

REPORT
OF
THE ASTRONOMER ROYAL
TO THE
BOARD OF VISITORS
OF THE
ROYAL OBSERVATORY, GREENWICH,

Read at the Annual Visitation of the Royal Observatory, 1858, June 5.

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I PROPOSE to include in this Report a record of the principal transactions in the Royal Observatory between 1857, May 23, and 1858, May 21, and a statement of its condition on 1858, May 21.

I. Grounds and Buildings.—In the older parts of the Observatory-buildings the changes made are very small. A doorway at the east end of the principal range of observing buildings, or the east side of the Transit-Circle-Room, which has been repeatedly opened and closed, is again opened, and it now presents (as will be further explained) the advantage of a covered entrance into the Observatory. When the small room for the Zenith-Tube, on the south side of the passage between the Computing Room and the Transit-Circle-Room, was erected, no provision was made for opening the window; and the appearance of the star in observation impressed on the observers the opinion that better ventilation was required. The window has been so altered as to admit of this ventilation, and the observers have no doubt that the image of the star is much improved. The Visitors will remark a change in the north window of the Octagon-Room. An alteration has been made in the exterior of the Altazimuth-Tower, with the view of bringing its appearance into harmony with that of the other buildings of the Observatory. The buildings generally are in good order.

The new South-east Dome has been constructed in exact conformity with the plan explained to the Visitors at their last meeting, and is in nearly all respects ready for reception of the Equatoreal. Its place is at a very small distance from the south-eastern corner of the Record-Room, where there was exactly space enough to allow three passages around it, (the principal passage to the Magnetic Ground, a passage

between the Dome and the Record-Room, and a passage on the edge of the Garden), which it was indispensably necessary to preserve. The stove, with underground draft, answers well for warming the two lower stories. The Drum-Dome, whose external diameter is 32 feet, is constructed with vertical standards upon a horizontal curb, tied by diagonal iron-hooping, covered with very thin boarding, and then covered with zinc. In planning this frame, I omitted to notice that a considerable stress is put upon the two principal standards which form the sides of the vertical shutter opening, and between which there can be no diagonal tie, and that in consequence there would be a sensible bending of the jointed curb when one of these standards should bear immediately upon one of the cannon-balls. A long piece of stiff iron curb, passing under the feet of these two standards and for some distance on both sides of them, is prepared, and is at the Observatory; its mounting is deferred for convenience only. I anticipate that it will entirely remedy the inconvenience that I have mentioned. The rack for motion of the dome is fixed to the wall; the machinery which acts on it is carried by the dome, and the person who turns the winch to move the dome is always on the side opposite to the shutter-opening, and therefore sees the object to which the telescope can be directed. The machinery for opening the two shutters is on the same side as the shutter-opening; the jointed rack for the vertical shutter, and the single rack and counterpoise for the horizontal roof-shutter, answer very well. A misunderstanding of a draftsman, which was not discovered till it was too late to remedy it, has left less room between the great north iron support of the equatoreal and the ring of the curb than I designed, and in consequence the winches of the dome and shutter-mechanism are compressed more than I could wish. I have not yet arranged an apparatus for fixing the dome, to prevent it from receiving an oscillation from the action of the wind. Other points of interest will be best seen in the building itself.

The passage on the North-side of the East Buildings and the Record-Room, and the approach to the door of the South-East Dome, are protected by a roof of rough glass. The whole of the Astronomical buildings, and the communications between them, and the approach from the entrance gate, are now under dry cover; with the exception of the Galvanic Room, which it will be difficult to connect with the others in the same way, though it would be very desirable to effect it.

A new principal map of the Grounds and Buildings has been prepared. The detail-plans and sections of the buildings are kept up as changes are made.

II. Moveable Property.—The words of the last Report to the Visitors might be cited as perfectly applicable to the present time. We have in charge the old Cape Altazimuth and sundry Standards; we have lent two small clocks, a magnet, and a

book. A part of the Observatory property, connected with our galvanic operations, is invested in the South Eastern Railway. The Official Copy of the Yard Standard appears to be in good condition. Our Catalogues of moveable property are amended from time to time.

III. Manuscripts.—Our Manuscripts are in good order. Continual attention is given to the collecting and binding of the papers which accumulate in the ordinary course of business, whether as produced by the internal work of the Observatory, or by the multifarious business (not always of astronomical character) from extraneous sources. A modification of the Manuscript Catalogue will soon be necessary.

The papers of the Board of Longitude are now finally stitched into books, in the arrangement in which we usually send our manuscripts to the book-binder. They will probably form one of the most curious collections of the results of scientific enterprise, both normal and abnormal, which exists.

IV. Library.—No great number of books has been added to the Library, serial works being however kept up. The Catalogue to which allusion was made in the last Report, is in use.

V. Astronomical Instruments :—

The Transit-Circle is in good order. The fault of insulation of the galvanic part, to which I alluded in the last Report, was speedily remedied. A small change has lately been made in the western pier which carries the microscopes; of this kind. The Visitors are aware that the illumination of those parts of the limb which are under view of the microscopes is effected by a single central lamp, on the external side of the pier, shining through holes which are perforated through the pier; and that in each hole there is a lens for intensifying the light upon the limb, and that the accurate reflection of the light from the limb up the tube of the microscope will depend in some measure on the position of the lens, and therefore a power of adjusting the lens is desirable. The only way of adjusting the illuminating lenses which had been used in practice, was to force wedges of different thicknesses between the sides of the brass tubes containing the lenses and the sides of the holes in the stone pier. The change now made is the following :—The interior of the stone pier is cut, to a small distance beyond the circle of illuminating-holes, into the form of

a concave spherical surface of which the lamp is the centre. To this surface of the stone are fixed concave brass plates, properly perforated in correspondence with the holes of the stone, and upon these the brass rings which carry the illuminating lenses are fixed, by thumb-screws passing through large holes that allow a considerable range of adjustment. I trust that we shall now make the appearance of the divisions under the microscopes unexceptionably good.

Mr. Simms, and Messrs. Ransomes & Sims, are at present engaged in preparing a Transit-Circle for the Observatory of San Fernando near Cadiz, similar to that at Greenwich (or rather to that at the Cape of Good Hope). Artificial stones of Portland cement, bearing the proper perforations, have been prepared here for the Microscope Pier. The blocks are shaped for the reception of concave brass plates for adjustment of the illuminating lenses, in the manner which I have just described.

I have lately had reason to think that the indications of the Transit-Circle External Thermometer have increased, so that it now reads too high by perhaps half a degree.

The Zenith Tube is quite satisfactory. The image of the star, since a free passage of air was allowed from the window, is almost always very good. No observation, I believe, is ever lost now from tremor of the quicksilver.

The Altazimuth is in good order. The error in the angle, between the horizontal axis of the vertical circle and the vertical axis of revolution, is not yet corrected: an attempt was made to unscrew the bolts which connect the Y's with their brackets, but the connexion was found to be so firm, that I have thought best to defer further operations until I shall have the assistance of a competent engineer.

The Chronographic Barrel Apparatus is in good order. Detailed plans of this mechanism (on which, at the date of the last Report, a draftsman was employed) have been prepared, and are attached to the description which is circulated with the published observations of 1856.

The Galvanic Apparatus, so far as it is included within the Observatory, is in good order. By some parts of this, our system of sympathetic clocks are kept in motion; by other parts, our Time-Ball is dropped, and hourly currents are transmitted to the South-Eastern Railway, and the Lothbury Station of the Electric Telegraph Company, (from which communications are made at 1^h to our Time-Ball at Deal, and to other Time-Balls in the Strand, Cornhill, and Liverpool,); by other parts, currents are sent for maintaining the action of a clock at the South-Eastern Railway Station, by which

communications are automatically altered ; by other parts, we possess the power of giving touch signals from the eye end of the Transit-Circle, to any of the wires of the Electric Telegraph Company, or of the British and Submarine Company. The communications, however, external to the Observatory, have been in a bad state. The four wires to London Bridge were injured, as we have reason to believe, by a thunderstorm in the last autumn ; and from the circumstance that the injured part is buried in the South-Eastern Railway, and that trains are running at every ten minutes during the day, it has not been possible till lately to open the ground for their examination. I trust that they will now, in the early morning hours, be examined and made good. Our other communication to London, by the Admiralty subterraneous wires crossing Blackheath, has also been in a bad state, but is now made nearly perfect. These faults (as will be stated hereafter) have in some measure impaired the efficiency of our external galvanic action.

The North Equatoreal is in an imperfect state, as regards the measure of hour angle. It is still applicable to the measure of North Polar Distance.

The East Equatoreal, and the double-image-Micrometer, commonly used with it, are in good order.

For the new South-East Equatoreal, the object-glass was furnished by Messrs. Merz and Son in the summer of last year, and I made various trials of it in a temporary tube carried by the temporary mounting which I had provided, and finally I was well satisfied with it. I cannot yet say that I have certainly divided the small star of γ Andromedæ ; but, for such a test, a combination of favourable circumstances is required. From what I have seen, I have no doubt of its proving a first-rate object-glass. The north support of the polar axis (wanting the small part at the top, which immediately supports the pivot) and the adjustable parts of the south support (also wanting some parts) are mounted in their places. No other parts of the instrument are here, but almost the whole of the work is in Messrs. Ransomes and Sims' workshops, very nearly ready. The hour-circle will probably be divided before the time of my presenting this Report, and this will enable the engineers to cut the teeth for the action of the worm of the clock-work, and also to finally fit together the polar frame. (I may remark, that in the temporary erections of the polar frame the engineers have expressed themselves satisfied and almost surprised at the stiffness given by its bracing.) The hour-circle clamps and slow motions, the declination-axis, the declination-circle, the declination-circle-clamps and slow motions, and the clock-work, are in different stages of advance. The old instruments of the Observatory have been preserved untouched.

VI. Astronomical Observations.—Our principal attention, as heretofore, has been fixed upon those objects which may be considered fundamental. The Meridional system is carefully preserved. In regard to stars observed on the meridian, the greater part of the observations have been devoted to the large clock-catalogue, of which the stars are never allowed (if possible) to pass unobserved in any year. Some observations, however, have been given to moon-culminators, occulted stars, stars favourable for zenith-points, stars with Mars and with comets, stars with large proper motion, low stars for refraction, variable stars, stars used for the longitude of Edinburgh, and stars observed at the request of private astronomers. In regard to moveable bodies observed on the Meridian, the Moon is never omitted; the Sun and Planets are omitted on Sundays; the Planets also are omitted after 15^h, unless when the Moon passes after 15^h. The chronographic method is exclusively used for transits of planets and of stars not very close to the pole (unless the galvanic apparatus is deranged).

The following is the tale of Meridional Observations from 1857, May 23, to 1858, May 21:—

Transits (two limbs, or two methods of observation being counted at two)	-	-	-	-	-	-	5,024
Pairs of observations of Collimators with the transit-telescope	-						309
Observations of transit-wires by reflexion	-						304
Observations of Collimator by Collimator	-						52
Circle-observations of all kinds	-						4,714
Observations of zenith-distance-wire by reflexion (included in the last)	-						293

The system of observations for adjustment is the same as for several years past.

The errors of graduation for every 1° of the meridian circle having been determined by the operation of last year, these have been taken as basis for determination of the errors of graduation of certain divisions in the series of arcs of 5'. Observations have been made and reduced for determining the errors of those divisions which fall under the microscopes in observations of Polaris, Polaris S.P., and the wire by reflexion, which come into use far more frequently than any others.

The number of double observations of γ Draconis with the Reflex Zenith Tube is 109, or 218 single observations.

With the Altazimuth: The total number of observed azimuths of Moon and stars is 788; of the Collimator, 424. The total number of observed altitudes of the Moon

is 407; of stars (for time only), 4; of the Collimator, 424. The complete observations of the Moon, on days when her meridian passage occurred between 0^{h} and 1^{h} solar time, are 2; between 1^{h} and 2^{h} , 2; between 2^{h} and 3^{h} , 11; between 21^{h} and 22^{h} , 2; between 22^{h} and 23^{h} , 1; between 23^{h} and 24^{h} , 0. The whole number of days of complete observations of the Moon is 210, or about $16\cdot9$ per lunation. The corresponding number on the meridian is 122, or about $9\cdot8$ per lunation.

I may here remark, that the erection of the new South-East Dome will slightly interrupt the observations of the morning Moons. As viewed from the Altazimuth, the new Dome occupies about 15° of eastern horizon, to the height of about 10° . As that space of 15° occurs nearly in the central portion of the Moon's azimuthal range of rising, and as that whole range, on the average, is not far below 90° , the interrupted part will correspond nearly to an interruption in the view of about one-tenth of the whole number of moon-risings, to the height of 10° . I believe that, on the average, there are not ten observations in the year which it is necessary to take so near to the eastern horizon as 10° ; and, therefore, I think we may estimate the loss of observations of the Moon from this interruption at about one in a year.

With the Double-Image-Micrometer, measures of Venus have been made on nine days, measures of Jupiter on four days, and measures of Mercury on one day. Considerable attention has been given to the determination of the scale of the Micrometer. It is clearly established that the scale is sensibly equal in different parts of the field, although some discordances have appeared between the results of different days.

Other observations are,—24 occultations of stars by the Moon, and 56 phenomena of Jupiter's satellites.

The excessively bad weather on the day of the Solar Eclipse of 1858, March 15, made it impossible to take at Greenwich more than two or three measures of North Polar Distance of cusps scarcely worth recording. With the assistance of the Rev. George Fisher and John Riddell, Esq., of the Greenwich Hospital Schools, and of six skilful and intelligent lads of the Upper School; and aided by the cordial hospitality of William Blower, Esq., of Bedford; Charles Simpson, Esq., of Harrowden, near Wellingborough; and W. De Capell Brooke, Esq., of Market Harborough; I organized three well-appointed observatories (one nearly on the central track, and one at each side of it), equipped for the purpose of making numerous measures of the distance of the cusps, by means of which the apparent correction to the diameters of the Sun and Moon, and the absolute correction to the elements of the Moon's path, would have been found with great accuracy. Only at Bedford, however, were a few observations obtained. In regard to all its real objects, the expedition failed entirely.

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VII. Reduction of Astronomical Observations. — In the Department of Right Ascensions from Meridional Observations, the deduced Apparent Right Ascensions of Center of Object are prepared to May 16, and the deduced Mean Right Ascensions of Stars to May 8. Personal Equations and Corrections for defective limb of the Moon are applied to the end of 1857. Mean Solar Times are formed to April 30. In the Department of North Polar Distances the reductions are entirely completed to May 8, excepting only the small corrections for imperfect illumination of the Moon's limb, which are completed to the end of 1857. It is to be remarked, that the circle observations were interrupted for a few days after May 8 by the operations of workmen on the pier, for mounting the adjustable illuminating lenses; since the workmen left, the observations were resumed, and the reductions to the state of Concluded Circle-Reading are nearly finished for current observations.

The Ledgers of Stars' Mean R.A. and Mean N.P.D.; the Annual Star-Catalogue; the Comparison of Observed Places, and Diameters of Sun, Moon, and Planets, with tabular places, in all their steps, and the exhibition of Heliocentric Errors where required, all in Longitude and Ecliptic Polar Distance, are completed for 1857. Various parts are finished to the end of April 1858.

For the Reflex-Zenith-Tube, every reduction is complete to the end of 1857, and daily reductions to the present time.

With the Altazimuth, the Azimuths are completely reduced to April 3, and everything to the application of Errors of Collimation as far as May 7; the Zenith-Distances complete to May 7; the Tabular Computations complete to May 7, and wanting only the applications of Semidiameter, to May 15; the Errors of Tabular R.A. and N.P.D. deduced to April 3; and the Errors of Tabular Longitude and E.P.D. to the beginning of February.

The Equatoreal-Observations of Brorsen's Comet are nearly reduced.

The Double-Image-Micrometer-Observations are reduced to the end of 1857.

The reduction of Occultations also is complete to the end of 1857.

On the results of the computations I may remark:—

The personal equations of chronographic transits, deduced from the observations of 1857, range (as compared with Mr. Dunkin) from $-0^s.14$ to $+0^s.18$. The range has undoubtedly increased. I cannot conjecture a cause for this.

The periodic and the occasional changes of Azimuth of the Transit-Circle, as inferred from observation of circumpolar stars, without sensible variation of position relative to the Collimators, still continue. It also appears (as before) that the eastern pivot rises when the temperature rises.

The determination of the colatitude from the observations of 1857 has given me some anxiety. The observations of Polaris (upon which the result principally depends) indicate that the assumed colatitude ought to be reduced by $0''\cdot4$; and this is supported as to sign, though not as to magnitude, by the three stars which stand next in importance; namely, δ Ursæ Minoris, Cephei 51, β Ursæ Minoris. The results from other stars have a somewhat mixed character. I cannot offer a conjecture on the cause of this change. On examining the observations of Polaris month by month, using in all cases transits above and below the pole, it appears that the observations of the summer months require a larger negative correction to colatitude than those of the winter months, and a preliminary inspection of the observations of preceding years seems to point to a similar conclusion.

The Azimuth-zeros of the Altazimuth are still found liable to fluctuation with changes of temperature, and the reading of the Collimator does not change to the same amount. There is no doubt of the advantage of adopting the zero determined from a star observed on the same night as the Moon, if possible. With this caution, the results of observation are extremely good, very nearly equal to those of the meridional instrument; perhaps I might say that three observations with the Altazimuth are equivalent to two with the Transit-Circle.

VIII. Printing of Astronomical Observations.—The volume for 1856 has been circulated lately. It contains, as Appendix, a description of the Chronographic Apparatus; the delay in the circulation of the volume arose from the accumulation of several small delays in the preparation of the plates for the description.

For 1857 the Transits with the Transit-Circle are printed to May 1, the Zenith Distances with the Transit-Circle to May 14, and the Azimuths with the Altazimuth to June 5. The apparent slackness of printing will cause no ultimate delay, as we have learnt with what rapidity Messrs. Eyre and Spottiswoode proceed when the pressure of parliamentary business is removed. The number of copies printed is 350.

A large part of the impressions of former years is at present stacked in the Lower Room of the new South-East Dome.

IX. Magnetical and Meteorological Instruments.—Little change has been made in these since the last Report.

Among the Magnetic Instruments; the free 2-foot Magnet, suspended by a silk skein, carrying a Collimator for view by a theodolite, and carrying a concave mirror for the formation of a spot of light on the photographic cylinder; the bifilar magnet carried by two skeins of silk, and the vertical-force magnet rocking on knife edges, each carrying a plane mirror for observation of a graduated scale with a fixed telescope, and each carrying a concave mirror for formation of a spot of light on a photographic cylinder; are in good order. The absolute-force-apparatus is, I believe, in a good state.

The Dipping Needles I should assert to be in excellent order, were I not baffled by the following observations. It was suggested to me by Professor Hansteen, that the tools and processes of chronometer makers are better adapted to produce truly cylindrical pivots than those of opticians. I therefore requested Mr. Dent to prepare for us two dipping needles, in addition to the two made by Mr. Barrow or Mr. Robinson. One of Barrow's needles was broken by accident. In addition to the remaining three needles, our own property, we have had trials of needles—prepared for the expedition on the Oregon Boundary, and for Father Secchi. Mr. Glaisher and his subordinate observers have been very anxious to make every observation as good as possible; and the necessity of extreme caution, suggested by the apparent faults to which I alluded in last year's Report, has never been put out of sight. I think I may also say, that these gentlemen have exercised the rare virtue of independence in every observation. The observations have sometimes been made in the meridian, and sometimes in two azimuths differing 90°. With this care it might be expected that the results, though perhaps irregularly discordant, would show no systematic discordance. The fact, however, is this. In all cases the observations in the meridian and out of the meridian give accordant results. The different needles give nearly the following value of dip:—

R. Obs. Barrow 2	68. 30
R. Obs. Dent 1	68. 17
R. Obs. Dent 3	68. 25
Secchi 1	68. 24
Secchi 2	68. 23
Haig 1	68. 17
Haig 4	68. 19

I am disposed to rate the uncertainty of determinations of dip as much greater than it is estimated by many magnetic observers.

In the Meteorological Department, the barometer and thermometers of the four classes of dry, wet, maximum, and minimum, for eye-observations; also the barometer and dry and wet thermometers for photographic registration, are the same as before. Two of the long thermometers plunged in the ground, as I mentioned in the last Report, had given trouble by their superabundance of fluid. Mr. Negretti, with great practical skill, opened them, withdrew five degrees of fluid, and resealed them. I am almost apprehensive that there is now scarcely enough of fluid.

The Osler's self-registering anemometer and pluviometer has at times failed properly to discharge (by its syphon) the full charge of water, and has always been defective in delicacy for the register of light winds. Messrs. Negretti and Zambra, I believe, have now made the pluviometer-discharge perfect (some alterations have also been made under my direction for improving the delicacy of its motion), and they hope to make the motion of the anemometer pressure-plate sufficiently easy. I have lately suggested to them a new principle of mounting of the pressure-plate, which I think may possibly answer the purpose better than that now used. I have attached to the vertical spindle of the vane a mechanism of wheel-work, for counting the number of revolutions made by the spindle in a long time.

Thermometers are attached to the new Dreadnought Hospital Ship, for measure of the temperature of the Thames water, as heretofore.

All this establishment appears to be in good order.

X. Magnetical and Meteorological Observations.—The instruments which I have mentioned have been employed with the most continuous regularity, by combination of photographic or other self-registering operation for uninterrupted record with occasional eye-observations for determination of zeros. The thermometers in the magnet-boxes have been read at twenty-four consecutive hours, once in every week, to the end of 1857, with the purpose of obtaining materials for reducing anterior observations (the thermometers having always been read four times a day, and the system of illumination not having undergone the least alteration for several years). The observations of the maximum and minimum thermometers in the Thames, interrupted at the date of the last Report, have been resumed, and are most regularly maintained. Regarding the Thames as the grand climatic agent on London and its neighbourhood, I should much regret the suppression of these observations.

In the present year, we have commenced to refer our observations to Greenwich instead of Göttingen time. The selection of time may not be unimportant, for the

following reason:—If an extensive system of magnetic observatories, well distributed over the earth, should be again equipped, I trust that simultaneous observations from time to time may form a part of their duties. These observations ought to be as strictly simultaneous as possible. In photographic records it is not easy, without apparatus devised specially for the purpose, to answer for the time within three or four minutes, and therefore I shall contemplate the employ, at these times, of eye-observations throughout. These could be made with considerable precision, exactly at the time pre-arranged; and it will, therefore, be desirable that the most perfect understanding exist as to the meridian to which that time is to be referred.

XI. Reduction of Magnetical and Meteorological Observations.—For reducing the eye-observations, equivalents and temperature corrections are applied for the declination and horizontal force magnetometers to the present time, and for the vertical force magnetometer to the end of 1857. The Zero of Theodolite is prepared and applied to the end of 1857. The reductions of the Dip-observations are kept up close. The first parts of the reduction of Deflexion-observations are prepared to the last month; the whole are completed to the end of last year; as are also the mere vibration-observations. Ordinary meteorological observations are reduced to the present time, and meteorological observations of all kinds to the end of last year.

For the photographic sheets, the time-scales and zeros of measure are prepared to the end of 1857. The ordinates, expressing the values of western magnetic declination, horizontal force, and vertical force, for numerous instants in each day, are measured, and their values are entered in proper sheets.

The results do not appear to present any point of remarkable interest. The Mean Westerly Declination of the free magnet has diminished from 1856 to 1857 by a few minutes, but I am not able to state the exact quantity. The vane-spindle has turned, in the direction following the Sun, about sixteen times in the year 1857, nearly the same number of revolutions as in former years.

Since the beginning of the present year, Mr. Lucas with five junior computers (formerly employed on the Lunar Reductions) have been occupied with the reduction of Magnetic Observations in the photographic series, from the beginning of 1848 to the end of 1856. The first step was, taking each of the photographic curves in succession, to sweep through it by hand a pencil line; under the general instructions that where the period of irregularities was very short, the line was to take a smooth course, representing as nearly as possible the mean values of the ordinates for some distance without regard to the rapid departures of the actual curve on each side; where the

period of irregularities was as long as two or three hours, the general bends of the curves were to be followed; and where the period was intermediate in length, a rule of intermediate character was to be observed. The number of days which it was thought necessary to reject entirely, on account of the extreme irregularity of character, was 92 in 9 years. The ordinates of the pencil curves are measured by scale for every hour, and their numerical values are entered in proper sheets, adapted to the processes of taking the means for every day, and the means corresponding to each of the 24 hours through every month. The whole of the hourly readings for Declination and Horizontal Force are entered to the end of 1856, and three-fourths of the entries are examined; about one-third of the sums for Means are formed. Nothing is yet done to the Vertical Force. The times of the Moon's upper and lower transit are marked on the time-scales of about one-sixth of the sheets; and preparations are made for taking the measures of the ordinates for lunar hours, and treating them in the same way as for solar hours.

XII. Printing of Magnetical and Meteorological Observations. The printing of the Observations of 1857 is not yet begun, but the whole of the manuscript is ready, wanting only some final revisions by the Superintendent of the Magnetic and Meteorological Department, and will probably be in the printer's hands at the time of my reading this report. The small alteration of form introduced in 1856, will be retained in 1857.

Two copies of Secondary Photographs are prepared to the end of 1856, and of Declination and Horizontal Force, for January of 1857. It is proper to mention that Secondaries have been employed (as far as we possessed them) for extraction and tabulation of the numerical values of the ordinates, to which allusion is made in the account of the extensive reduction of Magnetic Observations now going on.

XIII. Chronometers, Communications of Time, and Operations for Longitude.—The number of Chronometers now in the Chronometer-room is one hundred and four. A few of these are on trial for the Brazilian Government. Some of the Chronometers are compared every day, and some only once a week. The standard of reference is a Galvanic Clock, one of the sympathetic series; of which the Motor Clock is every morning adjusted by means of its auxiliary pendulum, to the best Mean Time that the Observatory can supply.

In the last winter, a new Chronometer Oven was prepared, in a form somewhat more convenient than that which we had previously used (and which had been copied from

the construction adopted in the Liverpool Observatory). For utilizing space, and at the same time preserving all the essentials of Chronometer-mountings, the simple expedient has been adopted of taking off the lids of the Chronometer-boxes. We are now able to try about forty Chronometers at a time in heat, with mechanical arrangements which I believe are perfectly satisfactory to all parties. Every Chronometer which comes into the Royal Observatory, for whatever purpose, is now rated for some weeks in a temperature of about 80° , and sometimes higher. Some curious neglects of adjustments have been revealed to us, which otherwise might only have puzzled us. I anticipate considerable benefit, not only to the service of the Royal Navy, but also to the habits of Chronometer-makers, from thus regularly directing our attention to the important thermal adjustment. In concluding this subject, it would be wrong to omit the acknowledgment that the careful attention to the subject of temperature is in no small degree due to the example set by Mr. Hartnup at the Liverpool Observatory. The power of carrying out the system in a satisfactory way has been derived from the introduction of gas to the Observatory.

The valuation of Chronometers for purchase by the Government rests (as heretofore) with me. The receipts, repairs, and issues of Government Chronometers, with the preparation of the proper Reports, Abstracts, and Digests, applying to those transactions, are also managed in the Observatory.

The external time-signals are given by the same regulated Motor Clock by which the Chronometer Clock is kept to accurate time.

In spite of the injury to our London Galvanic wires, the currents sent at mean noon every day have had sufficient power to effect the regulation of four Clocks of the General Post Office, by means of an apparatus which I explained to the Visitors two years ago; and also to exhibit the signals given by those clocks. The appearance here is very curious. Near to $23^{\text{h}} 26^{\text{m}}$, $23^{\text{h}} 28^{\text{m}}$, $23^{\text{h}} 32^{\text{m}}$, and $23^{\text{h}} 36^{\text{m}}$, four signals are exhibited which we know to come from four certain clocks, and which, by comparison with our clock, shew the errors of those four clocks. Of the correction effected at noon we see no trace; but very nearly at $0^{\text{h}} 26^{\text{m}}$, $0^{\text{h}} 28^{\text{m}}$, $0^{\text{h}} 32^{\text{m}}$, $0^{\text{h}} 36^{\text{m}}$, come four signals, showing the state of the same clocks as corrected. These observations are recorded. Each of the four clocks in question regulates a group of dependent clocks, by local galvanic currents, in a manner nearly similar to that by which our current at noon regulates those four principal clocks, and thus more than thirty clocks are kept very nearly to accurate time. I believe that it is the best instance of mechanical regulation that exists.

The state of the wires, however, has not enabled us to drop the Ball at Deal. The feeble current which arrives there has been used for some months merely as giving a signal, by which an attendant is guided in dropping the Ball by hand. The system has thus lost much of its original dignity; but I trust that under the kind attention of C. V. Walker, Esq., F.R.S., (Telegraph-Superintendent and Engineer of the South-Eastern Railway,) the wires will speedily be restored to their pristine integrity, and that we shall drop the Deal Ball by direct current, as formerly.

Operations have been twice undertaken, with partial success, for the determination of the longitude of Edinburgh. The first time was in the month of November. To avoid the defects of our direct line to Lothbury, I took the route of Blackheath, Admiralty, Strand Office, and Lothbury. For five days we had inexplicable failures, currents being visible, but far too weak for use. On the very last day at our disposal I discovered that the failure was in the Blackheath-Admiralty line, which was totally unfit for sending a distant signal. The wire was subsequently examined and repaired; and in the Easter vacation of Parliament the experiment was repeated. Although there was still an escape on this part of the circuit, which made it desirable for us to avail ourselves of the kindness of the Electric Telegraph Company in lending some very delicate instruments, still we were able to receive and transmit every signal efficiently. During the week devoted to this experiment the weather was so bad that only one evening could be used. In that evening, however, the same series of twenty-two stars were observed at both stations; and as the American method of touch-record of transits of stars over every wire was used (each touch, at whichever end, completing a circuit, which gave action to local relays at both ends, by which local batteries were made to impress signals on chronographic apparatus at both ends), we obtained very good materials for retardation of current and for difference of longitude. The retard is $0^{\circ}04$ very nearly, and the difference of longitude $12^{\text{m}} 43^{\circ}05$, subject to personal equations. Our success in this enterprize is entirely due to the hearty aid rendered by the Electric Telegraph Company, not only by the appropriation to our use of one of the long wires to Edinburgh, and by the loan of their instruments, but also by the cordial assistance of their officers, who, without interfering with our operations, gave their personal attention at both stations to render the apparatus efficient.

XIV. Personal Establishment.—The personal establishment is not altered. The First Assistant, Rev. R. Main, takes general superintendence and occasionally observes, especially with extra-meridional instruments; Mr. Dunkin manages the Altazimuth;

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Mr. Breen presides over supernumerary computers, and attends to computations and printing, being little occupied with observations; Mr. Ellis and Mr. Criswick arrange for transits and time-communications of all kinds; Mr. Lynn is charged with Meridian Zenith Distances; the mere observations with the various instruments being distributed indifferently among all these Assistants. They are aided by four supernumeraries. In the Magnetic and Meteorological Department, Mr. Glaisher (Second Assistant of the Observatory) is aided by Mr. Downs and three supernumeraries.

There are also a gate-porter, night-watchman, and labourer, and at least one carpenter in constant employ.

XV. Extraneous Works.—The Lunar Reductions which have been some time in hand are now in the following state. The correction of Burckhardt's error of parallax is completed to the end of 1853 (the latest period to which it is required). The calculations from Plana's theory are completed to the end of 1851. The tabular errors and the individual equations derived from them are grouped and added. Every thing is ready for the formation of final equations. In this state they are waiting for my general revision, which pressure of business has hitherto prevented me from giving, but which I hope to give in the approaching summer.

The distribution of a large part of the impression of Hansen's Lunar Tables was undertaken by us in the last summer; and that important work is now pretty well disseminated among astronomical observers and computers, academical bodies, and some libraries of reference, in all parts of the world.

XVI. General Remarks.—The only point of interest relating to the affairs of the Observatory, which is not included in the preceding Report on details of ordinary business, appears to be the approaching completion of the large Equatoreal; and the consideration of the direction which it may be thought desirable then to give our labours, and the addition which it may be necessary to make to our personal establishment.

With regard to the direction of our labours, I trust that I shall always be supported by the Visitors in my desire to maintain the fundamental and meridional system of the Observatory absolutely intact. This, however, does not impede the extension of our system in any way whatever, provided that such means are arranged for carrying out the extension as will render unnecessary the withdrawal of strength from what are now

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the engrossing objects of the Observatory. On the character of any such extension I request the instructions of the Visitors.

With regard to our personal establishment, I would not, in any case, propose the necessity of an addition until the want of it should have been absolutely felt. But prospectively I am bound to remark that, after the appliance of all possible mechanical contrivances to facilitate its use, the daily service of a large instrument is more laborious than that of a small one, and the subjects of its observation would probably require a greater number of hours of scrutiny than those of a small one, and that I see no probable escape from the conclusion that an additional competent Assistant (not an increase in the number of supernumeraries) will ultimately be required for the Observatory. The expression of the Visitors' opinion on this point would aid materially to guide me in the first arrangements which the completion of the Instrument may require.

Royal Observatory, Greenwich,
1858, *May 27.*

G. B. AIRY.