REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS.

1850.

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Read at the Annual Visitation of the Royal Observatory, Greenwich, 1850, *June* 1.

In recording the proceedings at the Royal Observatory during the last year, I have less of novelty to communicate to the Visitors than in the Reports of several years past. Still I trust that the present Report will not be uninteresting; as exhibiting, I hope, a steady and vigorous adherence to a general plan long since matured, accompanied with a reasonable watchfulness for the introduction of new instruments and new methods when they may seem desirable. For several reasons, it is convenient to terminate the Report with the end of a lunation; and it is therefore to be understood generally that the account now presented to the Visitors applies to the state of the Observatory on May 11.

I. Grounds and Buildings.—The subject of my principal remarks in the Report of last year was the erection of the Transit-Circle Room. Since the last Visitation, no change has been made in that apartment. And I am enabled by the experience of one year to speak most favorably of the principles adopted in its construction. Not a drop of water has entered at the shutters, either of the roof or of the walls. The shutters are managed easily, and every single shutter is independent of every other. When the shutters are opened, the surface which is next to the path of the light falling on the object-glass of the telescope is cool (not having been exposed to the rays of the sun), and will therefore not disturb the vision by the mixture of hot and cool air in the shutter-opening. And I would recommend that the same construction should be adopted in every new meridional observatory: that is, that the ridge of the roof should run north and south; that the roof-shutters should be upon the ridge of the roof, and the wall shutters in the middle of the end-walls; that all the shutters should turn on hinges opening outwards, the hinges being

on the east side (unless there is any peculiar reason for objecting to this); and that each place of meeting of the separate roof-shutters should be covered by a small supplementary shutter, to be lifted by the elevation of either of the adjacent principal shutters.

The room for the intended Reflex Zenith Telescope is now prepared in the place which I indicated in last year's Report, namely, in the small apartment at the north-east corner of the Transit-Circle Room. The walls have been raised, and a flap shutter has been mounted on the roof; the floor which is to carry the instrument is fixed about five feet above the Transit-Circle Room floor, and the pier which is to carry the mercury-trough is built on the pyramidal stove-flue below it. The height of the pier as at present adopted has been computed on the supposition that the object-glass of the existing Transit instrument will be used for the Reflex Zenith Telescope; if any other object-glass should be used, it will only be necessary to raise or lower the pier by half the difference of the focal lengths.

The changes in the approaches to the Octagon Room and the leads above it, to which I alluded in my last Report, were completed shortly after the Visitation. The Octagon Room is now accessible by an easy staircase from the principal passage of my dwelling-house; and the leads are reached by an external ladder-staircase, rising from the new south door of the North-east Dome. Great convenience has already been found in these changes.

Workmen are at this time employed in laying gas-pipes for the illumination of every part of the Observatory and of the dwelling-house.

II. Moveable Property.—Every thing remains nearly in the same condition as at the last Visitation. The St. Helena Instruments, however, have been transferred to the Greenwich Hospital Schools; and the Cape Altitude and Azimuth Instrument is retained only till it shall be convenient for the authorities of that Establishment to receive it. Our property generally is in good order.

I must not omit to call the attention of the Visitors to the admirable bust of Mr. Baily, which was presented to the Observatory by the Rev. R. Sheepshanks. Before another meeting of the Visitors, I hope to have it mounted on a proper pedestal.

III. Manuscripts.—The arrangement, binding, and preservation of manuscript books and papers of all kinds, whether relating to the observations made in the Observatory, to the secular business incident to the Observatory, or to the matters of general science which naturally come before me, have engaged much of my attention in the past year. Should no accident occur to destroy or to disperse this collection, I should hope that at some future time it may be found valuable, as bearing upon the history of almost every branch of physico-mathematical science pursued in this age.

At the present time the Manuscripts are in some confusion, as I am now engaged in a new classified arrangement.

IV. Library.—The Library has been kept up by continual small additions, but no large addition has been made in the last year. The books are generally in good order.

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

The Transit Instrument is in its usual good condition. Its pivots continue in the same satisfactory state as for many years past. Its error of collimation, as determined by using the St. Helena Transit for collimator, is extremely steady.

Troughton's Circle is still mounted on the eastern wall of the eastern buildings. Its microscopes in this position are not quite so steady as when they were fixed to its stone pier; but not the most trifling uncertainty from this cause attaches to the results of the observations. I still think, however, that the observations of the Sun or of any object transiting shortly before the Sun are in some measure vitiated by the passage of the visual rays so near to a heated wall.

The Altitude and Azimuth Instrument is in very good order. Its peculiarities, however, have demanded much of my attention, and probably will continue to demand it for some years. I stated in my last Report that the steadiness of the Zenith-Point and of the Error of Collimation is really remarkable; and I can continue to assert this, with even greater confidence, for the past year. It follows from this that the instrument is perfectly firm, and that the methods of observing and of applying the time-reductions are accurate, or at least are in each night's observations consistent with themselves. Still there is an occasional change (I think less frequent than formerly) in the apparent Zero of Azimuth. The winch-apparatus which was mounted about the time of the last Visitation, for turning the instrument in an unexceptionable manner, has been in constant use, but the liability to change seems to be little altered by it. In order to examine how far the change is real, I have mounted a collimating mark. The interference of buildings has compelled me to do this in an unusual way. The 25-feet object-glass of the old Zenith Tube is fixed in the North wall of the New South Dome staircase. The mark is fixed within the range of the Meridional Observatory, upon the cross wall which rises from the western side of the Computing Room, and just below the ridge of the Quadrant Room. An iron frame is bolted to the cross wall, and this frame carries a very strong brass tube (part of one of the old tubular standards of length) in which is fixed a plate with a round hole $\frac{1}{30}$ of an inch in diameter, which in use is illuminated by a gas-flame. By means of a lens of short focus, an image of this hole is made, of about $\frac{1}{300}$ of an inch in diameter; and this image is the mark for the collimator. It is seen in the telescope of the Altitude and Azimuth

Instrument as a beautifully defined circle, subtending an angle of $2\frac{1}{4}''$: and the Assistants who are accustomed to observe it believe that they commit no greater error than $\frac{1}{10}$ of a second. The readings of this mark are very steady. As it has been mounted only three months, I am scarcely able yet to found any positive deductions upon the observations; but, so far as they have gone, they incline me to believe that the true Zero of Azimuth of the instrument is steady; and that the apparent changes arise, in part at least, from errors of time depending on instability of the Transit Instrument, or upon irregularity in observing with it, or upon errors in the transmission of time from one instrument to the other. These uncertainties will probably trouble us a little longer: but I have no doubt of their being shortly removed. In the mean time I may state, that the mark has been found useful in many other ways than that for which it was primarily established. It dispenses with the necessity of observing stars for the Zenith-Point. It diminishes by one half the number of star-observations required for the determination of Error of Collimation and Zero of Levels: as its position below the horizon of the Altitude and Azimuth Instrument renders it peculiarly adapted for combination with a single star at a moderate elevation, for ascertaining that Error and Zero. Thus I compute that it delivers us from the labour of at least four calculations of Tabular Azimuth and Zenith-Distance for every fine evening. These calculations (requiring 7-figure logarithms throughout) are the heaviest of all that occur in the course of the Observatory reductions.

The two Equatoreals, and the detached Telescopes and other small instruments, are in their usual good order. In my last Report, I stated that a new double-image micrometer had then been prepared, and that I was well satisfied with it. It was founded upon a theory of Achromatism, explained by me in the Memoirs of the Royal Astronomical Society, from which theory two equations were found among five unknown quantities. It is evident that these equations might be satisfied in an infinity of different ways; and Mr. Valz, of Nismes, pointed out to me that a solution might be selected, preferable on some grounds to that which I had taken, and possessing this peculiar property, that the divided lens is concave. This is an advantageous circumstance, inasmuch as the lens is thin at its place of section, and the loss of light in the inclined pencils is insignificant. I have lately had an eye-piece constructed in accordance with Mr. Valz's numbers: and, as far as trial in an unfavourable evening permitted me to judge, it fully answered to my expectations.

The ancient instruments of the Observatory are preserved as formerly: but they have not undergone special examination for many years.

The large Transit-Circle has not advanced so rapidly as I had expected. The principal cause of delay was the shifting of the engineering works of Messrs. Ransome and May from one part of Ipswich to another. There has also, however, been a little difficulty in giving a perfectly accurate form to the pivots. This may be considered as now overcome,

and, as every other part of the iron-work is completed, as the silver band for graduations is inserted in the iron circle, and as the collimators are (in a temporary way) planted in position for adjusting the instrument, I trust that in no long time it will be fairly mounted.

The sections of the tube of the old 25-feet Zenith Sector remain in the wooden frame in which they were mounted last year for preservation. The micrometers, &c., are complete, and in place: but the object-glass, as I have already said, is mounted for use in connection with the collimating-mark of the Altitude and Azimuth Instrument.

No step will be taken in the construction of the Reflex Zenith Telescope until I shall be able to mount in it the object-glass of the present Transit Instrument. In the mean time I may remark that I see no reason for departing from the plan of construction which I explained to the Visitors at their last Meeting.

VI. Observations.—The general plan of Meridional Observations has undergone no alteration. If practicable, each star of the Nautical Almanac list is observed 20 times, with each of the meridional instruments, in three years. (In alluding to this particular list, I may take this opportunity of saying that it is scarcely extended enough for the convenient determination either of clock errors or of azimuthal errors, and that I have in contemplation to form a larger list, and to compute the corrections before-hand, so as to be prepared to determine the most important instrumental adjustments with shorter openings of clear sky than are at present required.) A general catalogue of stars down to the 4th magnitude, as taken from the Catalogue of the British Association, has been in hand for observation since November last. Other stars observed are, Stars culminating with the Moon, Occultation Stars, Stars in the lists for comparison with Mars, and Stars insufficiently observed in former years. The bodies of the Solar System are observed at every practicable opportunity: with no other exceptions than these, that the Moon only is observed on Sundays, and that on one day in each month (about the time of New Moon) nothing but the stars necessary for keeping up Clock Error is observed.

The Altitude and Azimuth Instrument has been used under precisely the same regulations as in the two last years, excepting that, since the middle of February, the efficient introduction of the Collimator Mark has rendered it unnecessary to observe more than one star in Azimuth (none being required in Zenith Distance) on every evening. The numbers of days of complete observation of the Moon with this instrument, and with the meridional instruments, in the twelve lunations (356 days) from 1849, May 20, to 1850, May 11, are as follows:—

Time of Passage of the Moon.			Number of Days of complete Observations with Altitude and Azimuth Instrument.	Number of Days of complete Observations with Meridional Instruments.
h		h		
0	to	1	0	0
1	to	2	4	0
2	to	3	7	0
3	to	4	9	3
4	to	5	7	4
5	to	6	12	6
6	to	7	10	3
7	to	8	11	5
8	to	9	12	6
9	to	10	11	7
10	to	11	13	7
11	to	12	9	5
12	to	13	12	8
13	to	14	14	6
14	to	15	11	6
15	to	16	9	4
16	to	17	12	6
17	to	18	13	7
18	to	19	13	8
19	to	20	9	4
20	to	21	8	0
21	to	22	3	0
22	to	23	3	0
23	to	24	0	0
Whole number of days of complete observations...			212	95

The advantage of the Altitude and Azimuth Instrument, in respect of the number of observations of the Moon gained, and of the parts of the lunation in which she is observed, is greater than in the two former years, and much greater than I had anticipated. When it is considered that (with insignificant exceptions) every Azimuth, and also every Altitude, is the result of transit over twelve wires, and that every constant of instrumental adjustment, excepting only that of azimuthal zero (to which I have specially alluded), is unusually steady, I am confident that the Visitors will assent to the opinion which I formerly expressed, and which I now repeat, that the erection of this instrument is the most important innovation that has been made in the Royal Observatory for many years.

In the last Report, I described a singular kind of Personal Equation (affecting transits of the Moon's Limb, and transits of stars, in different degrees) which had been discovered in reducing the Altitude and Azimuth observations of the Moon: and I stated that I had made a new arrangement of the duties of the Assistants, with the express object of confining observations of transits (with the Transit Instrument and with the Altitude and

Azimuth Instrument) to those observers whose personal equations appeared to be consistent, and also with the intention of so interweaving their observations with the Transit Instrument that their personal equations might be accurately determined. This plan has been steadily pursued, and it has even been much improved by a spontaneous effort of the Assistants, which is creditable to their intelligence and zeal. Without positive order, it has become established as a rule among them that the observer with the Altitude and Azimuth Instrument do also observe, if possible, a few clock stars with the Transit Instrument: these are used for the connection of time with the Altitude and Azimuth observations: and thus the results of the observations are absolutely freed from personal equation. These plans have been perfectly successful: the results for the Moon's place appear to be entirely free from error depending systematically on the observer.

The diameter of the Moon, corrected by former observations with the Meridional Instruments, appears to answer well for the Altitude and Azimuth Instrument.

The observations of the Moon near conjunction are already promising to lead to important conclusions. It is certain that the errors of the tabular place near to conjunction are very sensibly different from those in other parts of the revolution.

The inquiry into the apparent discordance between the astronomical and the geodetical longitudes of the Altitude and Azimuth Instrument has not been followed up.

For the reasons mentioned in the last Report, the Equatoreals have been little used. Their principal applications have been to observations of Mars, and of neighbouring stars selected by the directors of the American expedition; and to observations of transits of the Moon for correction of her diameter.

With the double-image micrometer, γ Virginis only has been observed.

VII. Reduction of Observations.—The reductions are in every respect as forward as it is possible to complete them.

The Transit Results, and the Circle Results (to the stage of mean places of stars reduced to the beginning of the year, and of apparent places of the centers of Sun, Moon, and Planets, as corrected for refraction, parallax, and semidiameter) are complete, as far as the observations supply determinations of instrumental constants. The Sun's semidiameter, as given in the Nautical Almanac, is increased by $\frac{1}{1000}$ part: the Moon's by $\frac{11}{4000}$ part: and the Moon's parallax by $\frac{1}{1200}$ part. The Errors of R.A. and N.P.D. for the Moon are converted into Errors of Longitude and Ecliptic N.P.D. to the present time. The Heliocentric Errors, &c., of planets are complete to the end of 1849.

The reduction of the Altitude and Azimuth observations is complete to the end of the April lunation, with the exception of a most trifling part of the very last stage in the computation of Moon's error of R.A. and N.P.D. from error of Azimuth and Zenith Distance. The primary reductions of Circle Readings, both in Azimuth

and in Zenith Distance, and of Refractions for Zenith Distance, are ready to the present time. The computed Tabular Azimuths and Zenith Distances, as deduced from the tabular R.A. and N.P.D. and the time of observation, are far advanced for the last lunation.

The Equatoreal computations and Micrometer computations are completed.

The Calculation of Occultations is completed, to the stage of Final Equations, to the end of 1849.

VIII. Printing of Astronomical Observations.—The Volume for 1848 has been completed, as regards its astronomical part, some time since; and has been waiting only for the Magnetical and Meteorological Appendix (of which I shall shortly speak farther). I need scarcely mention to the Visitors that a change in the system of printing, even though ultimately productive of a very great saving of labour and acceleration of publication, does at first cause some delay; more especially when the system of observations to which it applies has undergone an almost radical change.

In the Volume for 1849, the Transits and their reductions are printed to the middle of November, the Circle Observations and their reductions to the middle of April, and the Azimuths and their reductions to about the same time. The whole of the MS. for the Volume for 1849, in the shape proper for printing, is quite complete, and either in the Printer's hands or ready to be placed in his hands.

The form adopted in printing the Volume for 1849 is precisely the same as that in the Volume for 1848; the Transits and their reductions being reduced to one page, while the Circle Observations and their reductions still occupy two. In the last Report I suggested the printing of the Circle Observations in up-and-down lines, for the purpose of including the observations and reductions upon a single page: but the strong objections expressed by several of the Visitors at once decided me to lay aside that idea. I now find that, by placing in a lower compartment of the page those elements of reduction which at present occupy several columns in breadth but which cannot be general to all objects (as Parallaxes and Semidiameters on the one hand and Star Reductions on the other hand), it will be possible to include all on a page containing about $\frac{4}{5}$ of the usual number of observations, and thus to diminish the number of pages of that section in the proportion of 8 to 5: and I propose to adopt this for 1850, if it is agreeable to the Visitors.

I propose also to adopt in the Volume for 1850 a new type, the characteristics of which are that the tops of the 3, 5, 6, and 8, rise above the general line, and that the bottoms of the 4, 7, 9, project below it.

IX. Magnetical and Meteorological Instruments.—No change whatever has been made in these instruments, except by the introduction of the light of coal-gas charged with the vapour of coal-naphtha, for photographic self-registration both of the magnetic and of the

meteorological instruments. This light is perfectly efficient for photographic purposes (its photogenic intensity being as nearly as possible the same as that of camphine, or perhaps superior to it), and the lamps continue burning for many weeks without extinction, and almost without requiring adjustment. The chemical treatment of the paper is now so well understood by the Assistants that a failure is almost unknown. And, generally speaking, the photographs are most beautiful, and give conceptions of the continual disturbances in terrestrial magnetism which it would be impossible to acquire from eye-observation. The traces of the Vertical Force Magnetometer are still liable (though rarely) to dislocations, without any conjecturable cause. As I conceive (judging from the long duration of vibrations without remarkable diminution of the arc of vibration, and the clear depiction of very small disturbances of the vertical force) that our instrument is in at least as good order as any that has ever been made, I have no doubt that the indications of every Vertical Magnetometer are subject to error from the same causes, although in the ordinary eye-observations they are not discoverable.

It is worthy of remark that no difficulty is found in maintaining the photographic system through Sunday as well as through the other days of the week, without requiring any lengthened attendance of the Assistants on that day. The photographic sheets are taken from the cylinders and are placed in a dark closet (fresh sheets being substituted), and it is found that the operation of bringing out the impression can with perfect safety be delayed till Monday.

The deflexion-apparatus, vibrating-magnet, dipping-needles, barometer, thermometers (except occasionally the self-registering thermometers), the thermometers in the ground and those in the water of the Thames, the anemometers, rain-gauges, and electrical apparatus are in good order. The Actinometer has not been used lately.

X. Magnetical and Meteorological Observations. — Eye-observations of the three magnetometers, the barometer, and the wet and dry bulb thermometers, are made four times every day: these observations serve as zero points for the photographic register. Magnetic Dip is observed twice every week: and absolute measures of the terrestrial horizontal force are made (in Gauss's method of deflexions) at irregular intervals, but about once in six weeks: simple vibrations for horizontal force are observed more frequently. Self-registering instruments are read every day.

XI. Reduction of the Magnetical and Meteorological Observations.—The observations to the end of 1848 are completely reduced, to the extent to which it is proposed to reduce them. Every photographic sheet bears its time-scale and its line of abscissæ or zero of measure, by which every indication can be interpreted. Every eye-observation is completely corrected. And, in the Meteorological part, daily means and other deductions are

completed to the state in which they are printed for 1848, and in which it is proposed to print them for future years

The method of translating correctly the photographic indications, in regard both to time and to measure, has been so fully described in the printed account of the Photographic Apparatus inserted in the *Magnetical and Meteorological Observations*, 1847, that it is unnecessary here further to allude to it. But it is proper to allude to the method followed in regard to the dislocated traces of the Vertical Force photographs. From careful examination of these I was induced to believe that, from whatever cause these dislocations arise (the most probable causes being—the sudden dropping of a small weight, as that of a spider, on the magnet—or a change in the conditions of equilibrium determined by a horizontal twist of the knife edges on planes slightly inclined) they may be represented by simple change in the zero of measure. A small engine was therefore made, of which the lower part tightly held the photographic sheet, while the upper part, tightly holding a sheet of tracing paper, could slide in the direction of the vertical force measure; and, the curve being traced, with the tracing-paper unmoved, as far as a dislocation, the tracing-paper was then slid till its curve joined to the new section of the photographic curve. In this way continuous curves were formed, which I conceive to represent correctly the indications of a perfect instrument through the times to which those curves apply.

For 1849 and 1850, the state of reductions is nearly as follows:—The declination as observed by the eye is completed to the end of 1849: for 1850 the circle-reading is formed to the present time, and the reading for astronomical meridian very nearly to the present time; but they are not actually combined. In the photographs, the time-scales are laid down nearly to the present time, and the base-line readings from single observations are prepared to the end of 1849; but the adopted base-line readings from groups are not formed. The Horizontal Force reading is nearly in the same state, but somewhat more advanced in the step leading to the adopted base-line readings. The Vertical Force reading is in the same state, except that it is not thought necessary here to determine a value for the base-line; the observations of successive days, for any long period, being with difficulty comparable. The retracing of dislocated traces is not commenced for 1849.

The Dips are reduced to the present time; and the Absolute Measures of horizontal force nearly to the present time, the final step not being made for 1849 and 1850.

The Meteorological observations are completely reduced (in that state in which they are published weekly in the Registrar General's Report, and in which, with trifling alterations, it is intended to publish them in future in our Meteorological Appendixes), up to the present time. None of the Hygrometric calculations of former years, or of the means taken as in former years, have been prepared for 1849 and 1850.

XII. Printing of Magnetical and Meteorological Observations.—The Volume for

1847 has been in circulation several months. It contains, in addition to its usual matter, a description of the Photographic Self-registering apparatus, and of the method of using it, accompanied with lithographs of photographic sheets, in conformity with the instruction of the Visitors communicated to me some time ago.

The Visitors, at their last Meeting, acceded to the suggestion which I made, that the Magnetical and Meteorological Observations for 1848 should be printed in the abridged form which it had already been agreed by them to adopt for subsequent years, as an Appendix to the Astronomical Volume. This Appendix is all but completed: and I beg leave to submit to the Visitors a statement of its general arrangement. First, for the continuous Magnetometer Records. The photographic sheets were carefully examined, and every day was selected in which the movements of the magnets were so distinctly marked as to make it probable that the comparison of these movements with those observed at other localities might afford means of investigating the cause of magnetic disturbance. In addition to these, the prearranged term-days were taken. The whole number of days thus adopted is 162. For each of these days, the time and measure have been taken graphically from the photographic sheets at every well marked salient point of the trace; so that, by laying down points from the printed times and measures, and connecting them by straight lines, the curves will be very nearly reproduced. The number of points taken from a single sheet is exceedingly variable: from that of 1848, Nov. 17, Horizontal Force, 80 points are taken. The thermometer-readings (for the Horizontal and Vertical Force Instruments) are printed with them. Then follow the Results of Observations for Dip, Observations of Deflection (in a somewhat abridged form), and of Vibrations, and their Results. The Meteorological Observations commence with a tabular record, in which the observations of each day are contained in a single line extending across two pages. For Barometer, there is the mean of 4 readings corrected for temperature and corrected by the quantity which nearly produces the mean for the day; for Thermometers there are the highest and lowest dry thermometer readings, the greatest, least, and mean differences of dry thermometer and dew-point, the mean dew-point, the greatest and least readings of radiation-thermometers, and of the thermometers in the Thames; and also the difference between the actual mean temperature of the day, and that of the same day on an average of 7 years. For the Winds there are General Directions in two sections of each day; greatest, least, and mean pressures; and gross horizontal movement. For the Rain, there is the amount for the day. The Electricity and the Clouds and Weather are recorded by an abbreviated notation in such a way as to leave a very small uncertainty as to the time, and none as to the character, of each phenomenon. There is then an exhibition of the maxima and minima of the barometer readings, so arranged as to show every atmospheric wave; a table of the rotations of the wind; a daily reading of each of the thermometers fixed in the ground; extraordinary observations of the Electrometers, of Meteors, and of Auroras; and a comparison of the rain received in the different rain-gauges. I conceive that these details are amply sufficient

record of the peculiarities of every fraction of every day: the general laws of annual and diurnal changes being well established from the observations of seven preceding years.

XIII. Chronometers.—The chronometers are compared as in preceding years (except that, when there is no special reason for requiring two comparisons, one daily comparison only is taken, and sometimes only one weekly); their rates are reported and abstracted, the expenses of repairs are digested, the signal-ball is dropped, &c., as in former years. The number of chronometers now on hand is 112.

I am preparing an apparatus for heating the trial-chronometers by the flame of gas, in nearly the same manner which has been adopted with great convenience at the Liverpool Observatory.

XIV. Personal Establishment.—The attached Assistants of the Establishment are the following:—First Assistant, Mr. Main; Astronomical Assistants, Mr. Henry, Mr. Ellis, Mr. Rogerson, Mr. Dunkin, Mr. Breen; Magnetical and Meteorological Assistants, Mr. Glaisher, Mr. Henderson. Three Supernumeraries are at the present time employed. I am well enabled by experience to assert that this mixed system, of the regular employment of Assistants at fixed salaries whose attachment to the office is understood to be permanent, and of the occasional employment of Supernumeraries whose stipend and duration of employment are regulated as occasion requires by the Superintendant, is the most favorable possible for efficiency and economy.

XV. Extraneous Computations.—The reduction and printing of Fallows' observations at the Cape of Good Hope are completed, and no other work extraneous to the usual business of the Observatory has been undertaken. I have not however lost sight of the proposed printing of Maskelyne's ledgers of Stars and of the intended examination of Bradley's earlier observations, to which allusion has been made more than once.

XVI. General Remarks.—The matters to which I desired to invite the attention of the Visitors have been so completely embodied in the classified statements already read to them, that I have little of miscellaneous character to subjoin. Many arrangements, it will easily be understood, are waiting for the erection of the large Meridional Instrument. Still there are two points which have distinctly engaged my attention, and which I propose to urge as occasion serves, unless I shall see new reasons for doubting their propriety.

The first of these is, the introduction of the American method of observing transits, by completing a galvanic circuit by means of a touch of the finger at the instant of appulse of the transiting body to the wire of the instrument, which circuit will then animate a magnet that will make an impression upon a moving paper. After careful consideration of this method, I am inclined to believe that, in Professor Mitchell's form, it does possess the

advantages which have been ascribed to it, and that it may possess peculiar advantages in this Observatory, where the time-connexion of transits made with two different instruments (the Transit and the Altitude and Azimuth) is of the highest importance. But on the other hand this peculiar circumstance introduces special difficulties: for it makes it impossible for us to confine the time of use of the apparatus to the mere time of observing a series of transits (as is in the power of a dilettante observer), and the consumption of recording surface must be very great. Moreover, it will not be easy to arrange the times of gearing and ungearing the instrument (in order to save recording surface) so as to consult the convenience of both observers. In considering these things, it has appeared to me that the first point at which it is desirable to aim is, to produce a very uniform movement of the recording surface, even sufficiently perfect to enable me, if I shall think fit, to use that movement for the record of time instead of the usual detached sidereal clock; and I have mechanism now in progress, depending for its regulation on the motion of a nearly free conical pendulum in an arc whose radius does not exceed two degrees, by which, even when resistances are exceedingly variable, I almost hope to accomplish this object. I alluded in my last Report to the possible galvanic connexion of the different clocks of the Observatory, so as to make the motion of every clock depend on the motion of one: but I am now inclined to think that there is a better prospect of advantage in the American system of registering the observations made at different parts of the Observatory on one recording surface.

The second point is, the connexion of the Observatory with the galvanic telegraph of the South Eastern Railway, and with other lines of galvanic wire with which that telegraph communicates. No arrangement is yet effected for this purpose, but I continue to keep my attention on it, even with greater interest than formerly. I had then in mind only the connection of this Observatory with different parts of the great British island: but I now think it possible that our communications may be extended far beyond its shores. The promoters of the submarine telegraph are very confident of the practicability of completing a galvanic connexion between England and France: and I now begin to think it more than possible that, within a few years, observations at Paris and Brussels may be registered on the recording surfaces at Greenwich, and *vice versâ*.

I explain these suggestions, however, at present only for the general information of the Visitors, regarding it as my duty to take the active part in the planning of innovations which may be beneficial to the Observatory, and to communicate them to the Visitors as soon as they assume anything like distinct form. When the time for decision upon them shall come, I have no doubt of their receiving from the Visitors the attention which they may deserve.

G. B. AIRY.

Royal Observatory, Greenwich,
May 15, 1850.