figure 5).

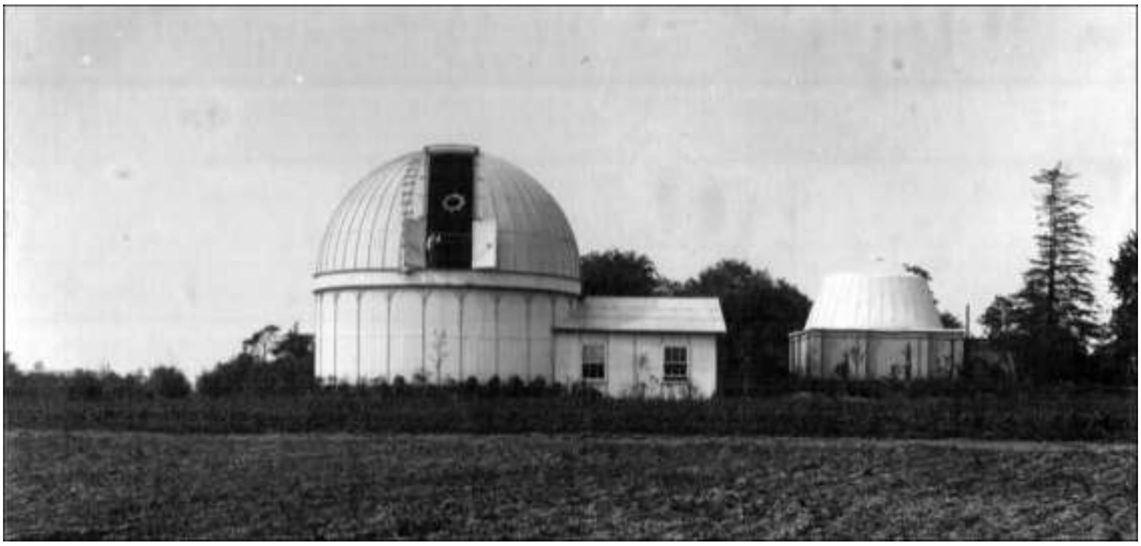

Figure 5- Newall telescope and dome at the University of Cambridge (*ca.* 1930).

In 1950 the telescope was rarely used and the dome needed repair. The University of Cambridge decided to donate the instrument. The National Observatory of Athens accepted the donation and the Newall refractor was transported to the Koufos hill near the Pendeli mountain (Greece). The construction of the new observatory started in 1957. The 25-inch refractor was installed at the top of a 5 m concrete pier (access to the eyepiece is facilitated by a moving floor). The new dome has a diameter of 14 m (Figure 6).

Figure 6- The Newall 25-inch refractor and new dome at the Penteli Astronomical Station (National Observatory of Athens - Greece).

Sources:

- King, H.C. (1955). *The history of the telescope*. Charles Griffin, High Wycombe, England.