REPORT

OF

THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH,

Read at the Annual Visitation of the Royal Observatory, 1857, *June* 6.

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I HAVE to offer to the Visitors a Report on the condition of the Observatory on 1857, May 23, and on the general history of the Observatory between 1856, May 19, and 1857, May 23.

I. Grounds and Buildings.—In regard to the existing buildings, I have only to state that, for convenience of communication, I have cut a passage through the ground story and basement of the Altazimuth Tower, piercing (for the most part) through Flamsteed's old walls. In doing this, it was found that those walls had at some previous time been greatly injured, so that I deemed it expedient at once to build up a window-opening with the soundest materials, to apply an iron tie to one of the walls, and to make good the part anciently injured as well as possible. I believe that all is now in a perfectly firm state. Nevertheless, I now regret that, in building the Altazimuth Tower, I did not pull down the old walls entirely, for the brickwork of the beginning of the last century appears in general to have been wretchedly bad. A very small portion of one ray of the Altazimuth pier was cut away. I shall afterwards mention the effect which this produced.

The other buildings are in good order. A little dry rot has appeared in the Transit-Circle Room, where stucco had been imprudently placed in contact with wood-work, and the joint was exposed to the drainage of water; but it is not important.

The foundations of the new South-eastern Dome have been laid, and I trust that the building will be completed in this summer. It is in the place which I indicated in the last Report, at the south-eastern corner of the Record Room, but not in contact with the Record Room. For explanation of the design generally, I beg leave to refer to the model which the Visitors have seen. I may here state that the local position of the

building compelled me to make the entrances into the three separate stories through the middle of the North Pier. A large stove is provided for the lower story, the draft of which passes underground into the chimney of the Record Room; and I expect that this stove, by means of a trap in the first floor, will sufficiently warm and dry the second story. The dome will be drum-shaped, 29 feet in diameter inside, framed with vertical wooden standards upon horizontal curbs, and tied by diagonal iron hooping. It is to revolve on cannon-balls, and to be moved by toothed-wheel machinery carried by the dome, which acts upon a fixed rack of the wall-curb. The observing aperture will be 3 feet wide. The shutters will be two; a vertical wall-shutter, and a nearly horizontal roof-shutter, opening (for convenience of the mechanism) on opposite sides, each shutter opening independently of the other. Each shutter will carry a curved rack, to receive the action of a pinion carried by the solid parts of the dome. For the vertical shutter, I have made this rack jointed, and thereby I have been able to make the shutter flap close to the opening when it is closed, and flap close back to the dome-wall when it is opened, a condition which is not unimportant for preventing the wind from exerting any action to turn the dome. For the nearly-horizontal shutter, I considered that the attempt to secure a shutter-movement of 180 degrees would introduce the necessity for the jointed rack, and would also require a complicated construction of counterpoises; and I have therefore avoided these by causing the shutter, both in its closed and in its opened state, to take a position inclined to the horizon, its angular movement being about 140 degrees; thus it will scarcely feel the wind, and the inclination will not be visible to spectators below. Other points can be explained orally.

The manuscript plans of the grounds and buildings are altered from time to time, as the changes of the buildings require.

II. Moveable Property.—No change of the least importance has been made since the last Visitation. There are now in deposit the Cape Altazimuth, the American Standards, the East India, Cape, Ramsden's, and Roy's Standards of Length; some ancient Pounds, and all the unappropriated copies of the new National Standards of Length and Weight. There are lent; a journeyman clock to the South-eastern Railway station; a journeyman clock and bar magnet to the Kew Observatory; and a copy of Piazzi's Catalogue to the Durham Observatory. Several clocks and other apparatus, the property of the Royal Observatory, as well as four galvanic wires to the London Bridge Station, are employed in the Deal Ball communication, and for other galvanic services. The Micrometer, which was lent to Colonel Lloyd, has been received; it had been deposited with an optician, who saw the allusion to it in the last Report, and noticed upon the micrometer-box the Royal Observatory mark (a broad arrow and star).

The Official copy of the National Standard of Length, now preserved in a mahogany box, appears to be in good order.

III. Manuscripts.—Our papers are preserved, carefully arranged, and bound, as usual.

The arrangement of the Board of Longitude papers has at last been taken up seriously, under the immediate superintendence of Mr. Main.

None of our manuscripts are at present out of the Observatory.

One manuscript only is at present borrowed by the Observatory, namely, the Minutes of the Meetings of the Board of Visitors, from the establishment of the Board down to 1784, May 27, at present placed in my hands by favour of the Royal Society. It is much to be wished that the volume or volumes, containing the minutes of subsequent meetings down to the year 1830, could be found. It would probably be judged best by all parties that the entire series should be lodged in the Royal Observatory.

IV. Library.—No great effort has been made to increase the Library; a few books being purchased from time to time, and the serial works being kept up.

The Library Catalogue, from additions and insertions of books, binding of pamphlets, &c., had become confused and unsightly, and a new manuscript catalogue is therefore in preparation. It is nearly finished.

V. Astronomical Instruments :—

The Transit-Circle is in good order. At present there is a failure in the insulation of one of the wires used in the chronographic registration of transits, where the wire is carried by a piece of ivory attached by iron screws; a construction which in many places I have been compelled to change for a piece of varnished wood attached by brass screws. This failure does not affect ordinary transits (for which the current passes through a closed circuit), but it would be fatal to the transmission of transits to a distant observatory (for which an earth-circuit would be employed). It will speedily be remedied.

In regard to the Reflex-Zenith Tube, I described in my last Report to the Visitors the construction which I proposed for destroying the tremors of the quicksilver by suspending its trough by means of straps of vulcanized caoutchouc, so as to leave it

the utmost possible freedom of motion. The construction has been perfectly successful; the tremors are absolutely destroyed, and the star has been observed at all hours of night and day. It so happened that it was observed on the very day on which it passed with the sun. In the night-observations it is found that there is a perfectly steady nucleus, occasionally with rays twirling about it; the latter evidently arise from the deranged state of atmosphere, which seems usually incidental to a zenith-sector-room; to this I shall endeavour to give attention.

The Altazimuth is in good order. A four-glass reflecting eyepiece has been made, which will tend to the facility and accuracy of observations at great elevations. I alluded in a preceding section to the cutting away of a very small portion of one of the rays of the three-armed pier which carries the Altazimuth. The quality of the brickwork is the best that I have ever seen, and not a single brick was disturbed beyond those actually removed. Yet the effect was to give the Altazimuth an inclination of about 23″. This inclination evidently depends on the elasticity of the brickwork. The angle between the axis of the vertical circle and the axis of general revolution, which at first was pretty exactly 90°. 0′. 0″, has now become, by gradual change, about 90°. 0′. 14″. The magnitude of the corresponding numerical correction to every observation of azimuth induces me to contemplate a re-adjustment of some of the mechanical connexions of the instrument.

The Barrel Apparatus for chronographic record of transits has been in constant good order. To check the occasional tendency of the pendulum to describe an unreasonably large circle (from trifling inequalities in the maintaining power, which it is difficult to suppress entirely), I have mounted a slender spring, so as to produce, when the circle is large, a light friction. As every such friction is accompanied with force directed to the center, it deranges the time of rotation. I have, however, planned a water-resistance which would be free from this objection, and which I may perhaps adopt in this instrument. A draftsman is at present employed in making plans of the Barrel Apparatus.

The Galvanic Apparatus for clock movements is in the same state as last year, five clocks being in sympathetic movement in the Observatory, one at the Hospital Schools, and one in the North Kent Station at London Bridge. That for signals has received this slight alteration, that the pull of the Time Ball Detent now alters the connexions of four triplets of springs. Of these, one controls the communications with the Electric Telegraph Company's office at Lothbury; by which hourly signals are sent on various railways; the time-balls at the Strand, Cornhill, and Liverpool are dropped; and the Post-office clock in Lombard Street is regulated. A second affects the communications with the South-Eastern Railway Station; by which hourly signals are sent on various lines in Kent, and the Time-Ball at Deal is dropped, and returns its signal to

acquaint us with its successful drop. The third and fourth are reserved for the prospective wants of the Royal Dockyards; they communicate with the Admiralty wire of the British Telegraph. The communication with the Post Office clock is remarkable. At $23^h.\ 26^m.\ 0^s$ of that clock a signal is given to Greenwich, the comparison of which with our clock acquaints us with the error of the Post Office clock. At $0^h.\ 0^m.\ 0^s$ of the Greenwich clock a signal is sent from Greenwich, which mechanically adjusts the Post Office clock. At $0^h.\ 26^m.\ 0^s$ of the Post Office clock a second signal is given to Greenwich, by which the efficiency of the adjustment is shown. I am in daily expectation of the extension of this system to three other clocks.

The North Equatoreal is, as it was last year, in an imperfect state.

The East Equatoreal is in its usual good working order. The double-image micrometer is in an efficient state.

For the new S.E. Equatoreal, the support of the north or upper end of the polar axis has been received, and is planted within the walls of the building in a position convenient for raising it to its ultimate destination. It is one piece of cast iron, extending from about 18 inches below the floor of the room to the polar point; it weighs nearly 5 tons, and is considered to be a good specimen of Messrs. Ransomes' excellent castings. The base of the north support will be tied to the south support by horizontal iron rods under the floor. The two end frames of the polar axis are prepared; a portion of one side of the upper end frame is cut away, to permit uninterrupted vision as far as the pole. For moving the polar frame in right ascension, there will be an hour-circle moved by clock-work, similar to that of the Northumberland telescope, to which the polar frame may be clamped at pleasure. This hour-circle is to have a graduation at its edge to be viewed by a fixed microscope, and a graduation on its plane to be viewed by microscopes of the polar axis. The clock-work is to be driven by water power, derived from the supply-pipes, and acting by a reaction machine, as at Liverpool. I expect that, with a compensation-pendulum, with Sieman's chronometric governor, and with a proper water resistance as I have suggested above, I can give extreme accuracy to the motion in right ascension. For fixing the polar frame in hour angle when transits, &c. are required, I propose a clamp independent of the hour-circle. The polar frame is to be entirely of iron, essentially on the principle of the Northumberland frame, but differing in several details, which will be best seen in the model. The declination-axis will be excentric, as explained by me last year. The clamping circle will be most conveniently carried by the polar axis, but the declination circle will be carried by the telescope, and will be viewed by two or more inclined microscopes, whose eye-ends are very close together, and very close to the pivot of the declination axis. I anticipate that in this way the use of the declination-microscopes,

ordinarily so troublesome, will be made comparatively easy. The illumination, I believe, can be conveniently thrown down the tubes of the microscopes themselves. The upper pivot of the polar axis and one pivot of the declination axis are to be perforated for gas pipes, and thus gaslight will be carried to every part of the frame where it may be required, even to the eye-end of the telescope. Those persons only who have used both oil lamps and gaslights under similar circumstances can fully appreciate the enormous advantage of this arrangement. Rings for galvanic contact will be mounted on the pivot of the polar axis, and on one pivot of the declination axis, and thus the chronographic system, and possibly the sympathetic-clock system, will be carried to the eye-end of the telescope. The telescope tube will probably be of wood. This account, with inspection of the model, will perhaps give the Visitors a clear idea of my proposals regarding the Equatoreal mounting. All this work is advancing in some degree, but there is still one important drawback; I have not yet received the object-glass. Messrs. Merz have not made a new object-glass to their satisfaction; they retain, however, the first in readiness, and can at any time transfer it for temporary use, so that I consider myself justified in making every possible preparation of mounting.

The old instruments of the Observatory remain in their usual state, having received no particular attention.

VI. Astronomical Observations.—The Meridional system is sacredly preserved. Each star of a large clock-star-catalogue is observed, if possible, twenty times in three years; some stars are observed for refraction; some as having been compared with the Moon; some on suspicion of proper motion, &c. The Moon is observed at every opportunity, without exception. The Sun and Planets are observed at every opportunity, except on Sundays, and except when they pass later than 15^h in the morning, in which state the large Planets only are observed, and only when the Moon also is to be observed. The transits have been observed almost entirely by the chronographic method, except for the close circumpolar stars.

The whole number of Meridional Observations from 1856, May 19, to 1857, May 23, is as follows:—In the Department of Transits: Observations of Transits (reckoning two limbs, or two methods of observation by ear and by touch, as two Observations), 4169; Observations of Collimator, by the Telescope of the Transit-Circle, 311 pairs; Observations of Transit-wires by Reflexion, 310; Observations of one Collimator by the other, 52. In the Department of Zenith Distances (reckoning two limbs, or a combination of Direct Observation with Reflexion Observation, as two Observations, and including the observations of the wire by Reflexion), Circle Observations of all kinds, 3663.

The general system of adjustment is the same which was described to the Visitors two years ago.

A complete examination has been made of the errors of graduation, down to every 1° throughout the circumference of the meridian-circle. The Visitors will remember that such an examination was made before the instrument was brought into use; the errors down to every 5° were considered in every respect satisfactory; but from a fault in the double-object-glass-microscope (arising apparently from a slight strain), one of the images in taking the 1° spaces was always a little indistinct, and some doubt seemed to rest upon the ultimate determinations of error. That optical defect has been remedied, but the new results differ so little from the old ones that it is clear that the defect produced no sensible inaccuracy. I propose to have the errors ascertained to every 5′, for a few degrees in which the reference to the same divisions is the most frequent. Observations have also been made for the form of the pivots; they show, as before, that there is no certainly appreciable error. Finally, observations have been made for the astronomical flexure of the telescope, which agree well with those previously made.

The number of double observations of γ Draconis with the Reflex-Zenith Tube is 124.

With the Altazimuth, the Moon has been completely observed on 198 days. This gives 15·8 per lunation. With the Transit-Circle the number of complete observations is 98, giving 7·8 per lunation. Of the observations with the Altazimuth, 0 are on days when the Moon passed between 0^h and 1^h of solar time, 3 when between 1^h and 2^h, 7 when between 2^h and 3^h, 3 when between 21^h and 22^h, 5 when between 22^h and 23^h, 0 when between 23^h and 0^h. There are no corresponding meridional observations. The whole number of separate observations of the Moon and Stars is 1058, and the whole number of observations of the Collimator 812.

A series of observations has been made for ascertaining any deviation from circularity in the form of the pivots of the Vertical Circle, but no sensible fault was found.

With the East Equatoreal, Brorsen's Periodical Comet has been observed on three days.

With the Double-Image Micrometer, measures of γ Virginis have been made on four days; measures of Venus on twenty days (sometimes two series in the day); measures of Jupiter on five days, and measures of Saturn on ten days. The value of one revolution of the screw has been re-determined; the new value agrees almost precisely with the old one.

Of irregular observations there have been,—16 occultations by the Moon (including two of Jupiter), 32 phenomena of Jupiter's Satellites, and one eclipse of the Moon.

VII. Reduction of Astronomical Observations.—In the Transit department, the Clock Times of True Transits are formed to May 21, the deduced Apparent Right Ascension of Center of Object to May 17, and the deduced Mean Right Ascension of Stars observed to April 25. Personal Equations are applied to the end of 1856. Mean Solar Times are formed to May 8. In the Zenith Distance department, the Circle Readings are completed to May 20, and every other reduction to the last step as far as May 9, wanting only the correction for the imperfect limbs of the Moon, which is finished to the end of 1856.

The Ledger of Stars' Mean R.A., that of Mean N.P.D., and the Annual Star-Catalogue, are completed for 1856.

For convenience of view, we have marked upon a large paper globe the places of all the stars observed from 1836 to 1853.

The comparison of Places and Diameters of Sun, Moon, and Planets, as observed, with those given by the Tables, together with the conversion of errors of R.A. and N.P.D. into geocentric and heliocentric errors of longitude and E.P.D., and all the usual deductions from the comparisons, are completed for 1856; and a large portion of the comparisons is made as far as 1857, May 9.

For the Reflex-Zenith Tube, the reductions are completed to the end of 1856, and the first steps to 1857, May 14.

With the Altazimuth, the Zenith Distances are completely reduced to the present time; and the Azimuths to April 20 (the end of the last lunation), the principal steps in the reductions being finished to the present time. The Tabular Computations of Zenith Distance and Azimuth, wanting the small corrections, are complete to May 8; the small corrections and steps of every kind as far as the inference of Errors of R.A. and N.P.D. are absolutely complete to April 20; the Errors of Longitude and E.P.D. are finished for 1856, and partly prepared for 1857.

The Equatoreal observations are not yet reduced.

The Double Image Micrometer observations are reduced to April 18.

The Occultations are nearly complete to April 2.

On some of the results of reduction I may remark:—

The Personal Equations in the chronographic method of registration, all the observers being compared with Mr. Dunkin, range from + $0^s{\cdot}15$ to − $0^s{\cdot}10$. But if Mr. Breen

be excluded (who has observed much less frequently than the others, and whose determination is therefore liable to error), the range is from + 0^{s}·08 to — 0^{s}·10. It would seem, however, that in the present year there is a tendency to increase the Personal Equations.

In regard to the Azimuth of the Transit-Circle and the Azimuth of its Collimator, Mr. Main has brought together the results of several years, and the following law appears to hold. There is a well-marked annual periodical change in the position of the Transit-Circle, the southerly movement of the eastern pivot having its minimum value in September, and its maximum in March, the extreme range being about 14 seconds; and there is a similar change, but of smaller amount, in the position of the Collimator. I cannot conjecture any cause for these changes, except in the motion of the ground. There is a very frequent change of still smaller amount in the Azimuth of the Transit-Circle, accompanied by a nearly equal change in the apparent Azimuth of the Collimator, so that from day to day the Transit-Circle and Collimator preserve their relative position unaltered; these I conceive to be the effects of accident in observation of the circumpolar stars, arising either from fault of the observer, or from irregularities either in the level or in the collimation; at the same time, viewing the great accuracy of the observations of circumpolar stars, and the extreme simplicity of the pivot-supports and of the instrument-frame, I cannot conjecture how such irregularities can arise.

There is also a well-marked connexion between the state of level of the axis and the temperature. The eastern pivot always rises when the temperature rises, the extreme range being about 6 seconds. I cannot offer any explanation of this.

There are still fluctuations of the Azimuth-zero of the Altazimuth, with persistence in the readings for the Collimator, usually connected with changes of temperature. Mr. Dunkin's examination of these has led to the conclusion that it is usually best to reduce the observations of the Moon on any night by means of the azimuth-zero determined by a star on the same night, in preference to taking the mean of azimuth-zeros through a large part of a lunation.

VIII. Printing of Astronomical Observations.—The Volume for 1855 has been circulated some time ago.

For 1856 the Transits are printed to July 31, the Zenith Distances to August 5, and the Azimuths with the Altazimuth to July 5. I propose to attach to this volume a description of the Chronographic Apparatus.

A considerable part of the impression of the Observations of preceding years, which was found inconvenient at the Royal Society's apartments and in the publisher's warehouse, has been brought to the Royal Observatory, which in future will probably (and, as I think, with propriety) be regarded as the depôt of the printed observations. In regard to these, it appears, I think, that the annual impression may be safely reduced; and I would submit for the consideration of the Board of Visitors whether it may not be fixed at 300 instead of 350, as at present.

IX. Magnetical and Meteorological Instruments.—These instruments remain generally in the same state as for several years past. There is the free 2-foot magnet, carrying a collimator for eye-observation and a concave mirror for photographic registration; the astronomical theodolite; the bifilar magnet and the vertical force magnet, each with plane mirror and concave mirror. A change has been made in the movement of the photographic cylinder on which the traces of the declination and bifilar magnets are recorded; instead of turning once in 12 hours, it is made to turn once in 24 hours, and thus the interference of the curves for the two halves of the day is prevented. There is also a rather rough apparatus for measure of absolute force, which I propose to examine carefully, but which at present I believe to be very good; and there is the $9\frac{1}{2}$-inch dipping needle (Robinson's last work, not Barrow's, as I have formerly stated,) the history of which must now be specially mentioned.

In the late winter I received a notice from Professor Hansteen that the dip, as determined at Greenwich, appeared to have become greater than was consistent with the changes of dip going on in the north of Europe. I communicated this letter to General Sabine, and received from him the information that there seemed to be a similar discordance between Greenwich and Kew. I then carefully examined the instrument, and I found in it such a fault of mechanical construction, that when the needle was lifted up from its agate bearings its upper point almost always struck the brass circle. This is quite sufficient to account for an apparent increase of dip. Moreover, the agates were so incumbered that it was difficult to clean them, and this would account for various irregularities. These defects have been amended, and perhaps a little more care has been given to the observations, and the apparent dip is diminished by nearly the quantity which Professor Hansteen conjectured. I regret that the dip-observations of several years past must now be considered to possess very little value.

In the Meteorological Department there are Newman's barometer; a barometer adapted to photographic registration; dry, wet, maximum, and minimum thermometers, principally by Negretti; a dry and a wet thermometer adapted to photographic registration; and four thermometers sunk to various depths in the ground. The last-

mentioned instruments have given some trouble in consequence of the fluid rising into the upper bulb of the tube, but I have nearly determined on attempting the hazardous experiment of opening them and withdrawing a part of the fluid. There is the long wire for collection of atmospheric electricity. There are also a maximum and a minimum thermometer in the Thames, attached to the Dreadnought Hospital Ship; but, from a change in the ship and in the personal establishment, the efficiency of these has been interrupted.

All these instruments are in good order, subject only to the special qualifying remarks made above.

X. Magnetical and Meteorological Observations.—No change is made in the system of observations; photographic self-registration being applied to the principal magnetical and meteorological instruments, pencil self-registration being applied to the wind and rain, and eye-observations being intermingled for zeros. Commencing with 1856, August 25, the thermometers in the magnet-boxes have been read at twenty-four consecutive hours once in every week, with the view of obtaining bases for complete reduction of the observations. The regular observations of the maximum and minimum thermometers in the Thames have been interrupted, as has been stated above, but I hope that arrangements may be made for their restoration.

XI. Reduction of Magnetical and Meteorological Observations.—For the eye-observations, the equivalents of scale-readings, temperature-corrections, &c., are formed and combined, to the present time for the declination and horizontal force magnetometers, and to the end of 1856 for the vertical force magnetometers. The Western Declination is formed to April 30. The Dip-observations are reduced to the present time, the Deflexion-observations to April 28 (the later reductions requiring examination). Other vibration observations are reduced to the end of 1856. The daily meteorological observations are reduced to the present time.

The Photographic Sheets are furnished with time-scales and lines for measure-zeros to the end of 1856, and some progress is made in preparing for those of 1857. The ordinates of the photographic curves for the magnetic observations are expressed in numbers to the end of 1856, but no similar step has yet been taken for the records of the barometer or thermometers.

I contemplate, as soon as I shall have some computers liberated from the Lunar Reductions, to take in hand the further reduction of the magnetic observations. I propose generally to follow in the path which General Sabine has marked out. At the

same time, I confess that I am still in some difficulty as to the treatment of the capriciously disturbed curves which so frequently present themselves.

XII. Printing of Magnetical and Meteorological Observations.—No part of the observations of 1856 is printed; but the MS. for 1856 is entirely ready, requiring only its final revision. A slight alteration is proposed in the form of printing the Meteorological Observations, principally for more distinct monthly division; in other respects I do not propose to depart from the arrangement of last year.

Two secondaries have been taken from each sheet of Declination and Horizontal Force and each sheet of Vertical Force in 1855, one from each sheet of Declination and Horizontal Force through 1856, and from each sheet of Vertical Force through about six months of 1856. No further multiplication of photographic sheets has been attempted.

XIII. Chronometers, Communications of Time, and Operations for Longitude.—The number of chronometers in the chronometer-room is sixty-eight. All are compared with the Mean Solar Clock, which is sympathetic with the Corrected Motor Clock of the Galvanic System: some every day, others once in the week. The chronometers on trial for purchase have, for several years past, been sometimes exposed to extreme temperatures; and lately I have determined to extend this system in a lower degree to the Admiralty chronometers, subjecting all in turns to artificial heat as high as 80° Fahrenheit. The Observatory takes charge of the valuation of chronometers to be purchased by the Government, and of the receipts, repairs, and issues of chronometers belonging to the Government.

The Motor Clock of the galvanic sympathetic system is adjusted every day, after comparison, by means of an auxiliary pendulum, which is put in mechanical connexion for a time with the clock pendulum, and by which the rate of the clock is either accelerated or retarded by $\frac{1}{100}$ of its whole value as long as the two pendulums are united. By this clock our own sympathetic connexion is maintained, and time-signals are sent to other places. I am desirous of introducing the system of galvanic connexion for clocks of small dimensions; a system which would frequently be very convenient.

The number of failures of the Time Signal Ball at Deal, dropped by galvanic current from the Royal Observatory, in the course of one year has been nineteen. When it is considered that four connexions must be made on the line before it is fit to receive our current, and that then there must be four contacts at Greenwich and one at Deal, this number of failures will appear very small. Other Time Signal Balls are dropped

by currents issued at the same time, at the Strand, Cornhill, and Liverpool; but though I am happy to supply with regularity the currents required for these purposes, I do not hold myself responsible for their success. I have verified experimentally the perfect practicability of dropping a ball at Devonport by a current from Greenwich.

The clock in the Lombard Street Post Office is adjusted and registered with the greatest regularity.

No operations have been undertaken for difference of longitude. But we have made occasional experiments with the relay-instrument in connexion with the Chronographic Transit-Register, as that connexion would be required in the operation of determining longitudes in the American manner.

XIV. Personal Establishment.—Within the last year we have lost by death the Senior Assistant, Mr. John Henry, the last who remained from Mr. Pond's establishment, and one of the most faithful and zealous of my coadjutors. The establishment at present consists of the following members:—First Assistant, Rev. R. Main. Astronomical Assistants, Mr. Dunkin, Mr. Breen, Mr. Ellis, Mr. Criswick, Mr. Lynn. Magnetical and Meteorological Assistants, Mr. Glaisher (ranking as Second Assistant of the Observatory), Mr. Downs.

Mr. Dunkin takes charge of the Altazimuth; Mr. Breen attends principally to computations, supernumerary computers' work, and printing; Mr. Ellis and Mr. Criswick control the Meridian Transits, the Galvanic Arrangements, and the Chronometers; and Mr. Lynn superintends the Meridian Zenith Distances.

Four supernumeraries are employed in the Astronomical department, and three in the Magnetical and Meteorological department.

Three servants are attached to the Observatory, and one workman at least is constantly occupied on the petty repairs and petty works perpetually requiring attention.

XV. Extraneous Works.—The additional Lunar Reductions, which were commenced last year, are advancing rapidly to a conclusion. I propose to suspend the calculations from Plana's theory at the end of 1851; but the correction of the parallax for Burckhardt's error discovered by Mr. Adams, must be carried to the end of 1853. Mr. Lucas and six computers are employed on this work.

Mr. Main's examination of Bessel's Refraction Tables, to which allusion was made in the last Report, is completed; it shows that the correction required, though small, is distinct. The temperature coefficient can scarcely be improved.

The account (by myself) of the construction of the National Standards of Length is completed. Some supplementary works relating to the equipment of the Exchequer Office still require attention.

The British Government had for some years past contributed by pecuniary grants to the preparation of Professor Hansen's Lunar Tables. In the last winter they undertook the entire expense of printing a large impression of the Tables. The reading of the proof sheets (a very considerable labour) has been effected entirely at the Observatory. I may take this opportunity of stating that the use of these Tables has enabled me, as I think, incontestably to fix the capture of Larissa to the date B.C. 557, May 19. This identification promises to prove valuable, not merely for its chronological utility, but also for its accurate determination of an astronomical epoch, the point eclipsed being exactly known, and the shadow having been very small. Several calculations have been made in reference to this and the two other ancient eclipses (of Agathocles and Thales), which I am now preparing to combine in one system of calculation.

XVI. General Remarks.—I would wish to call the attention of the Visitors to two points of different kinds and different degrees of interest. The first is a merely temporary matter, which has perhaps already suggested itself to the Visitors, on hearing the details of various kinds which have been read to them; the second is a matter of more permanent interest.

The first point is the state of our Ordinary Reductions. They are more completely brought up to a level with the observations than at any preceding time within my recollection. This has arisen from a curtailment of some of the observations. Although our establishment is strong, yet there are circumstances connected with it, and scarcely known in other observatories, which materially absorb its strength. Among these are, the severe regularity of the meridional observations; the anxious watching for the Moon with the extrameridional instrument, and the heavy calculations consequent on it; the constant attendance of one Assistant on the details of the galvanic arrangements; the labour connected with the detailed printing of observations and reductions; the care of chronometers; and the amount of reference on many subjects (not exclusively astronomical) both by the Government and by private persons. I found it necessary (as I stated in the Report of last year) to restrict the morning observations of planets, and I have further found it necessary to diminish the list of

refraction-stars, and to check the young observers in their desire to fill up the evening by observations of standard stars. In consequence, the number of observations exhibited in the present Report is less than in the last Report and in some preceding; but every observation is good, and is to the purpose. The effect of these limitations has been that the work is brought to a very perfect state, that we have been able to take up several matters of order which had been too long left in neglect, and that a breathing time has been obtained in which we have been able to attend a little to matters of astronomical science, historical, fundamental, or external to the Observatory. I do not think that any one has accused this institution of want of industry, and I anticipate the approval of the Visitors for sometimes imposing moderation on our industry.

The second point is the state of education of the Assistants of the Observatory. In regard to the discipline of the system and the good conduct of the individuals there is nothing to desire. In regard to the education of the Assistants, I have thought that improvements might be introduced which would be creditable to the establishment and beneficial to science. By beginning with the lowest computers I think that I may be able to effect this. In the neighbourhood of Greenwich at least there are better schools in existence than there were formerly, and among the youths who present themselves as candidates for employment, it is easier to find well-educated young men than it has been heretofore. It is even more necessary to provide for the educational progress of the Assistants and computers than for their state of instruction at the beginning. I have therefore drawn up notices of requirements for Assistants and computers of different grades, upon which I propose to act in future, accompanying these with indulgences which I think will remove all difficulties in the way of their acquiring the knowledge which is demanded. In making this innovation I have not lost sight of the consideration, that ultimately the Assistants and computers themselves would be great gainers by it. The existence of such a system will of course set aside in a great measure the understood custom of promotion by seniority; but that custom has never been the rule in the Royal Observatory, and I have myself departed from it in raising the rank of Assistants. The change of system which I propose is, in my view, an important one, and for this reason I submit it specially to the consideration of the Visitors.

Royal Observatory, Greenwich,
1857, *May* 27.

G. B. AIRY.