


Occasional Notes


No. 2 | An Independent Miscellany of Astronomy | 26 October 2018

In *Occasional Notes* No. 1, my article on John Herschel includes letters written by his daughter Francisca. I also have in my collections a large number of letters written by William Rutter Dawes, and letters and documents received by him. For the most part these do not concern scientific matters, but instead provide an insight into the social affairs of a group of astronomers who remained close friends over a period of half a century. When reading these letters I often have to remind myself that I am holding the paper that Dawes held and wrote upon with the ink from his ink-well, and I sometimes sense that I might be intruding in his private affairs. Nevertheless, these letters were written more than 150 years ago – a temporal distance sufficient to remove such impediment. With this in mind, a glimpse into this correspondence is presented here.

The second article in this issue is Part II of Alan Snook's report on his restoration of a fine instrument manufactured by Rob and Jim Hysom.

Bob Marriott

Smyth, Dawes, and Lassell

In the first volume of the Royal Astronomical Society's *Monthly Notices*, published in 1830, William Henry Smyth presented an account of the observatory that he had established in Bedford, including a description of his 5.9-inch Tulley refractor.

The object-glass of the telescope is of 8½ feet focal length, with a clear aperture of $5\frac{9}{10}$ inches, worked by the late Mr. Tulley, from a disc purchased by Sir James South at Paris. It is considered to be the finest specimen of that eminent optician's skill, and will bear with distinctness a magnifying power of 1200. In giving this high character of my telescope, it is proper to state, that I have tried its light by the cluster in the sword-handle of Perseus, by several of Messier's nebulae, and by resolving portions of the Via Lactea into stars. Its distinctness is proved by the ready vision of the companions of Polaris, Rigel, α Lyrae, and α Capricorni, and also by the facility with which λ Ophiuchi, σ Aquarii, θ Persei, μ Cephei, δ Serpentis, ζ Herculis, and ε Boötis are seen double; ζ Orionis and ξ Librae triple; β Capricorni quadruple; and σ Orionis multiple. I estimate its general action by the lunar mountains, cavities, and shadows, under all powers; the lucid polar regions of Mars, the sharpness of the double ring of Saturn, the gibbous aspect of Venus, the shadows of Jupiter's satellites across his body, the splendid contrast of colours in α Herculis, γ Andromedae, and other superb double stars; and the comparative facility with which such tests as σ Coronae Borealis, τ Aquarii, θ Virginis, η Bootis, and δ Equulei, admit of measurement.

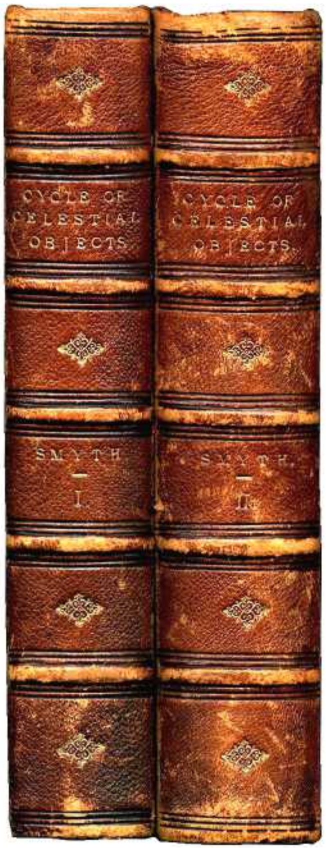
Over the next decade or so, Smyth carried out a methodical survey, resulting in the two-volume *A Cycle of Celestial Objects*, dedicated to Sir John Herschel and published in 1844. The intended readership is indicated by the sub-title, *For the Use of Naval, Military, and Private Astronomers*, and it was not inexpensive: £5 (in current terms about £500). The first volume, Prolegomena, is essentially a handbook of practical astronomy, and the second volume, the Bedford Catalogue. contains 850 objects in the cyclic order of Right Ascension. After his survey was completed, Smyth rehomed the Tulley refractor at the residence of the antiquarian and polymath Dr John Lee, of Hartwell House, near Aylesbury, and at the same time he moved to St John's Lodge, close by.

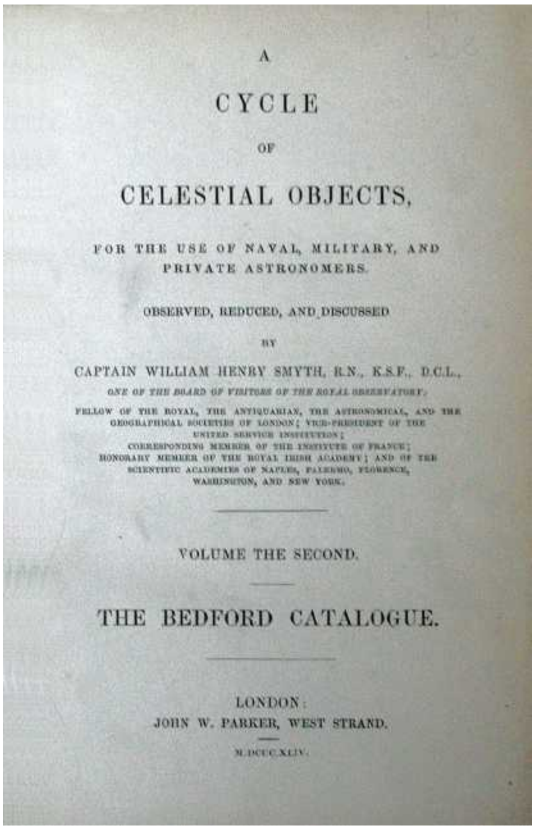
Smyth's 5.9-inch Tulley prepared for a Transit of Venus Expedition in 1874. It was later acquired by the Science Museum in London, but in the late 1980s the astronomy gallery was closed down and all the instruments were placed in storage. Now, thirty years later, this splendid instrument is again on display.

Smyth was particularly adept at recording star colours, and in 1864 he published a monograph entitled *Sidereal Chromatics*:

> It may be proper to premise that the light of the two stars composing the double one is frequently found to be of very dissimilar intensity, and often of very dissimilar colours; and no one who has ever directed a telescope to the heavens can have failed to be struck with the brilliant hues they present, especially such lovely objects as γ Andromedae, α Herculis, and ε Bootis.

Smyth's descriptions of star colours are prolific and evocative, but Otto Struve (who frequently wrote in Latin) used rather less poetic terminology, including obscurissima, obscura, pallida, livida, alba, sub-flava, flava, sub-caerulea, caerulea, rubicunda, and rubra – and, as Smyth notes in *Sidereal Chromatics*: 'That masterly observer, perplexed by the tint of the close companion of ξ Orionis, somewhat sesquipedalianly designates it *olivaceasubrubicunda*'.





A

CYCLE

OF

CELESTIAL OBJECTS,

FOR THE USE OF NAVAL, MILITARY, AND PRIVATE ASTRONOMERS.

OBSERVED, REDUCED, AND DISCUSSED

BY

CAPTAIN WILLIAM HENRY SMYTH, R.N., K.S.F., D.C.L.,

ONE OF THE BOARD OF VISITORS OF THE ROYAL OBSERVATORY;

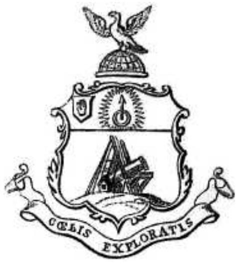
FELLOW OF THE ROYAL, THE ANTIQUARIAN, THE ASTRONOMICAL, AND THE GEOGRAPHICAL SOCIETIES OF LONDON; VICE-PRESIDENT OF THE UNITED SERVICE INSTITUTION; CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE; HONORARY MEMBER OF THE ROYAL IRISH ACADEMY; AND OF THE SCIENTIFIC ACADEMIES OF NAPLES, PALERMO, FLORENCE, WASHINGTON, AND NEW YORK.

VOLUME THE SECOND.

THE BEDFORD CATALOGUE.

LONDON:
JOHN W. PARKER, WEST STRAND.

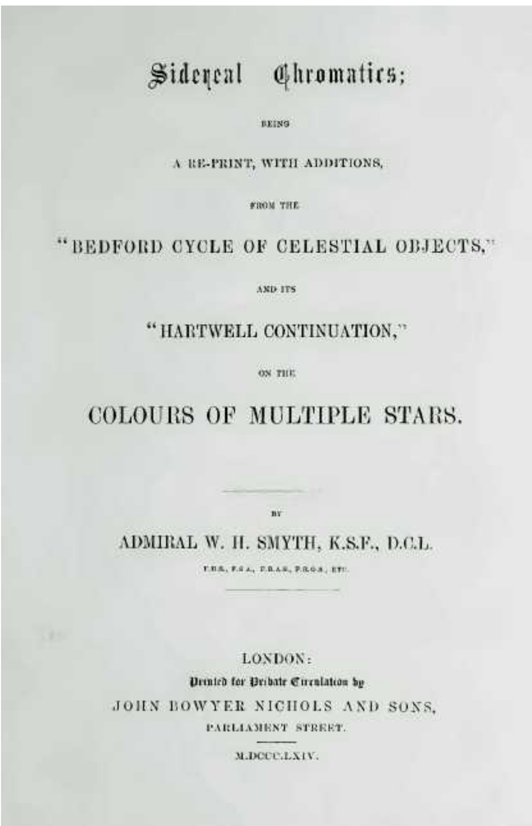
M.DCCC.XLIV.



To John Frederick William Herschel, Bart., &c. &c. &c.

As a testimony of the highest admiration and esteem, a memorial of long-continued friendship, and a grateful acknowledgment of important advice in the pursuit of practical astronomy. And as a heartfelt token of respect for the memory of his excellent father – whose indefatigable zeal, never-failing resources, depth of inquiry, and almost unrivalled quickness of conception, have rendered his life an era in astronomical science – this Cycle of Celestial Objects is most respectfully inscribed by his faithful friend, William Henry Smyth.

Smyth intended to publish a second edition of the *Cycle*, and the work was subsequently entrusted to Isaac Fletcher. Nothing came of this, however, as Fletcher strayed from astronomy after he was elected a Member of Parliament, and in 1879 he commited suicide. Eventually, in 1881, George F. Chambers produced an enlarged edition of the Bedford Catalogue (but not the Prolegomena) with numerous additional objects. In *Sidereal Chromatics* the colour plate is not particularly good, but in the 1881 *Cycle* the improved frontispiece shows twenty-four colours as examples. In the 1844 edition of the *Cycle*, Smyth describes 114 colours, including sixteen shades of white, though in *Sidereal Chromatics* he writes: 'Our having noted the colours from fruits, flowers, vegetables, jewels, and the like, involves conflicting uncertainty, since most of those objects are of various tints.' He also includes a list of colours which could be the same or approximately the same but with different descriptions. The 114 colours in the 1844 edition of the *Cycle* are listed here.



Sidereal Chromatics;

BEING

A RE-PRINT, WITH ADDITIONS,

FROM THE

"BEDFORD CYCLE OF CELESTIAL OBJECTS,"

AND ITS

"HARTWELL CONTINUATION,"

ON THE

COLOURS OF MULTIPLE STARS.

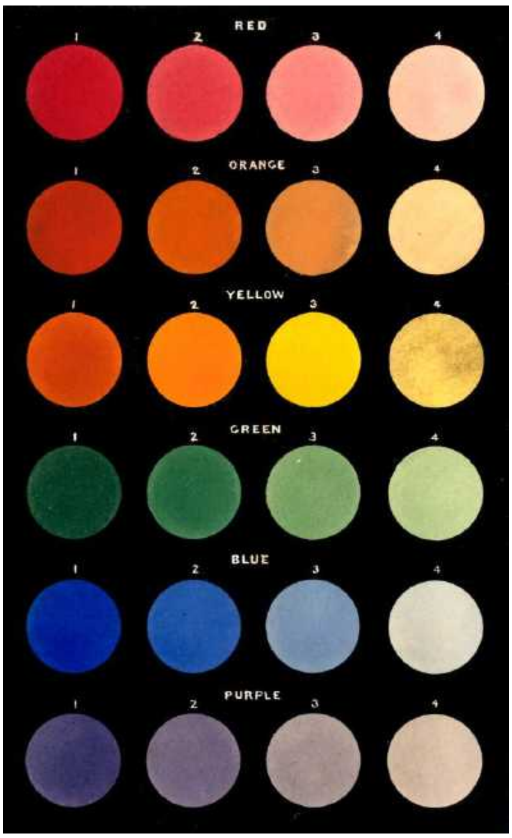
BY

ADMIRAL W. H. SMYTH, K.S.F., D.C.L.

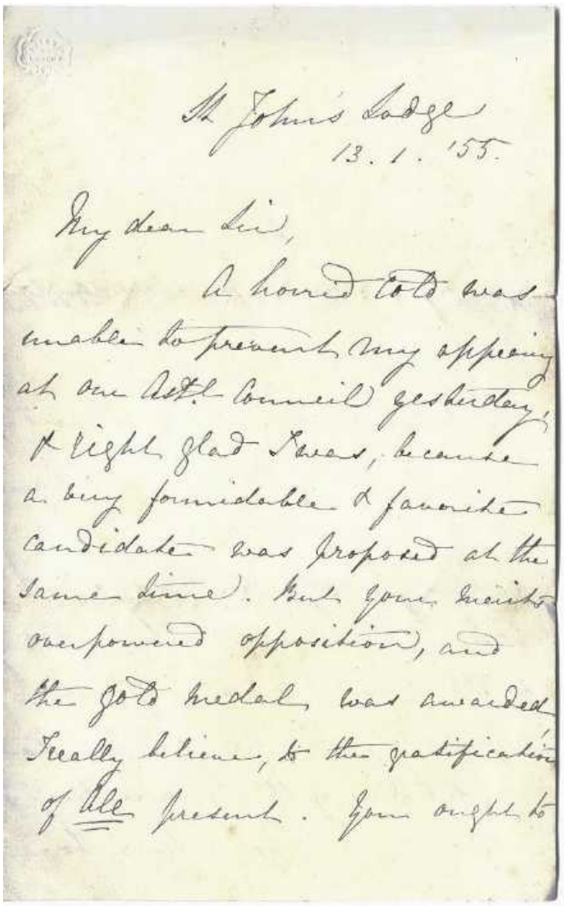
F.R.S., F.S.A., F.R.A.S., F.R.G.S., ETC.

LONDON:
Printed for Private Circulation by
JOHN BOWYER NICHOLS AND SONS,
PARLIAMENT STREET.

M.DCCC.LXIV.



White	Bright orange	Clear blue
Pale white	Orange-yellow	Lucid blue
Dull white	Ruddy yellow	Sapphire
Fine white	Fawn	Pale sapphire
Lucid white	Straw	Sky blue
Very white	Pale straw	Cerulean
Bright white	Cream-yellow	Smalt blue
Brilliant white	Yellowish	Fine blue
Intense white	Yellow	Intense blue
Pearl	Pale yellow	Cobalt
Silvery-white	Faint yellow	Deep blue
Creamy-white	Dull yellow	Livid
Yellowish-white	Light yellow	Dusky blue
Greenish-white	Bright yellow	Indigo
Bluish-white	Pearly yellow	Lilac
Flushed white	Topaz	Pale lilac
Flushed	Pale topaz	Faint lilac
Ruddy	Deep yellow	Light lilac
Reddish	Lucid yellow	Brilliant lilac
Red	Crocus yellow	Violet
Rose	Golden yellow	Pale violet
Pale rose	Fine yellow	Amethyst
Pale red	Orpiment	Purplish
Dull red	Greenish-yellow	Purple
Plum	Greenish	Pale purple
Dusky red	Green	Lucid purple
Garnet	Pale green	Grey
Pale garnet	Light apple-green	Lucid grey
Grape red	Emerald	Clear grey
Golden red	Pale emerald	Light grey
Lurid	Light emerald	Pale grey
Scarlet	Sea green	Dull grey
Cherry red	Pale sea green	Dusky grey
Blood	Bluish-green	Dusky
Fiery red	Bluish	Cinereous
Orange	Blue	Ashy
Pale orange	Pale blue	Pale
Light orange	Light blue	Very pale


St Johns Lodge
13. 1. '55.

My dear Sir,

A horrid cold was unable to prevent my appearing at our Astl. Council yesterday, & right glad I was, because a very formidable & favourite candidate was proposed at the same time. But your merits overpowered opposition, and the gold medal was awarded I really believe, to the gratification of All present. You ought to

The *Cycle* is a remarkably scholarly work. It assumes that the reader is well educated and has knowledge of classical languages, and the Greek and Latin quotations are not translated. The following is an extract from the entry on β Cygni:

> A bright double star on the Swan's bill, about 13°½ to the south-south west of Wega. A 3, topaz yellow; B 7, sapphire blue; the colours in brilliant contrast, by which term I do not mean the mere optical complementary tints, but relating to these bodies as radiating their own coloured lights ... Ulugh Beigh and Tizini called β Cygni, *Minkár el dejájeh*, the hen's beak; but its more usual appellation is Albireo. This name is of doubtful origin, introduced, as it appears, by Bayer, and ingeniously conjectured by Ideler to be a corruption of 'ab iero' in the Latin version of the *Almagest*, where the translator from the Arabic *euris* for *ornis* made *eurisim*, which he supposed to be the Greek *Ερύσιμον*, in Latin *Irio*. Hence the *Hierezim* of Riccioli, whose *Astronomia Riformata* exhibits some curious blunders of black-letter transcription.

At about the same time that Smyth began his survey, William Rutter Dawes began his work on the micrometric measurement of double and multiple stars that he would continue for almost forty years, using fine refractors by Dollond, Merz, Clark, and Cooke. His first paper, 'Observations of the Triple Star ζ Cancri', was published as an abstract in the Royal Astronomical Society's *Monthly Notices* in 1831 and complete in the *Memoirs* in 1833. The observations were made with a 3.8-inch Dollond achromatic:

> This instrument was constructed for me last year by Mr. Dollond; and from the perfectly round, clean, and very small discs with which it exhibits the fixed stars, it is peculiarly adapted for the examination of very close and delicate objects. It is mounted equatorially, with horary and declination circles, each of two feet diameter, and is furnished with a position and parallel-thread micrometer, possessing a variety of magnifying powers, from 55 to 625. The instrument was fitted up with a special view to the examination of the positions and distances of the multiple stars.

On 13 January 1855, Smyth conveyed news to Dawes concerning the award of the Gold Medal of the Royal Astronomical Society.

A horrid cold was unable to prevent my appearing at our Astl. Council yesterday, & right glad I was, because a very formidable & favourite candidate was proposed at the same time. But your merits overpowered opposition, and the gold medal was awarded, I really believe, to the gratification of *All* present. You ought to have had one long ago.

South's measures besides Knighthood, got him our Medal, the Copley, the Institute's, & £300 a year!

But while Mrs. Smyth and myself congratulate Mrs. Dawes upon this, we deem it only a tardy acknowledgement, not a reward, & look steadily to the claims which you are ultimately making upon the gratitude of the intellectual world. You have borne yourself nobly in spite of illness and adverse chances.

Believe me always, yours most truly, W. H. Smyth.

At the Annual General Meeting of the Royal Astronomical Society held on 9 February, the President, George Biddell Airy, delivered an extensive address detailing Dawes' work over twenty-five years, concluding with a short speech accompanying the presentation:

> In the name of the Council of the Royal Astronomical Society I present you with the Medal of the Society, in acknowledgment of your long-continued devotion to astronomy, of your numerous contributions to various divisions of that science, of the remarkable excellence of your observations, and the recognised value of your suggestions. And I trust that there remain to you many years of health and happiness, many years of enjoyment of your favourite science, and many discoveries tending to the material and intellectual advance of astronomy.

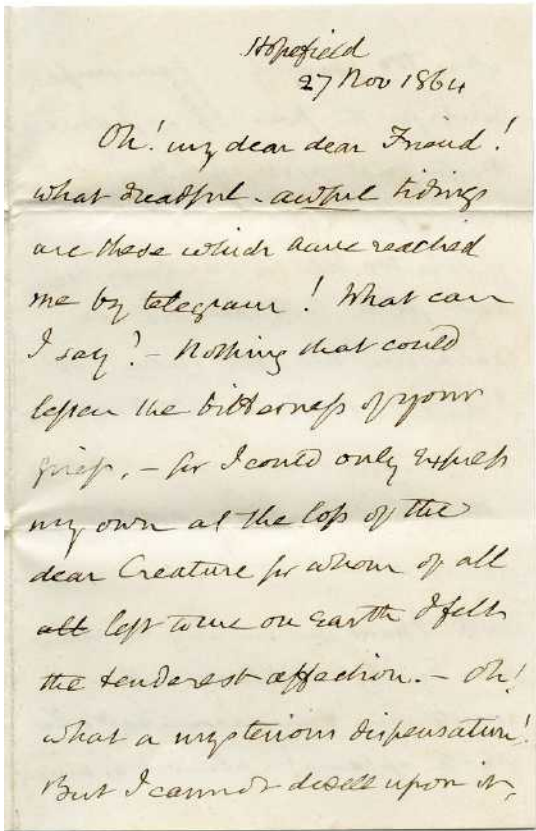
During the winter of 1864–65, Dawes produced a fine series of drawings of Mars, using an 8-inch refractor recently purchased from Cooke of York – the last of Dawes' two dozen or so instruments. In 1867 he sold the Cooke to George Hunt of Dulwich, and after Hunt died in 1896 it was purchased by William H. Maw, who installed it in his observatory at Outwood Common, Surrey. Maw died in 1924, and the instrument was acquired by Baker's of Holborn. Soon afterwards, it was purchased by William J. Thorrowgood, who in 1927 bequeathed it to the Royal Astronomical Society. It was then placed on loan to Cambridge Observatory, where it remains in use. (For details, see my paper, 'Dawes' Observations of Mars, 1864–65', published in the BAA *Journal* in 1988.)

In the midst of his series of observations of Mars, Dawes suffered the greatest tragedy of his last years. In the early 1820s he had studied at St Bartholomew's Hospital and had qualified as a doctor. His sister Judith and her husband lived in Liverpool, but in 1826 Judith died. Subsequently, her husband returned to Antigua to maintain his business, but did not take their daughter, Mary Anne. Dawes therefore moved from Buckinghamshire to Liverpool, where the Congregational minister Thomas Raffles (cousin of Sir Stamford Raffles, the founder of Singapore) persuaded him to undertake a ministry. Dawes thus settled in Ormskirk, where he served as a dissenting minister and as a doctor, and it was there that he raised his niece from the age of nine months until she was old enough to go to boarding school. Eventually, Mary Anne married James Taylor, a Fellow of the Royal College of Surgeons, and within a few years they had two sons and two daughters. On 27 November 1864, Dawes received a telegram from James Taylor informing him that Mary Anne, then aged 39, had died. His response was impassioned and immediate.

Oh! my dear dear Friend! What dreadful awful tidings are these which have reached me by telegram! What can I say? Nothing that could lessen the bitterness of your grief – for I could only express my own at the loss of the dear creature for whom of all left to me on earth I felt the tenderest affection. Oh! what a mysterious dispensation! But I cannot dwell upon it, it is too painful. I am impatient for the particulars promised by the first post, yet dread their arrival.

It is too late for our early Sunday post, for the telegram did not reach me till after noon – so I shall put this by till tomorrow. I hope dear Mary was at home. May God in mercy support you, for no other can!

28th. I have this morning recd. letters from Emily & Mr. May. How mysterious & unaccountable the whole appears! – almost as much so medically as in the aspect of a Providential dispensation! But I cannot, & need not, at present add more; & that all the consolation which our Heavenly Father himself can give may be imported to yourself & all so painfully interested in this heavy calamity, shall be the fervent prayer of your most truly affectionate & deeply sympathizing friend, W. R. Dawes.


Hopefield
27 Nov 1864
Oh! my dear dear Friend!
What dreadful – awful tidings
are these which have reached
me by telegram! What can
I say? – Nothing that could
lessen the bitterness of your
grief, – for I could only express
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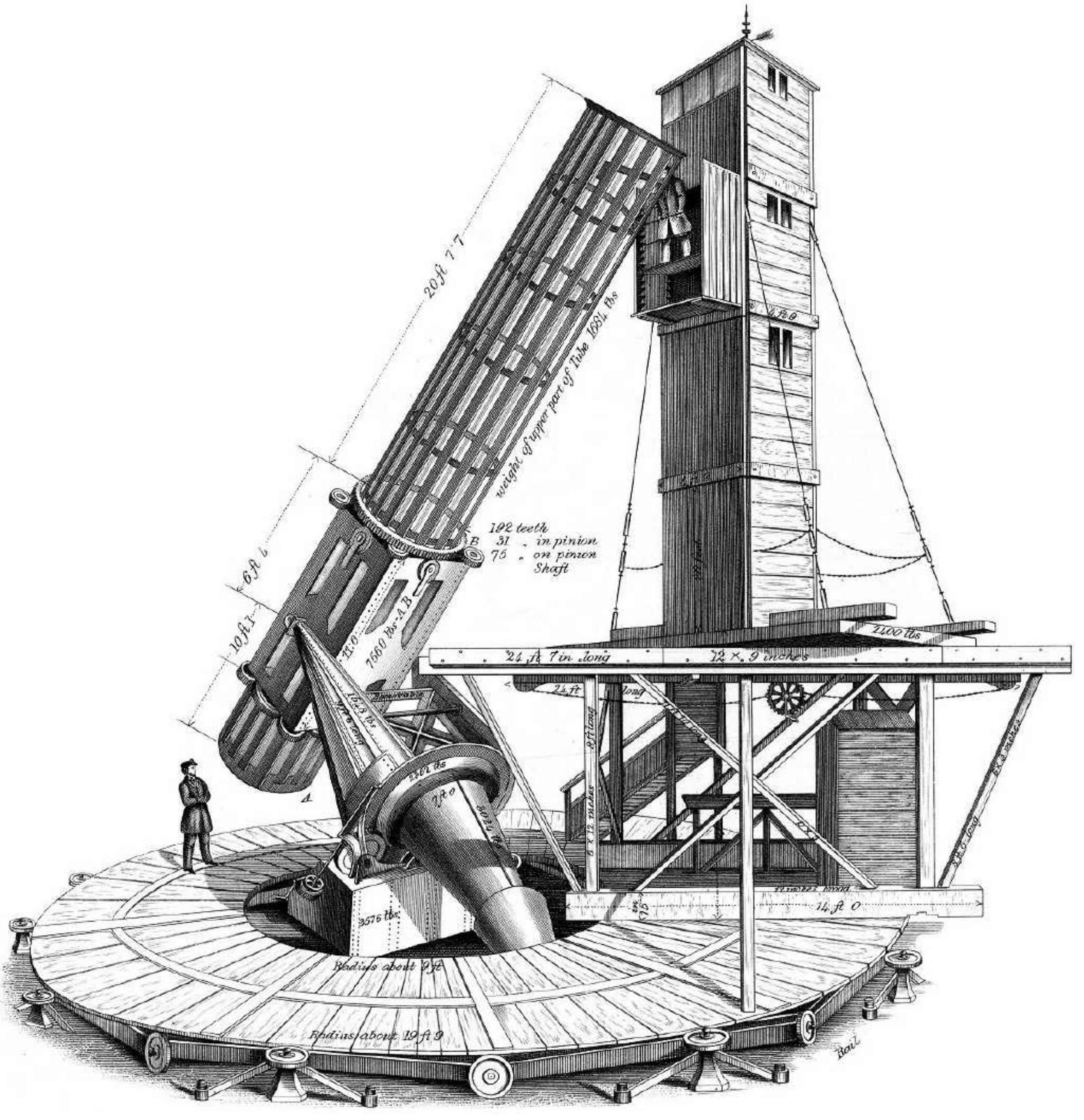
dear Creature for whom of all
all left to me on earth I felt
the tenderest affection. – Oh!
What a mysterious dispensation!
But I cannot dwell upon it,

On receiving a letter from Lady Margaret Herschel, Dawes felt unable to reply immediately. He was no doubt suffering from what would now be diagnosed as psychological trauma, and it was not until 24 January that he released his emotions in a letter of several hundred words:

> ... my heart has failed me, & I felt that I could not enter on the subject. Indeed, I am almost ashamed to confess that my poor heart seems sadly broken down, and have lost nearly all the energy it once had. This last stroke has proved very heavy to me, & has added much to the desolation of my affections ... You are well aware how great a favourite my dear niece was with us. As the only surviving daughter of an only & dearly loved sister, I must under any circumstances have felt a peculiar regard for her ... To bow with submission is the utmost I can attain to; and often I fear that my true feeling is rather that of being crushed by a sense of helplessness ...

This cathartic letter is preserved in the Herschel papers in the archives of the Royal Society (HS 6.120).

Despite these tragic circumstances and his failing health, Dawes' determination in pursuing his astronomical work did not diminish. He completed his series of observations of Mars, and during his last three years he published more than thirty articles in the *Memoirs* and *Monthly Notices* of the Royal Astronomical Society, *The Astronomical Register*, and *Astronomische Nachrichten*, including an extensive report on the Leonid meteor storm of 1866 and his monumental 366-page 'Catalogue of Micrometrical Measurements of Double Stars'. Moreover, in 1865 he was honoured with election as a Fellow of the Royal Society. These final achievements can well be considered a triumph of will over adversity.



By this time, William Lassell – whom Dawes' had known since they first met in Liverpool almost forty years earlier – had returned from his second sojourn in Malta and had settled in Maidenhead. He had offered his 48-inch reflector for the Melbourne Observatory, but the offer was declined, and instead, Howard Grubb was commissioned to manufacture what became known as the Great Melbourne Telescope.

In 1867 the Royal Astronomical Society published two volumes of *Memoirs*, the second of which (vol. 36) contains Lassell's 'Observations of Planets and Nebulae at Malta', 'Miscellaneous Observations with the Four-foot Equatoreal at Malta', 'A Catalogue of New Nebulæ discovered at Malta with the Four-foot Equatoreal in 1863 to 1865', and Dawes' 'Catalogue of Micrometrical Measurements of Double Stars'. The first of Lassell's papers includes a general description of his 48-inch reflector, from which the following is extracted.

There are two large specula, of exactly 4 feet clear aperture, and respectively of the foci of 441.8 and 448.1 inches. The length of the tube is 37 feet, and its diameter 4 feet 3 inches, of the lattice or skeleton form, flat bars of iron being joined (with spaces between, nearly equal to the breath of the bars) by flanchrings at convenient distances. The object of making the tube of this form was to prevent the possibility of any currents of differently heated air in the tube; or of any inequality of the internal and external temperatures – it appeared to answer this end perfectly.

The principle of mounting, even when carried out on this large scale, I consider successful; and I have not been annoyed by any sensible amount of flexure in the framework, in the course of its use. Up to the latitude of Malta, 35° 55', it answers well; but I should hesitate to erect it in a much lower latitude without some modification. There is no roof or covering over the telescope; but the observer or observers are protected by being placed in one or other of the storeys (according to the altitude of the object to be viewed) of a tower, which affords a means of getting conveniently at the eye-piece, which, when the telescope points to the zenith, is about 39 feet from the ground.

A staircase within the tower leads to the different storeys, which are about 4 feet 6 inches square, and afford abundant room for papers, micrometers, eye-pieces, lamps.

and any other small apparatus required; beside furnishing to the observer a most grateful shelter from the dew, and occasionally from an inclement wind. During observation, however, the size of the storey in use becomes practically much larger, by the opening of the folding-doors and letting down of the platform, the available space being then about 6 feet 9 by 4 feet 6 inches. The tower is carried round on a circular railway, and has besides, a revolution on its axis and a radial motion to and from the telescope; so that at most altitudes and hour-angles the eye-piece is easily accessible. It has been usual, however, for the most obvious reasons, to observe within three hours of the meridian, east or west.

I have not attempted to carry on the telescope by a driving clock, properly so called; as the great weight, amounting to many tons on the bearings, makes it a difficult problem. I have, however, a system of wheel-work, terminating in a fly-wheel and winch-handle, which I might almost say answers equally well. The train is so regulated that to give the telescope a sidereal motion it is only necessary to turn this winch-bandle once, accurately, in every second. A sort of skeleton-clock giving motion to a loud-beating pendulum is placed adjacent to the handle, and it is the duty of an assistant (he may be merely a peasant) to take his place at this winch, giving it one revolution for every vibration of the pendulum. The fly-wheel generally insures the uniformity of each revolution, and a very short initial training is generally sufficient to enable the workman to make the revolutions perfectly coincident with the beats of the pendulum. In some respects this mode of driving is superior to the ordinary mode; for it can be instantly interrupted, or accelerated, or retarded at pleasure, when required for any special purpose. The amount of labour is not great, as it may be continued for hours without being oppressive.

Attached to this regulating-clock are two dials, the finger or index of one of them having a retrograde motion and the dial figured accordingly; while the other is direct. The first, of course, belongs to the eastern hour-angle which is constantly diminishing, the second to the western. Being set to the present hour-angle at the commencement by the observer – if from clouds or any other cause the observation is interrupted – when the sky clears, the assistant can by mere inspection of the dial, bring up the telescope to correspond with it, by another winch, having a quiet motion; without the observer having to descend from the tower, or interfere in any way.

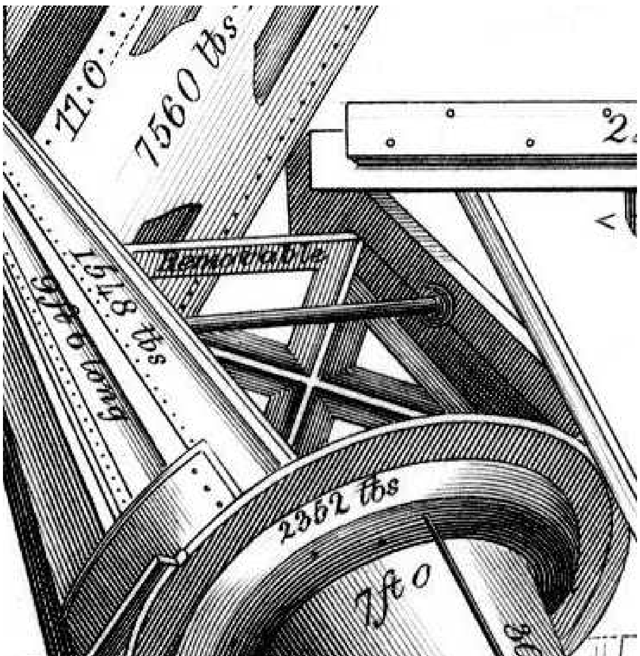
Two assistants are all the observer requires, and they are far from being constantly engaged. One or other of them (and they generally interchange during a long night's observation) is occupied pretty constantly in driving the telescope – the other fitfully, in carrying on the tower, as the telescope retreats from it. I may remark that I have often been struck with the convenience – I had almost said luxury – of observing which has been made compatible with so large a telescope. Almost all altitudes are equally convenient, by the adaptation of the several attitudes of kneeling, sitting, or standing, none of them irksome when not continued too long; and the head is always in a comfortable position, which I am persuaded influences not merely the convenience, but the accuracy of observation. The observer is also sheltered from the dew, with all the apparatus of drawing materials, &c., almost within arm's length.

The adjustments of the instrument did not materially vary from the time of its first erection, i.e. there were no changes which could he traced to any alteration of either polar or declination axis. I do not, however, mean to say that the telescope could be used otherwise than differentially for giving any accurate places; nor that it was not liable to a change of three or four minutes of arc, at widely different hour-angles: but these errors seemed to arise mainly from minute changes in the position of the great speculum (which it is well known cannot be constrained), as it necessarily rolls over somewhat in changing from east to west. The errors, however, were generally so moderate in amount as to give no trouble in the kind of work we pursued, and so nearly constant at the same hour-angles, as to make it unnecessary to spend time in investigating which of the many minute disturbing causes had the greatest share in the effect. During the three years of my sojourn, the large mirrors were repeatedly polished and interchanged, involving a complete readjustment of both large and small specula; but the corrections generally remained within such narrow limits as to present no difficulty or inconvenience.

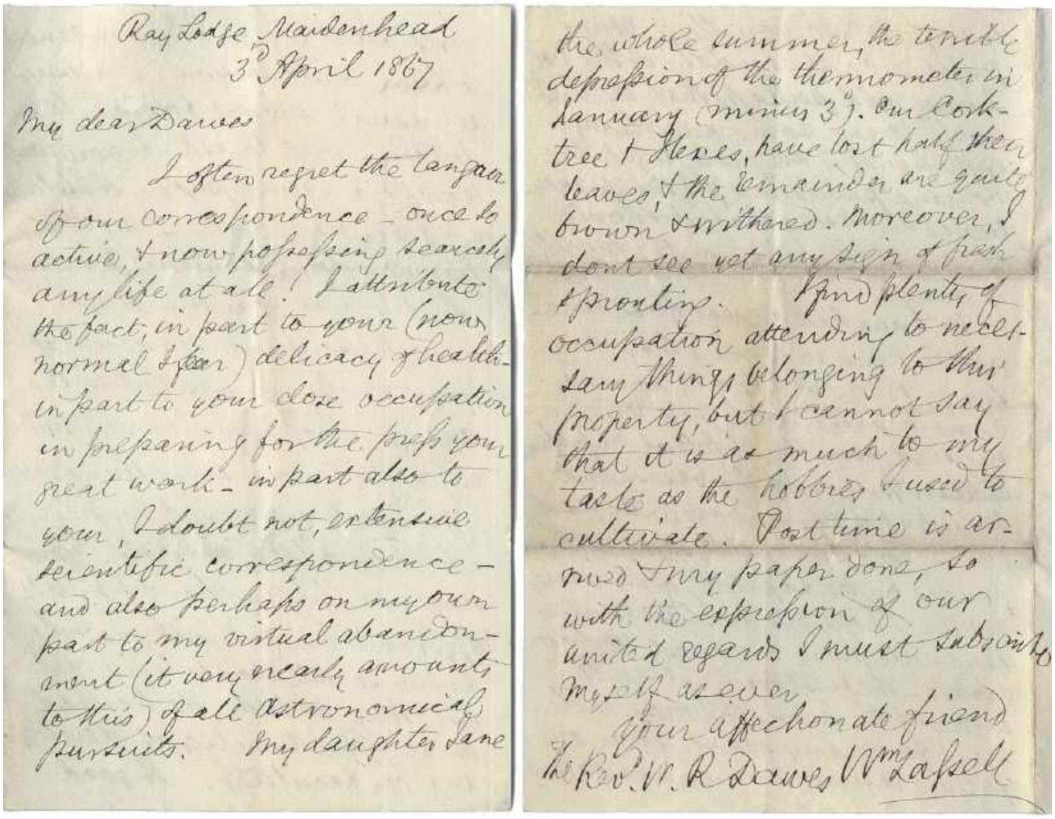
The telescope being entirely in the open air, and exposed to every change of weather and temperature, the specula, both large and small, were necessarily subject to more exposure than if they had been in a closed building, especially the plane specula, placed high in the air at the upper end of the tube. Yet the only two planes which were in use have never been repolished, and I am not certain that there is a sensible or obvious deterioration of lustre in either of them. It is, however, practically of much more importance that the surface of the plane should be purely brilliant than that that of the concave should be so. In case of any injury to the lustre of the latter, the means were at hand in the polishing machine, and by the occupation of a single day, of renewing the surface without risk of spoiling it. It is scarcely necessary to remark that in saying that the telescope was exposed to every change of weather, I do not mean that the surfaces of both the mirrors were not reasonably well defended by close-fitting covers.

The two systems of levers for zenithal and horizontal support of the great speculum, which I first applied to the 2-foot telescope, have, with slight modification, been applied to these large specula with equal success. I find these levers quite essential to eliminate inevitable flexure, and give round images of the stars.

In the illustration above, Lassell includes details of the dimensions of the overall structure and the dimensions and weight of each component of the telescope (as in the segment here). The lower part of tube alone weighed 7,560 lbs, and the total weight was 19,754 lbs – 8.8 tons (8,960 kg).



Soon after Lassell settled in Maidenhead, however, it seemed that after forty years of telescope construction, observation, and discovery, life had become mundane. In April 1867 he wrote to his old friend Dawes, concerning a dog.



Ray Lodge Maidenhead
3d April 1867
My dear Dawes
I often regret the langour of our correspondence – once so active, & now possessing scarcely any life at all! I attribute the fact, in part to your (now normal I fear) delicacy of health – in part to your close occupation in preparing for the press your great work – in part also to your, I doubt not, extensive scientific correspondence – and also perhaps on my own part to my virtual abandonment (it very nearly amounts to this) of all astronomical pursuits. My daughter Jane

the whole summer, the terrible depression of the thermometer in January (minus 3°). Our Cork-tree & Ilexes, have lost half their leaves, & the remainder are quite brown & withered. Moreover, I dont see yet any sign of fresh sprouting. I find plenty of occupation attending to necessary things belonging to this property, but I cannot say that it is so much to my taste as the hobbies I used to cultivate. Post time is arrived & my paper done, so with the expression of our united regards I must subscribe myself as ever
Your affectionate friend
The Revd. W. R. Dawes Wm Lassell

I often regret the langour of our correspondence, once so active, & now possessing scarcely any life at all! I attribute the fact, in part to your (now normal, I fear) delicacy & health, in part also to your, I doubt not, extensive scientific correspondence, and also perhaps on my own part to my virtual abandonment (it very nearly amounts to this) of all astronomical pursuits. My daughter Jane forestalled me, or I had intended to write to you on a very unusual subject for me to entertain, viz. to ask if you would accept a young puppy of I believe a rather nice breed – all that has been done, however, & I am glad to hear you think your new dependant somewhat prepossessing. As this is the case, perhaps you would not object to know something more of his history, & even of his pedigree, which is a little curious. You have seen his mother, & I think approved her; but with one who knows so little about dogs and cultivate them so little, she has had small opportunities of developing her faculties. A good many months ago I observed a strange dog, perfectly black, & not very unlike Nell, wandering on the estate, which I attempted to drive away & told my men to do the same; but the animal returned again & again, until at length after two or three days I paid more attention to the dog & examined his collar, on which I found the name engraved of a Captain in the army residing in Queen's Gardens Hyde Park. Moreover, close attention to the animal even with my imperfect knowledge, made me think him valuable, & that his owner would be much at a loss for him. I therefore wrote off instantly to the address thus obtained; and beside all this having observed a growing intimacy bewteen the stranger & Nell, I thought there was no harm both for the safety of the dog & the enjoyment of the couple, to shut them up together for the night, until I should hear from the owner. The next morning the Captain sent over his coachman for the dog with a polite letter thanking me for my attention. From the coachman I learned that he was a pure retriever of great value & that he had been perfectly trained for his peculiar & characteristic work. How he came to stray here I am not perfectly informed, but I understood that he had been temporarily placed in the care of a friend who had in some way neglected him. So you will now have become in some degree acquainted with the reputed & I believe the real father of the little youngster we sent you. His only remaining brother is thriving well, & if he continues to do so I mean to keep him instead of an older half brother of his not so well bred. I forgot to mention the disconsolateness of Nell which was quite affecting when she had to part from her new acquaintance.

I called the other day on Strangeways & Co. Castle St. Leicester Square about some of my letter-press of my Maltese Observations, which along with Sir John Herschel's communication & yours, are I believe to form the contents of the forthcoming volume of the R.A.S. I feel it an honor to be in such company, but my reason for mentioning the subject now, is to say that the printer tells me that your carriage stops the way, & he requested that if I should have the opportunity, I would be good enough to tell you this. Your paper is in the middle of the volume. I may add perhaps that the Prest. [Charles Pritchard] wrote to me some months ago expressing his anxiety to get the volume published, & I think mentioned his desire that it should appear at the latest in the month of June.

We have had a great flood here, greater I am informed than any since 1852. It has not however come near the house, nor communicated the slightest impression of damp even to the basement storey; but it covered a few acres of our fields & prostrated some of the fences by the rapidity of its retirement. I hope our earliest winters here will prove our most unfavourable – the first having been the most inclement for many years. I fear our foliage cannot recover even during the whole summer, the terrible depression of the thermometer in January (minus 3°). Our cork-tree & ilexes have lost half their leaves, & the remainder are quite brown & withered. Moreover, I don't see yet any signs of fresh sprouting. I find plenty of occupation attending necessary things belonging to this property, but I cannot say that it is as much to my taste as the hobbies I used to cultivate. Post time is arrived & my paper done, so with the expression of our united regards I must subscribe myself as ever your affectionate friend, Wm. Lassell.

In 1913, Dawes' great-nephew Rev Arnold Dawes Taylor – the youngest of Mary Anne's four children – related an anecdote to W. F. Denning concerning Dawes' previous retriever, Dash. Apparently, Dash regularly accompanied Dawes to his observatory, which was at some distance from his house, and carried the observatory key in his mouth. On their return home, Dash would deliver the key to the housemaid. On one occasion, however, Dawes was asked to visit someone who had just had an accident. He therefore agreed, and told Dash to take the observatory key home.

> Off went the dog obediently. Next day, Mr Dawes went to take the key from its usual place, but it was not there, and on enquiry he found the dog had arrived without it. This was awkward; but, taking a bunch of keys from his pocket, he called the dog, held them up, and said 'Key, Dash, key!' The dog hesitated a moment, then ran off at full speed down the garden, dug up the key which he had buried under a cabbage, and brought it back in triumph!

After 1857, Dawes' observatory was situated in the grounds of his house, and as Arnold Dawes Taylor was born in 1852, this story was probably secondhand. If it dates from the mid-1850s or earlier, then the puppy presented by Jane Lassell was probably a consolatory replacement for the beloved Dash. Dawes died on 15 February 1868, when his new canine friend was barely more than a year old. My collection of documents includes an empty envelope with the address written in another hand and postmarked two days after Dawes died. On the back of this envelope are two words: 'Dawes' dog'. In the absence of an accompanying letter, there remains a poignant mystery.

Despite Lassell's despondency in his letter, which must have been an evocation of a temporary mood, he retained his enthusiasm. He continued to record his activities, and in 1875 he published a major illustrated paper 'On Polishing the Spectra of Reflecting Telescopes'. He also served as President of the Royal Astronomical Society during 1870–72.

The 48-inch, however, remained dismantled and in disrepair for several years, and in 1877 he wrote of its eventual and perhaps inevitable fate:

> I ultimately consigned the cast and wrought iron-work to the furnace and tilt-hammer of the engineer, and the specula to the crucible of the bell-founder. I may add that when witnessing the breaking up of the specula, I was not without a pang or two on hearing the heavy blows of sledge-hammers necessary to overcome the firmness of the alloy; and the expressed admiration of the bell-founder on seeing the whiteness, brilliancy, and compactness of the metal as revealed by the fractures.

Lassell did not give any reasons for the destruction of the 48-inch. He probably knew of no-one who would want to use it or maintain it, or perhaps he accepted that time had expired for speculum-metal optics. It seemed that nothing remained of it, but in 1981 one of its plane secondaries, preserved in a tin box packed with wood, cotton wool, and two protective tin plates, was discovered at the Institute of Astronomy in Cambridge, though it is not known how it came to be there. Lassell made three flats for the 48-inch, which he marked 'A', 'B', and 'C'. The back of the flat discovered at Cambridge is marked 'B' twice with white paint, and a red 'B' is painted on one of the tin plates and on the lid of the box. The dimensions of the polished surface correspond with Lassell's measurements: 'Examined three plane specula belonging to Four foot Eql. Transverse axis about 7 ins conjugate 5 ins.' Pasted on the inside of the lid of the box is a piece of paper with a note in Lassell's hand: 'Plane Speculum B Polished on machine 9th July 1875. Examined 10th on usual tests of Dial, name & small figures engraving.' This also corresponds with Lassell's records: '1875 July 9 Repolished Plane B with a view to reduce its convexity & also improve its definition.' This plane mirror and its accompanying remnants are now preserved in the Whipple Museum of the History of Science, in Cambridge.

William Rutter Dawes (1799–1868). Photograph by William Huggins, *c.*1865. (RAS MSS Add. 94, No. 43.)

William Lassell (1799–1880). Photograph taken on 12 June 1879. (RAS MSS Add. 91, Vol. 3, No. 97.)

Restoration of an AE350 f/5–20 Newtonian–Cassegrain: Part II

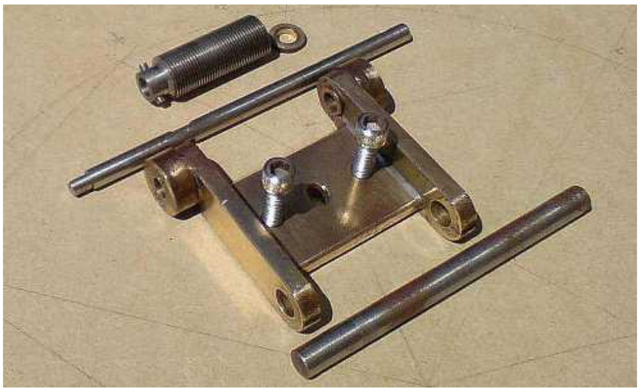
Alan Snook

This instrument was made by Astronomical Equipment of Luton in 1974–75, and was operated at the Hicks Observatory at the University of Sheffield from 1975 to 2008. My first report on its restoration was published in *I&I News* New Series No. 29 (16 June 2017).

The RA worm drive

The original set-up comprises a 23-mm diameter steel worm gear engaging with a 720-tooth phosphor-bronze worm wheel of 14½ inches diameter. The diameter of the worm wheel is in line with the traditional rule-of-thumb that the main drive gear should be as large as, or larger than, the main mirror. The worm and wheel are single-envelope; that is, the teeth on the wheel are cut concave to wrap around the worm gear. (In a double-envelope gear set, the worm is also cut concave to wrap around the wheel.)

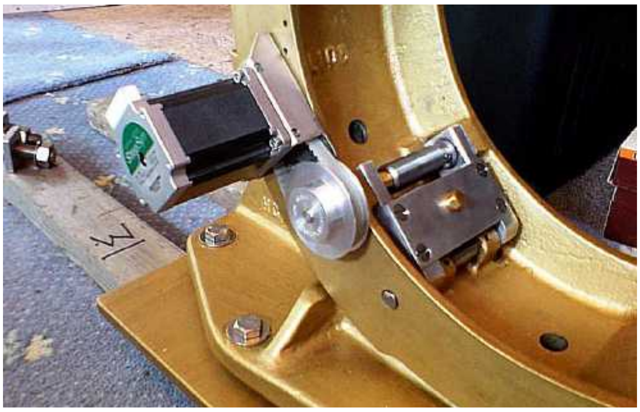
The worm gear rotates on a 10-mm diameter steel shaft held in custom-made plain phosphor-bronze bearings which by their design also act as thrust bearings, taking up the force which acts along the length of the worm gear shaft. The bearings are screwed onto a substantial brass carrier. The carrier hinges at the other end on a ½-inch diameter shaft. Its contact with the worm wheel is adjusted by two cap head screws and then locked in place by a third centre bolt. The photograph shows the worm gear and carrier disassembled.



The original design duty cycle was for sidereal rate with a maximum rate of up to sidereal +60%; that is, up to about 0.°4 per minute. My aim is for the telescope to be capable of remote operation. Alan Buckman (of AWR Technology) has suggested that this demands a slew rate of at least 0.°7 per second. This is about two orders of magnitude greater than what it was designed for, so modifications have to be incorporated to cope with the extra stresses and strains.

The photograph shows the huge amount of wear in the phosphor-bronze bearings. For scale, the worm shaft is 10 mm in diameter and the distance between the two bearings is about 75 mm. The wear in the far bearing is not too bad, but the near bearing is completely shot. There was no easy provision for lubricating the bearings, and the consequent wear can be seen. The asymmetric wear also indicates that the proper adjustment of the worm gear, using the trio of opposing bolts, had proven difficult to get right in use. Additionally, the fixed worm gear would also be susceptible to any slight deviation in concentricity of the worm wheel, causing it to run alternately slack and stiff. To solve these limitations it was clear that the phosphor-bronze plain bearings would have to be replaced with ball races. Furthermore, I am grateful to John Carruthers for his suggestion to spring-load the worm gear carrier, which will enable the worm gear to 'float' and automatically compensate for any variations in the contact between the worm and wheel.

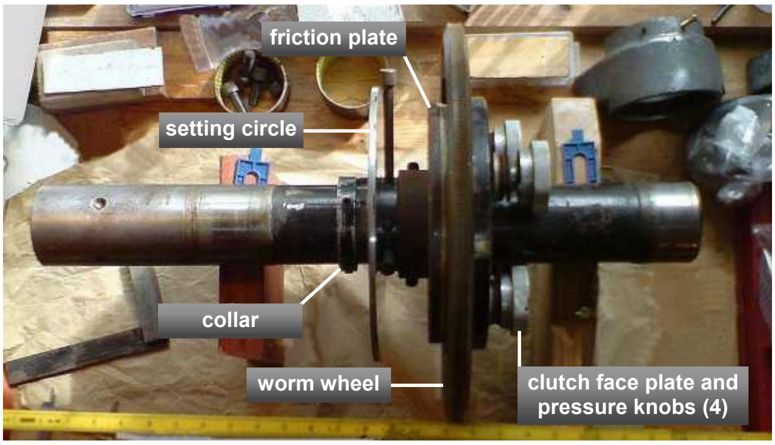
After a session at the drawing board it was swiftly realised that the existing brass carrier could not be modified to accommodate either the ball races or the spring loading. John therefore fabricated a new carrier from hefty aluminium bar. The redesign moved the central cross bar from the bottom to the top of the arms to allow space for the compression springs. Much effort went into selecting the ball races, and space was very tight. The limiting factor was the clearance between the worm wheel and the shoulders of the ball races. We therefore settled on angular contact ball races, which provide a combination of ball race and thrust race in a single space-saving unit.

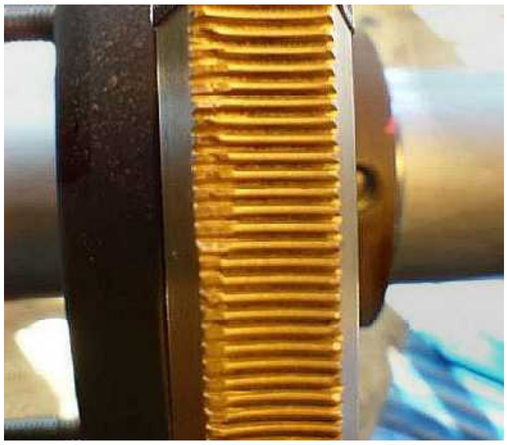


This photograph shows the test assembly of the new spring-loaded worm gear carrier, together with the new AWR-supplied stepper motor, zero backlash pulleys, and toothed belt drive. The compression springs are neatly out of sight under the aluminium cross-piece, and a single brass screw compresses the springs to provide clearance for assembly of the polar shaft. Everything has been done in aluminium, brass, or stainless steel to avoid corrosion. This stage took a lot of time and energy. It is key to the future successful operation of the telescope, so hopefully it will all work as expected when it comes to the first trials.

The polar shaft: 24 x 3 inches; weight 20 kg

The shaft is steel, and the minimum diameter is $2^{15}/_{16}$ inches. It appears that the bearing surfaces are made up to exactly 3 inches in diameter, with stainless steel sleeves fitted over the shaft. On first inspection the bearing sleeves appeared to be in worryingly poor condition. They were pitted in places by set screws tightened down in completely the wrong places, and they appeared discoloured and corroded. However, they cleaned up very well with 600-grade abrasive paper and judicious use of coarser abrasive on the rougher areas. Checking dimensions with the callipers, I am pleased to say that the bearing sleeves have survived very well. They are round to the accuracy I can measure, there are no wear ridges, and no further work is required. Two register marks were machined into the top end face of the shaft to take the guesswork out of aligning the two set screws that lock the fork to shaft, with the conical pits cut into the polar shaft. The next photograph shows the polar shaft before stripping down. One of the pits can be seen at left.





The RA drive clutch: weight 11 kg

The clutch (above) comprises two main steel components which sandwich the worm wheel with adjustable pressure. One component is an annular plate carrying four threaded studs. The plate is 8¾ inches outside diameter, 4 inches inside diameter, and 9 mm thick. There are four 3½-inch long studs threaded ⅜-inch BSW, fixed at 90º, centres spaced on a 6¼-inch circle. On the side that carries the studs, the friction material is fixed using thirteen equally spaced countersunk screws. The friction material is 4.4 mm thick and in good condition, and no work is needed. Each of the four studs carries a threaded aluminium knob, and each knob screws down onto a thrust race, applying a clamping pressure to the clutch. The other component is a machined casting. The face plate is $9^{3}/_{16}$ inches in diameter by 18 mm thick, and is drilled with four holes of $^{25}/_{64}$-inch diameter spaced at 90º to match up with the studs on the other component. In addition, there is a fifth $^{25}/_{64}$-inch hole spaced at 33º from one of the four. The face plate is carried on a boss, $3^{5}/_{32}$ inches deep by 4 inches outside diameter. The outside is a tight clearance fit with the hole in the circular plate. The central hole through the boss is 3 inches in diameter to match the polar shaft. The casting is locked to the polar shaft by two 1¼ x ½-inch BSF grub screws. The only work needed was to strip off the old coatings and repaint. The thrust bearings were cleaned, and the aluminium knobs were cleaned and repolished. The photograph shows the knobs before and after.

The Right Ascension drive worm wheel: weight 6 kg

The wheel is 720-tooth phosphor bronze, 14½ inches in diameter. The teeth are $^{9}/_{20}$-inch wide, and the central hole is 7 inches in diameter. The wheel rotates around the clutch casting and is sandwiched between the two parts of the clutch. The photograph shows typical damage to the gear teeth along the lower edge at left. This damage was mostly along the lower edge of the wheel, and inspection revealed that teeth around 40% of the circumference are damaged. Typically they have have been crushed, and the damage probably occurred after the telescope was decommissioned. I suspect that the polar shaft, with the wheel, clutch, and other components all fitted, had been stored with the majority of the 40-kg weight resting on one edge of the gear wheel. At worst, the damage extends across no more than 20% of the width of the teeth. A counsel of perfection would be to have the teeth recut, but I considered that that might come with quite a price tag. Also, the main contact patch with the worm gear will be in the undamaged centre of the teeth. So, I elected to clear the gaps between the individual teeth. This photograph shows the gear wheel jury-rigged with the clutch and polar shaft on the workbench ready for the work.

Every tooth was inspected using a magnifying visor, and the damaged sections were marked out with sticky tape. I then worked through those sections tooth by tooth, using needle files to clean the damage. To protect the teeth from further damage during storage, and assembly or disassembly of the mounting, I covered the entire rim with a 4-foot offcut of thick-walled translucent 20-mm PVC hose, split lengthways.

The right ascension setting circle: weight 1 kg

This is a 10-inch diameter aluminium plate, graduated 00–24 hours in 5-minute divisions. The scale was badly deteriorated and practically illegible, and cleaning and polishing did not prove sufficient. Fortunately the engraving is quite deeply cut, so I was able to use 600-grade abrasive paper to remove the worst of the corrosion. The end result is far from perfect but will suffice. I then ran black paint into the engraving, removing excess, once dried, with a hardwood lollipop stick. The centre and underneath were stripped of black Hammerite and repainted. The Rustoleum paint system requires the use of a sticky tack-coat primer when painting aluminium, stainless steel, and the like, but the tack-coat is unpleasant stuff, exuding nasty fumes. Having applied the tack-coat with my best brush, I was dismayed to find that it uses different thinner to the Rustoleum paint! The paint thinner will not touch the tack-coat. Hurriedly experimenting with a selection of compounds in the cupboard, I found that xylene did a tolerable clean-up job.

The banana casting with polar shaft bearings and new worm gear unit

The photograph shows the banana casting ready for attachment to the base casting. At either end, the refurbished polar shaft bushes are attached by ½-inch BSW hex head cap screws. In the centre is the new spring-loaded worm gear carrier, and on either side of that are the new stainless steel M20 clamp bolts.

The fork: 32 x 32 x 7 inches (approx.); weight 48 kg

For me, this is the heart of the engineering on this mounting. It is not merely a fork; it is art. Just making the pattern for this one-piece aluminium casting must have represented a big investment in time. And, I wonder, how many or few did they make? My first task was to check the fit of the polar shaft into the main boss of the fork. It appears to be a snug fit without tightening the two clamp screws. I could insert a 4-thou inch (about $^1/_{10}$ of a millimetre) feeler gauge between the shaft and the boss. A dial gauge indicated that the shaft had a tenth of a degree (6 min) of free movement in the boss. This will lock out with the pair of hefty clamp screws inserted and tightened.

It was noted that the top end of the polar shaft could do with two registration markers to aid alignment of the clamp screws with the corresponding depressions machined into the shaft. I cut these into the shaft with the Proxxon fitted with a ball milling cutter. The next task was stripping the paint to get back to metal; but it is only when such a large and intricate task is begun that it becomes apparent how expensive Nitromors is. The top coat of silver paint bubbled up readily, but the original factory-finish Hammerite underneath took more persuading. This method was never going to work. After making many enquiries I located a chap a few miles away with shot-blasting equipment at home in his garage, and he did an excellent job on the fork and some other intricate components, such as the mirror cell. The fork is now awaiting replacement of the Oilite bearings in which the declination shafts spin, and painting, though the paint can only be applied when humidity is below a stated percentage. (The bare aluminium fork is shown in the last of these photographs.)

The 3-inch guidescope

The guidescope is by Ron Irving. The objective is a cemented doublet, probably a Littrow type. The back of the flint glass lens (the surface on the eyepiece side of the objective) is flat, the diameter of the glass is exactly 3 inches, and the clear aperture through the cell is less, about 74 mm. The measurement does not seem to be a sensible Imperial fraction. The objective was dirty, and the inside was flecked with specks of black paint that had peeled off the inside of the tube. The lens cell, made of aluminium, came apart without any bother, and I cleaned the lens with acetone and cotton balls. This proved successful, but there are some spidery blemishes on the outside that could not be removed. Perhaps these are deteriorated patches of a coating. There are also a couple of tiny 'pimples' on the inner surface which also refuse to clean off. None of this will have any noticeable effect on the image.

The old paint on the guidescope did not respond at all to Nitromors stripper. Instead, I had the tube shot-blasted inside and out, with excellent results. This showed up a lot of damage. Some of the thumbscrews on the mounting rings had been tightened down so hard that they dented the aluminium tube, and rough handling had caused a few other dings. There are also straight lines of corrosion pits running lengthways along the tube, which initially were puzzling. Early photographs of the telescope installed show runs of electric cable taped to the tube. These cables evidently trapped dew, made acid by Sheffield city pollution, against the tube, where it ate away at the paint and underlying aluminium. The photograph shows, at left, the corrosion along the line of an electric cable and, at right, a crease from impact damage.

To disguise this damage I elected to cover the tube and dew cap in 3M Series 1080 carbon-fibre effect film wrap. This material is used by vehicle customisers and carries a three-year guarantee in such use when professionally applied. I hope that in this less demanding use it will have a much longer service life. The film is self-adhesive and is applied using pressure and a heat gun (hair dryers will not do the job). The film is 0.15 mm thick, and has done a decent job of hiding all the corrosion pits and the smaller dings. The tube has two internal baffles, at 5 and 16 inches from the objective. The interior of the tube I have painted with Culture Hustle's Black 2.0. This is a super-black acrylic paint created by artists as a riposte to the restrictions on Vantablack, recently invented by Surrey Nanosystems. Unfortunately, Vantablack is classed as weapons-grade black, and availability is restricted.

The guidescope is held in the usual way in a pair of rings, each with three ⅜-inch BSW brass thumbscrews. One set of thumbscrews had been pilfered, and 1½-inch steel hex bolts had been substituted. John Carruthers kindly turned three new brass thumbscrews. The original AE thumbscrews have straight knurling, and John's new ones have diamond knurling. A stylish lens cap and a plug for the drawtube were 3D-printed by my son Rob, who also produced two flat split rings which sit under the thumbscrews and prevent them from damaging the carbon-fibre wrap. The guidescope was completed on 29 October 2017 and screwed to a temporary board and trialled in daylight. At a range of 680 metres the field of view in a 10-mm Plossl eyepiece took in 40 x 15 cm squares of wire stock fence, or 6.0 metres. This is a true field of view of $^{6}/_{680}$ = 0.0088 radians or $0^{\circ}\!.5$. The eyepiece has an apparent field of 50°, so the magnification is $^{50}/_{0.5}$ = x100. This further implies that the object glass has a focal length of 10 mm x 100 = 1,000 mm. The clear aperture is 74 mm, so the focal ratio is f/13.5. As a double-check on this result, the exit pupil with a 25-mm Plossl eyepiece was estimated at 1.8 mm. The magnification is $^{74}/_{1.8}$ = x41, and the focal length 41 x 25 = 1,025 mm. This is in decent agreement with the first method. The photographs show the guidescope as it came to me, dismantled, and restored.

Some assembly at last

A first trial assembly of the polar axis was attempted on 12 November 2017. It was quickly found that the bottom bush of the shaft passed through the top bearing satisfactorily but would not go into its bottom bearing. Also, the top bush refused to fit into the top bearing. The bearings had been resleeved (as described in the previous article), but that should not have made any difference. Consequently, there followed many hours of methodical work with fine-grade abrasive papers until a nice, smooth

fit was achieved on both bearings. A safe method of assembly was worked out that ensures no damage to potentially vulnerable parts. This method was inspired by an excellent home video available on YouTube, which shows the assembly of another Hysom telescope, a 19-inch, in a back garden in 1992: https://www.youtube.com/watch?v=91YN86jBR1U.

This last photograph shows the 14-inch with the (unpainted) fork attached to the top of the polar shaft. I put a cord around the worm wheel and pulled tangentially with a spring balance. It currently needs about 11 lbs force (not foot-pounds) to get it moving, and about 7 lbs force to keep it moving slowly. This converts to (say) 50 and 30 newtons. It will be interesting to see how this increases when the optical tube assembly is added.

To be continued …

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