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REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS.

1849.

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REPORT OF THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS,

Read at the Annual Visitation of the Royal Observatory, Greenwich, 1849, *June* 2.

THE changes which have been made in the material parts of this Institution have been, generally speaking, but a following out of changes commenced or proposed at the last Meetings of the Board; the progress of reductions is little more than a continuation of the same system, maintained with great spirit to the present time. These will be explained with the greatest clearness by a Report drawn out in the same form as that which has been adopted for some years past.

I. Grounds and Buildings.—In the Report of last year I stated to the Visitors that I was then engaged in preparations for the annexation to my dwelling-house of the North-west Dome and Zenith Tube Room. This work was completed in the summer of last year. This arrangement, while it adds in various ways to the comfort of the Astronomer Royal, is also a matter of positive advantage to the Observatory. It is a real gain that an absolute impediment should be opposed to the mounting of instruments in localities so extremely unfit for them as were those of the North-west Dome and Zenith Tube Room.

The erection of the Transit Circle Room is now completed. This work has occupied nearly the whole time since the last Visitation of the Observatory. At that time Jones's Cape Circle was in use, preparations having been already commenced for removing Troughton's Circle to a shed or Temporary Observatory attached to the East end of the East Buildings, its long axis passing through the wall of the building and lodging on a pier built within a room. The Circle was used in this place for the first time on July 22; Jones's Circle was then dismounted, and stowed away on the Magnetic Ground, and the old Circle Room was pulled down. It will be remembered by the Visitors, that I proposed to use the Piers of the Two Circles for the new Transit Circle, and that one of the Piers was to be bored for eleven Microscopes passing through it in a conical arrangement, and for eleven Illuminating Holes whose axes are distributed on the surface of another cone. After an unsuccessful attempt to bore the Pier of Troughton's Circle (the material of

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which was found to be a stratified grit-stone, called by the workmen " Dundee Granite"), Jones's Pier (of Portland Stone) was bored. The axis of each hole, small and great, was bored completely through before the Pier was disturbed. The Piers were then taken down, and their stones spread over the Front Court, and the enlargement of the holes (a very troublesome operation), and the cutting of the stones where required, were completed there. It may be worth mentioning, as a point in the history of the instruments, that on taking down Jones's Pier it was found that the upper part of the western wall of the East Buildings rested upon the Pier. The Piers were then rebuilt in their new position, and the walls of the room were built up. The roof and shutters were then arranged in general conformity with the plan which I had indicated at first, namely, with the ridge of the roof N. and S., and with hinged flap shutters, balanced by counterpoise-weights, and moved by machinery nearly similar to that at the Berlin Observatory. The wall-shutters are simply doors, managed by no very complex machinery inside. The whole of this is now completed, and will probably be worthy of the attention of the Visitors. The Piers for the Collimators are built; the Collimators, though in the room, are not yet mounted, as I propose to mount a 5-feet transit-instrument in a temporary way, so as to enable me to determine the meridional direction with great accuracy, and by means of this to plant the Collimators very exactly in their proper positions. In the external architectural arrangements, I have endeavoured to give a face harmonizing with other parts of our buildings.

I have hitherto made no preparation in the buildings for the intended Reflex Zenith Telescope. I propose to plant it in the small low room which is attached laterally to the Transit Circle Room, and which has contained for some years past only a desk and a chest of drawers. A pyramidal flue of the old stove will make a firm foundation for the quick-silver. But as it is necessary that both the trough of quicksilver below and the eye-piece above should be easily accessible, I am unable to arrange the building until I know the length of the telescope. If the old 25-feet object-glass be mounted, it will be necessary to raise the building to the windows of the first-floor. Perhaps, however, it will be more convenient to use the object-glass of the present Transit-Instrument; or, perhaps, it may be possible to obtain an object-glass of larger aperture. In either of these cases it is most likely that the height of the existing room would suffice.

At the present time, operations have been commenced for an alteration in the approaches to the Octagon Room. For many years this room has been in a state of insulation; for, by the necessary closing of the old entrance into my dwelling-rooms by the side of the Ball Clock (these rooms being entered, ever since the construction of the southern apartments for Dr. Maskelyne, from the long passage of the house), there is no access to the Octagon Room except from the open air. At the same time the room has become a passage room; formerly to the Camera Obscura in its western turret, then to the upper apparatus of the Time Ball; but, finally, for the daily access to the two self-

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registering Anemometers mounted on the leads. To remedy these inconveniences I am now commencing the construction of two staircases; one rising from the long passage of my dwelling-house, and entering at the south-eastern window of the Octagon Room; the other an external broad-staved ladder rising from the new entrance of the North-east Dome to the leads of the Octagon Room. When these are completed, the whole series of buildings will be in a state of communication vastly superior to any in which they have been before the present time.

The North Kent Railway, as I stated in a former Report, is now carried in the valley which nearly surrounds Blackheath on the south side; and its works are at this time almost completed. It will be remembered by the Visitors, that when the question of carrying this Railway through Greenwich Park was discussed, the Visitors supported with their judgment the opinion which (guided by experiments) I had expressed, namely, that the Railway in that place might cause some small inconvenience to the Observatory, but that it would produce no serious injury to it. In confirmation of this judgment I beg leave to state that I have lately visited the Observatory of Edinburgh, built on the Calton Hill; the North British Railway is there carried actually through the same hill, at a linear distance from the Edinburgh Observatory, apparently less than that of the proposed line in Greenwich Park from the Royal Observatory; the rock of the hill is hard, and apparently very likely to transmit vibrations; yet, as I am assured by Professor C. P. Smyth, no inconvenience of the smallest kind is felt in the Observatory.

II. Moveable Property.—Our Moveable Property, instrumental and domestic, is generally in good order. The Journeyman Clock and Bar Magnet lent to the Observatory at Kew; the copy of Piazzi's Catalogue lent to the Observatory at Durham; and the two Massey Chronometers, delivered by Admiralty Order to Sir James South, are still out of our hands. At the present time there are in our hands the following instruments not strictly belonging to the Observatory:—Ramsden's 20-feet Standard; Roy's 3-feet Standard; the Cape 10-feet Standard; the Royal Society's 3-feet Standard; and the Royal Astronomical Society's 5-feet Standard. Also the Cape Altitude and Azimuth Instrument, and some of the St. Helena Instruments; which are to be transferred (with the sanction of the Admiralty) to the Observatory that is to be erected at the Greenwich Hospital Schools.

III. Manuscripts.—As some papers of Mr. Pond's have been found in a state which required care for their orderly preservation, and as it had become necessary to dispose of a great number of papers on various subjects, economical and scientific, which have gradually accumulated since the year 1835, a great effort has been made to arrange them, and one hundred and forty-eight volumes are now ready for the binder. The former volumes actually in my custody, and catalogued as Manuscripts, are preserved in the Fireproof Room with the usual care.

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IV. Library.—No additions, of unusual importance, have been made to the library. The books are in general good order, and are under certain regulations placed at the service of the Assistants.

V. Astronomical Instruments.—The standard instruments of the Observatory are in good order.

The Transit appears to be in every respect in an excellent condition. As the telescope, which was usually employed as a collimator, was removed some time since, in order to be prepared to serve as a collimator for the Transit Circle, an unusually long interval has elapsed without a determination of its error of collimation: but I have had such ample experience of the stability of this adjustment, that I have not been much disquieted by that delay. Very lately, however, the 5-feet St. Helena Transit has been used as a collimator: and a perfectly satisfactory result, accordant with former determinations, has been obtained. Jones's Cape Circle, although extremely troublesome, from the discreditable irregularity of its faulty division, appeared to give satisfactory results.

When Troughton's Circle was first mounted in its new locality, its microscopes were somewhat unsteady. This probably arose from the contraction or expansion of the wooden blocks inserted in the wall, and to which the microscope-pedestals are screwed. After a short time, this unsteadiness disappeared, and the obervations in general became perfectly good. I am, however, inclined to think that the locality (by the side of a wall which fronts the east, and thus receives the rays of the Sun before he passes the meridian,) is not favourable for accurate observations of the Sun.

The Altitude and Azimuth Instrument is in perfectly good order. The Zenith Points of the Vertical Circle are, perhaps, more steady even than those of a Mural Circle. The extreme accuracy of determination of Azimuthal Reading also, at any one time, is proved by this circumstance. The Error of Collimation of the telescope is found by comparing the difference of horizontal transits, Face East and Face West, for a high star, with the similar difference for a low star, and in this process, the error of each single observation usually receives a small divisor, yet the Errors of Collimation thus determined are extremely steady. As a matter of certain inference from this, the zeros of the transversal levels are necessarily well determined. But when corrections for these constants of adjustment are applied, and the Zero of Azimuth is finally obtained, this Zero does change from time to time to the amount of four or five seconds. I have stated before, that this error may depend on a twist of the Transit Piers (a doubt which I hope will be removed when the Transit Circle is mounted), or an uncertainty of Personal Equation (a doubt which, under a system shortly to be explained, will be removed at the end of this year). It may possibly arise from the following cause.—As the rotating part of the instrument, which weighs nearly a ton, turns in the central part of the lower fixed circle, and with considerable friction, it is evident that when the instrument is turned by hand it tends to twist the fixed circle.

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In order to remove this tendency, I have had winches applied to the pinions by which a moderately-slow motion in azimuth is given to the rotating part, and the Assistants are instructed to effect the motion in azimuth by these winches only. The re-action upon the teeth of the racked circle will then almost exactly balance the tendency of the central friction, and the remaining tendency to twist the fixed circle will be insignificant. As this apparatus has been mounted only a few days, I am unable yet to give any account of its effect.

The two Equatoreals, and the detached Telescopes and other small instruments, are in general good order. A double-image micrometer, made some time since on the principles explained in a communication to the Royal Astronomical Society, has been substituted with advantage for that formerly in use. The ancient instruments appear to be in their usual state.

The massive parts of the Transit Circle are progressing under the care of Mr. May (of the firm of Ransomes and May, the engineers who constructed the principal part of the Altitude and Azimuth Instrument). The axis, including the central cube, the two cones, and the two chilled pivots, is made in two similar casts. Of these five copies were made, of which the two best were selected. A massive lathe having been chosen for the turning work, and its center movements having been carefully examined, the two sections of the axis have been centered for turning, and are at this moment (I believe) on the lathe. The clamping-circle is turned, and its arms are fitted in. The arms of the division-circle are turned: the division-circle, which appeared good in the cast, was found somewhat spongy when its surface was turned off, and another is now cast ready for turning. The foundation plates of the Y's are cast, annealed, and planed; the Y's are cast; the telescope tubes are cast, the adopted castings being remarkably uniform and sound, and little heavier than stout sheet iron; and other parts are in various states of progress. I am confident that this instrument will present one of the most beautiful specimens of cast-iron work that has ever been made. Mr. May expects to be ready for the Opticians by the middle of August. In the mean time, Mr. Simms has fitted up the Collimators and their pedestals, which I hope very shortly to mount on their piers, and has in hand the plate which is to carry the eye-ends of all the microscopes, and other parts relating to the microscopes and illuminators.

The old Zenith Tube has been divided at the screw joints of its long tube, and has been mounted for preservation in a wooden frame. The upper part of it is at the present moment mounted in a temporary way for trial of the principle, and of some of the auxiliary fittings, of the intended Reflex Zenith Telescope.

I now beg leave to call the attention of the Visitors to a Model of the Reflex Zenith Telescope in the shape which I finally propose for it. As affecting the general mounting, the Visitors will remember, that the micrometer and the object-glass are united, and that the only way of putting the telescope in focus is by altering the distance between the object-glass and the surface of the quicksilver. After careful consideration, I have determined on doing this by a vertical motion of the tube in which the object-glass is mounted; the weight of the

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tube, &c. being supported by a counterpoise, and the motion being effected by rack and pinion, with a clamp-screw for fixing when in the proper position. I also intend that the quicksilver trough shall have a communicating trough, in which shall rest a float, carrying a stalk that rises as high as the object-glass. If this stalk be of the same metal as that part of the micrometer on which the measure depends, a correction for measures, as affected by thermal expansion and by alteration of focal length, will be immediately obtained from it. As, practically, the sole object of the instrument will be the measure of the zenith-distance of γ Draconis, I propose to fix the eye-tube and the prism-reflector in the position corresponding to the image of that star; and as the interruption to the pencil of rays so caused would be slightly excentric, I propose to interrupt the rays in a corresponding degree on the other side. The amount of interruption to the light of the object-glass by this apparatus and its carriers would be most insignificant. I contemplate now that the Observer should remain fixed in position while the object-glass and micrometer are reversed, his face being turned either to the East or to the West, in order that his hand may conveniently reach the micrometer head. Any other position might, however, be taken for him, if any better determining reason should be found. I propose that two wires be used, for observing the star in the two positions of the micrometer; that other wires be mounted, at intervals very nearly equal to their interval (the small difference admitting of being determined with extreme accuracy), and that the scale of the micrometer be determined by placing it in a transverse position, and observing the transits of γ Draconis, and perhaps other stars, across this series of wires. Supposing an ordinary simple micrometer adopted with this arrangement, it would then be necessary to read the micrometer before reversing the object-glass. But I propose to use a more complex micrometer; not a double micrometer in the ordinary sense, but an apparatus in which a micrometer A carries every part of a micrometer B; that A be read before beginning; that the first bisection be made by B; and that without altering or reading B the second bisection be made by A, and that both be then read. This apparatus would possess two great advantages, viz., that no reading would be necessary between the observations, and that the same hand would be used in both bisections; while the two observations would still be made upon two wires fixed to the same metallic frame, and no weakness, or new liability to friction, would be introduced. The field may be illuminated either as a Transit Instrument is usually illuminated, or by a small illuminator very near the object-glass; or the wires may be illuminated.

With the Zenith Sector thus mounted, I should conceive that every observation ought to be accurate to one-tenth of a second.

As I have been much occupied, both with the ordinary business of the Observatory and with the extraordinary business attending the changes now going on, I have been in no hurry to make the final arrangements for this instrument. It is therefore still open for consideration whether the object-glass of the Zenith Tube, the object-glass of the Transit Instrument, or a new and larger object-glass, should be adopted for it.

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VI. Observations.—The Meridional Observations have been conducted on the same plan as for several years past. The triennial group of 20 observations of each of the Nautical Almanac stars has been kept up as far as practicable; stars culminating with the Moon, occultation stars, and stars observed but a small number of times in preceding years, have also been observed. The Sun, the Moon, and all the Planets, have been observed at every practicable opportunity; except on Sundays, when only the Moon with proper stars is observed; and on a monthly holiday, for which a day near to New Moon is chosen.

For the observations with the Altitude and Azimuth Instrument, the rule laid down is the same as that of last year. The continued success of this rule, as exhibited by the number of days and the parts of the Moon's orbit at which complete observations are obtained in the twelve lunations from 1848, June 2, to 1849, May 20, will be appreciated from the following table:—

Time of Passage of the Moon.			Number of Days of complete Observations with Altitude and Azimuth Instrument.	Number of Days of complete Observations with the Meridional Instruments.
h		h		
0	to	1	0	0
1	to	2	2	0
2	to	3	5	0
3	to	4	5	3
4	to	5	11	9
5	to	6	9	5
6	to	7	14	9
7	to	8	11	3
8	to	9	13	9
9	to	10	10	6
10	to	11	12	7
11	to	12	8	8
12	to	13	11	8
13	to	14	12	8
14	to	15	9	6
15	to	16	11	8
16	to	17	10	7
17	to	18	11	5
18	to	19	8	5
19	to	20	10	6
20	to	21	7	3
21	to	22	4	1
22	to	23	1	0
23	to	24	1	0
Whole number of days of complete observations....			195	116

The proportion of the number of days of complete observation to the number of

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lunations is somewhat greater than it was last year for the Altitude and Azimuth Instrument, and decidedly greater for the Meridional Instruments.

In working up the last year's observations, it was pointed out to me by Mr. Dunkin that the large Tabular Errors of the Moon in R. A., deduced from observations with the Altitude and Azimuth Instrument, were invariably given by Mr. Breen's observations. A complete investigation was made into this circumstance; and it was found that, as compared with Mr. Dunkin, Mr. Breen's R.A. of the Moon were always too small by about $0^s{\cdot}38$, while his N.P.D. were not sensibly erroneous. This is precisely the result that would be produced by a personal equation affecting the transits of the Moon, both horizontal and vertical, by a quantity differing from the personal equation for stars by the constant time $0^s{\cdot}38$. I believe that such a thing as a personal equation different in quantity for the Moon and for the stars has never yet been recognized; but in this instance it appears certain. As it is known from long experience that Mr. Dunkin's method of observing the Moon as well as the stars does not differ sensibly from that of our standard observers, I have thought myself justified in applying the correction $-0^s{\cdot}38$ to Mr. Breen's results for the Moon's Tabular Errors in Right Ascension. When this is done, the results of the observations with the Altitude and Azimuth Instrument are fully as accordant as those with the Meridional Instruments.

To prevent the recurrence of a similar difficulty, the following arrangement is now made. Mr. Breen observes only with the Mural Circle. The observations with the Altitude and Azimuth Instrument are intrusted entirely to three observers, whose methods of observing I have no cause to doubt. The observations with the Transit Instrument also are made by the same three observers, with the occasional assistance of a fourth. In this manner there will be obtained ample means for determining the personal equations of the observers.

An examination of the results for the stars, both in Azimuth and in Altitude, led to the conclusion that the astronomical difference of longitude between the New South Dome and the Transit Room is sensibly discordant from the geodetic difference. The calculations have since the beginning of this year been made with proper attention to the geodetic difference of longitude and latitude; and this accuracy, with the improved determination of personal equations to which I have alluded, will enable me to verify or disprove this curious result.

Little attention has been given to the Equatoreals, as I consider the branch of astronomy to which they apply to be so well followed up in other observatories, public and private, that in general it is impolitic for us to devote much time to it. We have, however, observed Encke's Comet and the Transit of Mercury; and have taken transits for the Moon's diameter: we have also examined Hind's variable star, and watched the Lunar Eclipse.

With the double-image micrometer we have made some measures of γ Virginis, and some of Jupiter and Venus. But the most important set of observations is a series of

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measures of Saturn in four directions, at the time when his ring had disappeared. They appear completely to negative the idea that Saturn's form differs sensibly from an ellipsoid.

Some attempts were made to measure the diameter of Uranus, but they are probably worth little.

VII. Reduction of Observations.—It will appear from the following details that the reductions are nearly as forward as it is possible to keep them.

The Transit-work of every kind, to the stage of final results deduced from the observations (including as the last stage applications of semidiameters for the Sun, Moon, and Planets, and applications of the star-corrections for the stars,) is complete to the present time.

The Circle-work of every kind (to the same stage) is complete to the present time; the computations for defective limbs of the Moon, and the reductions of Transits for Position of the Circle, being a very little in arrear.

The observations with the Altitude and Azimuth Instrument are reduced, as far as is practicable without determination of instrumental constants, to the present time. It is found convenient to determine the instrumental constants in groups of complete lunations. The whole of the computations, to the final stage of errors of R.A. and N.P.D., are complete to the end of the April lunation; and the determination of instrumental constants for the May lunation is in progress.

The Equatoreal computations are complete, excepting only an insignificant step in regard to the Moon's diameter.

The Micrometer reductions are complete.

The time-reductions of Eclipses and Occultations are about a month in arrear. The elaborate calculation of Occultations is complete for 1848, and in progress for 1849.

The Deductions of every kind from collected Meridional observations and collected Altitude and Azimuth observations, to the stages of Errors in Longitude and Ecliptic N.P.D., and Heliocentric Errors, are complete to the end of 1848.

The Grand Catalogue of Stars, formed from all the observations to the end of 1847, to which I alluded in my last Report, is completed; the star-constants e, f, g, h, l, e', f', g', h', l', for all the stars, and the day-constants E, F, G, H, L, for every day to the end of 1860, are also completed.

It will be perceived from this statement that the condition of the current Reductions of Observations is most satisfactory; and that, in addition to the keeping up of current reductions, we have been able to effect the collection of the results of several years' observations of stars into a general catalogue, and to execute the very considerable labour of preparing the constants required for a new system of star-reductions. The power of doing this has been given entirely by the command of Supernumerary Computers, which has been placed in my hands by the grants of money with which the Government have intrusted me for that purpose.

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VIII. Printing of Astronomical Observations.—The Volume for 1847 is completed, and might have been published some time ago, but that I thought it desirable to bind with it the Great Catalogue (of which the Introduction and the Day Numbers are already printed completely, and the Catalogue itself is completed beyond the fifth hour). The new part of the volume, namely, the observations with the Altitude and Azimuth Instrument and their reductions, has been arranged with the view of reducing the extent of printing as much as practicable; but the number of elements of observation, and the number of steps of reduction, make it impossible to retrench this very much.

In the Volume for 1848, I have, by re-arrangement of the numbers retain ed,and by omitting some which were not absolutely necessary, reduced the printing of the Transits to one-half of its former extent. The whole of the Transits, with their reductions (excepting one sheet), are printed, and one sheet of the Ledger of collected results of Mean R.A. of Stars de duced from observations is printed. The Circle Observations, with their reductions, are printed as far as July 11. The observations of Azimuth with the Altitude and Azimuth Instrument, and their reductions, are printed as far as October 10. The greater part of the Manuscript of the remaining tabular work is in the Printer's hands, and a portion of the Introduction is prepared for him.

The reduction of the extent of printing, every thing essential being at the same time preserved, is still an object of my care. I believe that it will not be possible to reduce the printing of the Circle Observations, with their reductions, to a single page, unless the lines be turned in the up-and-down direction. If the Visitors see no objection to this, I shall be prepared to make this change in the next Volume which is sent to press.

IX. Magnetical and Meteorological Instruments.—No absolute change has been made in the instruments since the Visitation of last year, although much labour has been employed in making all perfectly serviceable. The Photographic apparatus of the Declination and Horizontal Force Magnetometers was in the middle of last year already perfectly effective; that of the Vertical Force Magnetometer was so, for intervals of time varying, perhaps, from an hour to a day, but was subject to capricious jumps of the zero point. It was evident that these arose from some instability of the instrument, or of its parts, and very great pains were taken by Mr. Barrow in uniting firmly every part of the magnetic and light-directing portions of the magnet. At length I was convinced that these disturbances arose from the effect of small jars upon the support of the instrument, which probably allowed the earth's directive horizontal force to turn the magnet sideways, and thus to alter the adjustment in regard to the vertical force; and that these jars occurred in greatest number when, in the act of changing the camphine lamps, a slight sideways pressure was given to the support. I therefore made for the lamp an independent support, leaving the light-aperture to be carried by the instrument-support as before; and this alteration removed almost the whole of the anomalies. Still, occasionally, jumps occur; but they are unfrequent, and they offer no difficulty in the interpretation of the photographic curves.

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The deflexion-apparatus, vibrating-magnet, and dipping-needles, are in good order.

The barometer, the thermometers of all kinds for the temperature of the air, the thermometers for the temperature of the ground, those for the temperature of the water of the Thames, the Anemometers, Rain Gauges, and Electrical Apparatus, are in good order. The Actinometer has received no alteration.

The self-registration of the barometer by photographic operation is satisfactory.

Since the last Visitation, the photographic arrangements for the Dry Bulb and the Wet Bulb Thermometers have been completed, and they are now perfectly efficient.

Although the attendance to the various parts of the photographic operations is troublesome, yet there is only one circumstance attending them which can be described as annoying, namely, the liability of the camphine lamps to smoke. It has for some time been with me a matter of difficulty how to avoid this nuisance; for the light of oil lamps, or that of coal-gas, will not make a sensible trace on the photographic paper. Mr. Brooke, however, at my request kindly undertook a series of experiments, and he found that coal-gas, charged with the vapour of naphtha, makes a trace as nearly as possible similar to that of camphine. I propose, therefore, now to introduce gas to the Observatory; in the first instance it will be laid only for the photographic lamps; but it will, doubtless, soon be used for many applications in the Astronomical as well as in the Magnetical and Meteorological Department.

X. Magnetical and Meteorological Observations.—Personal observations of the various instruments intended for the register of continual changes are made four times every day. These serve as zero determinations for the continuous register of the photographic apparatus. Magnetic Dip is observed twice a week. Deflexions (for absolute measure of directive horizontal terrestrial magnetism) about once in six weeks. Vibrations more frequently.

Self-registering instruments, whether continuous or givin g only maxima and minima, and cumulative instruments, are read every day.

XI. Reduction of the Magnetical and Meteorological Observations.—The reductions for 1847 may be considered as quite complete, one or two final tables only being not yet formed.

For 1848, the reductions are less complete. The magnetic declinations observed by the telescope are completely reduced, and the value of the base-line reading for the photographic sheets determined, to the end of the year; and thus (as the time-scales are laid down nearly to the present time) every photographic sheet for declination can be read off to the end of 1848. In like manner every photographic sheet for horizontal force can be read off to 1848, June 28; the telescope-observations are reduced to the end of the year, and this section will speedily be brought to the same stage as that of magnetic declination. For vertical force, the time-scale is laid down to the end of March, 1849; and as, from the

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nature of the instrument, these results must be purely differential, extending consistently through no very long time, I consider this section as brought up as far as possible. Some trouble, however, will yet be required for those periods in which the jumps of the zero have been frequent.

It will be best, I think, to preserve the sheets in this state, translating the results into numbers only in those instances in which, from the existence of great disturbance, or from the probability of comparisons, their immediate value is more evident.

The Dips are reduced to the present time; the absolute-measure-deflexions, and the vibrations to the end of 1848, wanting some trifling examinations.

The daily reductions of meteorological observations, to the stage in which they are furnished for the Registrar-General's Report (that is, to the formation of Dew-Points, and the general translation of results of wind and rain-gauges, and the daily means of all instruments), are complete to the present time. The Actinometer reductions to the end of 1848. No further reductions of meteorological observations are made for 1848 or 1849.

The retardation of these reductions has arisen, partly from the diversion of our supernumerary force to the preparation of the Great Catalogue and its auxiliary numbers, but partly also from some uncertainty as to the steps to be taken in regard to our future printing.

XII. Printing of Magnetical and Meteorological Observations.—The Daily and Extraordinary Observations of every kind are completed for 1847. The Magnetical Abstracts are begun.

The manuscript of the whole of the Magnetical Abstracts, and nearly the whole of the Meteorological Abstracts, is in the printer's hands. That of the Introduction will shortly be ready.

Lithographs of Photographic sheets have been prepared, in conformity with the instructions of the Visitors, for insertion in this volume.

With regard to the Magnetical and Meteorological Printing for 1848, although abstractedly I could wish that this volume should appear in the same shape as its predecessors, yet I cannot help thinking that the advantage of printing in this shape is hardly commensurate with the expense borne by the scientific funds of the country, and with the oppression on our now reduced personal establishment. If it meets with the approval of the Visitors, I would propose that the general scheme of instructions laid down at their Meeting of 1848, December 1, and which was intended to apply to years following 1848, should apply to the year 1848 also. In this case, the Magnetical and Meteorological Observations, commencing with 1848, will appear as an Appendix to the volume of Astronomical Observations.

XIII. Chronometers.—Under this head I have no special remark to make. The routine of rating, abstracting the rates, abstracting the expenses, dropping the signal ball,

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&c., goes on as usual. The number of chronometers on hand for rating at the present time is 98, of which the greater part are rated daily, the remainder weekly.

XIV. Personal Establishment.—The Assistants now regularly attached to the Observatory are the following:—First Assistant, Mr. Main; Assistants in the Astronomical Department, Mr. Henry, Mr. Ellis, Mr. Rogerson, Mr. Dunkin, Mr. Breen; Assistants in the Magnetical and Meteorological Department, Mr. Glaisher, Mr. Henderson. Five Supernumerary Computers are at the present time employed in the Observatory. I beg leave again to call the attention of the Visitors to the circumstance, that the liberality of the Government in placing funds at my disposal for the employment (at my own discretion) of these Supernumeraries, has enabled me to effect a very great amount of numerical computations, and at a comparatively small expense. I am confident that the Visitors will appreciate the liberality and the value of this grant.

XV. Extraneous Computations.—The only computations now going on here, which, though of an astronomical character, are extraneous to the strict business of the Observatory, are the Reductions of Fallows' observations at the Cape of Good Hope. These reductions are in every main point finished. I have been anxious that no pains should be spared to insure their accuracy, as the results must undoubtedly serve as the foundation of accurate astronomy in the Southern Hemisphere.

Want of leisure alone has prevented me from proceeding with Maskelyne's Star-ledgers and Bradley's earlier observations, to which allusion was made in the last year's Report.

XVI. General Remarks.—Although the state of the Observatory, generally, as described in the preceding Sections of this Report, is nearly that which I consider to be proper for it; and although I conceive that no important modification can ever be made in the general direction of its labours, yet it is not to be supposed that we can ever with propriety stand quite still. Some changes must be made from time to time simply for the sake of economy and convenience, as in the proposed alterations of form of printing; more important changes will be forced on us by the increased facilities for procuring large object-glasses, which will undoubtedly alter not only the dimensions but also the forms of instruments (an effect which has already shewn itself in the plan of the Transit-Circle now in progress); but changes of a still more radical kind must sometimes be made, dependent on the progress of sciences which at first sight seem to have little relation to Astronomy.

One such change has already been made by the introduction of Photography, as a means of self-registration of magnetical and meteorological instruments; whether the same principle can ever be applied to the self-registration of astronomical observations is, perhaps, doubtful. Another change will depend on the use of galvanism; and, as a probable instance of the application of this agent, I may mention that, although no positive step has

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hitherto been taken, I fully expect in no long time to make the going of all the clocks in the Observatory depend on one original regulator. The same means will probably be employed to increase the general utility of the Observatory, by the extensive dissemination throughout the kingdom of accurate time-signals, moved by an original clock at the Royal Observatory; and I have already entered into correspondence with the authorities of the South Eastern Railway (whose line of galvanic communication will shortly pass within nine furlongs of the Observatory,) in reference to this subject. The policy of using galvanism in the way lately proposed in America, for the register of transit-observations, is perhaps doubtful, except in very peculiar cases.

I allude to these subjects, however, with the hope of conveying this idea to the Visitors: that while, on the one hand, the general steadiness of plan of the proceedings at the Observatory is, as I trust, sufficiently proved by the account which I have exhibited of what has been done, and what is still to be done; on the other hand, there is no disposition to allow this institution to remain stationary in merit, while others are advancing. I have always endeavoured to make myself personally acquainted, not only with the progress of Astronomy in other observatories and other countries, but also with the improvements in the sciences and the arts, which can even distantly be connected with Astronomy; believing that this course is always prudent, and that in the competition of other rising institutions, it will become almost necessary.

G. B. AIRY.

Royal Observatory, Greenwich,
1849, *June* 1.

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