

*Report of the Kew Committee for the Year ending  
October 31, 1890.*

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The operations of The Kew Observatory, in the Old Deer Park, Richmond, Surrey, are controlled by the Kew Committee, which is constituted as follows :

Mr. F. Galton, *Chairman.*

Captain W. de W. Abney, C.B., R.E. Prof. W. G. Adams. Staff-Commander E. W. Creak, R.N. Prof. G. C. Foster. Admiral Sir G. H. Richards, K.C.B.		The Earl of Rosse, K.P. Prof. A. W. Rücker. Mr. R. H. Scott. Lieutenant-General R. Strachey, C.S.I. General J. T. Walker, C.B. Captain W. J. L. Wharton, R.N.
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The work at the Observatory may be considered under the following heads:—

- 1st. Magnetic observations.
- 2nd. Meteorological observations.
- 3rd. Solar observations.
- 4th. Experimental, in connexion with any of the above departments.
- 5th. Verification of instruments.
- 6th. Rating of Watches and Marine Chronometers.
- 7th. Miscellaneous.

#### I. MAGNETIC OBSERVATIONS.

Throughout the past year the magnetographs have worked in a satisfactory manner. In accordance with the usual practice, determinations of the scale values of all the instruments were made in January last.

The values of the ordinates of the different photographic curves then determined, were as follows:—

Declinometer : 1 inch =  $0^{\circ} 22' \cdot 04$ .    1 cm. =  $0^{\circ} 8' \cdot 7$ .

Bifilar, January 10, 1890, for 1 inch  $\delta H = 0 \cdot 0278$  foot grain unit.

,, 1 cm. ,, =  $0 \cdot 00050$  C.G.S. unit.

Balance, January 13, 1890 for 1 inch  $\delta V = 0.0296$  foot grain unit.  
 „ 1 cm. „ = 0.00054 C.G.S. unit.

In the case of the vertical force magnetometer, it was found necessary to re-adjust the instrument, and as at the same time its sensibility was slightly altered, the scale value was again determined, with the following result:—

Balance, January 21, 1890, for 1 inch  $\delta V = 0.0284$  foot grain unit.  
 „ 1 cm. „ = 0.00051 C.G.S. unit.

With regard to magnetic disturbances, no very exceptional movements have been recorded during the year.

The principal disturbances were on the following dates:—November 1 and 26—28, 1889.

The monthly observations of Horizontal Force, Inclination, and Declination with the absolute instruments have been made in accordance with the usual practice.

Information on matters relating to terrestrial magnetism and various data have been supplied to Professors Thorpe and Rücker, Dr. van Rijkevorsel, Dr. Atkinson, Professor Chistoni, and Captain Schück.

*Magnetic Sub-Committee.*—Professors W. G. Adams, A. W. Rücker and Captain Creak having been requested by the Committee to act as a sub-committee to consider the form to be employed in framing the appendices to this Report, have held two meetings. They decided that in future the Magnetic and Meteorological Appendices should be presented to the Royal Society as soon after the 1st of January as possible, instead of accompanying the Report itself, and therefore closing with September 30th as heretofore. This arrangement will take effect with the present issue.

At the suggestion of Professor Rücker, the Kew Magnetical Declination results for the years 1883, 1886, and 1887 have been recently discussed in a paper published by the Physical Society of London in their Proceedings, entitled “On the Diurnal Variation of the Magnet at Kew,” by Messrs. Robson and Smith. These gentlemen, students in the physics class at the Royal College of Science, kindly gave their assistance in the labour of tabulation and computation.

At the request of Professors Thorpe and Rücker, facilities have been afforded to Messrs. Gray and Briscoe, who are also attached to the physical laboratory in the Royal College of Science, South Kensington, to make magnetic base observations from time to time at Kew, with the view of their employment in the Magnetic Survey of Great Britain and Ireland now in progress on a more extended scale than that on which it has before been carried out.

## II. METEOROLOGICAL OBSERVATIONS.

The several self-recording instruments for the continuous registration respectively of Atmospheric Pressure, Temperature, and Humidity, Wind (direction and velocity), Bright Sunshine, and Rain have been maintained in regular operation throughout the year.

The standard eye observations for the control of the automatic records have been duly registered, together with the daily observations in connexion with the U.S. Signal Service synchronous system.

The tabulations of the meteorological traces have been regularly made, and these, as well as copies of the eye observations, with notes of weather, cloud, and sunshine, have been transmitted to the Meteorological Office.

With the sanction of the Meteorological Council, data have been supplied to the Council of the Royal Meteorological Society, the editor of 'Symons's Monthly Meteorological Magazine,' Dr. Rowland, and others.

Tables of the monthly values of the rainfall and temperature have been regularly sent to the Meteorological Sub-Committee of the Croydon Microscopical and Natural History Club for publication in their Proceedings. Detailed information of all thunderstorms observed in the neighbourhood during the year has been forwarded to the Royal Meteorological Society, soon after their occurrence.

*Electrograph.*—This instrument has been in constant action throughout the year, and comparisons with the portable electrometer have been made from time to time.

*'Times' Weather Chart.*—The supply of the chart exhibiting copies of the daily traces of the self-recording meteorological instruments at the Observatory ceased by instructions from the 'Times' office in March last, after continuous publication for 14 years.

The fog gauge set up on the north side of the Observatory in 1884 has been recently dismantled, as it has not been found possible to measure the intensity of this phenomenon by its means.

*Fort William Observatory.*—At the request of the Meteorological Council, a barograph and a thermograph which have been stored at Kew Observatory since their return from Armagh Observatory in 1886 have been thoroughly re-fitted, and, after a short experimental trial, were re-packed and forwarded to the new Observatory at Fort William for use at the low-level station worked in conjunction with the Observatory erected on the summit of Ben Nevis.

In June last, on receipt of information from Mr. Omond, the superintendent of the Ben Nevis Observatory, that the new building was ready for the reception of the instruments, Mr. T. W. Baker proceeded to Fort William and set them up and put them in proper adjustment. Having done this, and instructed Mr. Omond in their manipulation

and the attendant photographic operations, he returned to Kew, leaving the establishment in good working order on July 14.

Owing to the cost of gas, mineral oil is used as the illuminant, as is the case at Valencia Observatory also.

### III. SOLAR OBSERVATIONS.

Sketches of Sun-spots have been made on 198 days, and the groups numbered after Schwabe's method.

*Time Signals.*—These have been received with great regularity all through the year, failure in transmission having only occurred on six days, on one of which the signal was duly received at the proper time, but was not recorded, the chronograph clock having been deranged by an accident.

*Transit Observations.*—Solar and sidereal transits have been occasionally observed as a check on the signalled times.

During the past summer 225 series of observations of the Sun's actinic power have been made with Violle's actinometer, described in the last Annual Report, upon the plan arranged by General Strachey and Mr. Blanford. Copies of the instrumental readings will be transmitted to the Meteorological Office for discussion, the cost of the experiments being defrayed by that establishment.

By the kindness of Mr. C. Baker, of High Holborn, the Observatory has received the original sunshine record cards obtained by the late Mr. Rand Capron, F.R.A.S., at his observatory near Guildford, Surrey, during the years 1880 to 1887.

The Winstanley radiograph, deposited at the Observatory in 1880, was recently repaired at the suggestion of Mr. R. H. Scott, and set up on the lawn. Its action is, however, not considered satisfactory, and it has been decided to return it to the owner.

### IV. EXPERIMENTAL WORK.

The *Electrical Anemograph*, after working on the staging erected on the roof, 14 feet to the north of the Beckley instrument, and recording by means of a battery composed of eighteen Fuller's cells, was dismantled on July 22, and packed for storage. During the period it was at work, the traces were forwarded weekly to the Meteorological Office.

*Oils.*—At the request of the Meteorological Office, various specimens of lubricating oils have been applied to the gearing of the anemograph with the view of determining the best for use under the varying conditions to which it is exposed.

*Pendulums.*—The swinging of the invariable pendulums at the Royal Observatory, Greenwich, having been completed during the past winter, the apparatus was dismantled and returned to Kew,

where it is now stored awaiting further disposal. A paper describing the operations, and giving full details of the values of the vibration numbers obtained at Kew and at Greenwich, has been contributed to the Royal Society by General Walker (see 'Phil. Trans.,' vol. 181, A, p. 537). The result shows the number of vibrations made by a seconds' pendulum in one day to be 0.64 greater at Kew than at Greenwich.

*Cloud Photographs.*—At the suggestion of General Strachey, Chairman of the Meteorological Council, a new departure has been made in the photography of clouds during the past year, with the view of simplifying the operations of determining the height and velocity of their movement. Both cameras have been rigidly fixed on their stands, with the axes of their lenses pointed directly to the zenith, and photographs are now taken simultaneously of the area of the sky surrounding the zenith within a circle of a radius of about 15°. These photographs are superposed one on the other, so that the two pictures shall appear to coincide, and a simple measurement of the distance between the images of the zenith points, which are marked by intersecting lines, gives a means of readily determining the height of the cloud above the surface of the ground. A second measurement made in like manner of the displacement of the zeniths in a second pair of photographs taken after a given interval of time serves to show the rate of travel of the cloud and the direction in which it is moving at the instant of observation. Twenty groups of clouds, giving heights extending from 1½ miles to 8 miles, and rates of motion from 5 miles to 64 miles per hour, have been photographed and measured in this manner during the past summer.

A wooden frame, 12 feet in height, has been constructed, which is occasionally erected above each of the cameras in order to verify the position of their zenith points and the orientation of the cross lines on the photographic plates.

#### V. VERIFICATION OF INSTRUMENTS.

The following magnetic instruments have been purchased on commission and their constants determined:—

- 1 Inclinator, for Padre Denza, Rome.
- 2 Collimator magnets for Professor Chistoni, Italy.
- 1 Pair of dip needles for Hong Kong Observatory.
- 1 Pair of small dip needles for Senhor Capello.
- A single dip needle repaired for Professor Mielberg.

*Sextant Testing.*—This branch of the work of the Verification Department has been very active during the past year, 346 instruments having been examined and certified, and tables of corrections supplied. Owing to the decay of the photographed scales of some of

the collimators through damp, it was thought advisable to fit new and improved scales to all of them. On being furnished with the necessary drawings, Captain Abney kindly had the set of photographs made in his laboratory, and they were duly fitted to the collimators by Mr. Adie.

Care was taken to replace them exactly in the same positions as those occupied by the old scales, and after they were set up a re-determination of all the angles was very accurately made and recorded for future use.

Steps have recently been taken with a view of fitting electric lamps, worked by a storage battery, to the instrument for testing the parallelism of the dark shades, in order that this operation may be performed in the absence of brilliant sunshine, a condition which has hitherto rendered it impossible to complete the examination of these shades in cloudy weather.

*Sextant Telescopes.*—The Committee, having had their attention drawn to the low optical power of some of the telescopes supplied with sextants submitted to them for examination, have given instructions that no certificate of the highest class should be issued with any instrument if the telescope is not capable of distinguishing the smallest angle exhibited by the division of the graduations on the arc of the sextant.

The *Hydraulic Press* used for testing the behaviour of deep sea thermometers under hydrostatic pressures of  $3\frac{1}{2}$  tons per square inch is not capable of exerting the higher pressures now required by the Admiralty for thermometers employed in the deeper soundings.

The question of strengthening the press was submitted to Messrs. Armstrong and Co., who reported that the cost of doing so would exceed the sum the Committee could afford to expend upon the apparatus.

*Normal Thermometers.*—The Committee having considered the desirability of having some thermometers accurately compared with the hydrogen thermometer of the Conservatoire des Poids et Mesures, at Paris, instructed Mr. Whipple to convey to the director of that office the set of three closely graduated mercurial thermometers, whose calibration errors were investigated in 1879, by Professors T. E. Thorpe and Rücker (see 'British Association Report,' 1881, p. 540), and also an alcohol thermometer graduated at Kew for the special purpose of the comparison, its scale extending from  $-100^{\circ}$  to  $+90^{\circ}$  Faht. The examination of these thermometers has now been completed, and M. Benoit has sent his report upon them to Kew Observatory.

In addition to the usual instruments submitted for verification, the Committee have been called upon for special examination and reports referring to the following articles: the Admiralty, for a Gun Director

Telescope, and new pattern Officer's Telescope; the War Office for a barometer supplied to the Netley Hospital; and the makers for a new Watkin's Clinometer, and Watkin's Aneroid with open scales; as well as various instruments for the Anglo-German Boundary Commission on the Gold Coast.

*List of Fees.*—The Chairman of the Committee, with a view of making the public more conversant with the systems of verification and rating in use at the Observatory, prepared in the early part of the year a pamphlet entitled "Tests and Certificates of the Kew Observatory." Of these 1,000 copies were printed, of which 200 have been distributed to the principal opticians and instrument makers, and others sold to the general public.

The total number of other instruments compared in the past year was as follows:—

Air-meters .....	5
Anemometers .....	14
Aneroids .....	62
Artificial horizons.....	3
Barometers, Marine.....	134
,, Standard .....	44
,, Station.....	28
Binoculars .....	336
Compasses.....	17
Hydrometers.....	364
Inclinometers .....	1
Magnets.....	2
Navy Telescopes .....	152
Rain Gauges .....	15
Rain Measures.....	33
Sextants.....	346
,, Shades .....	78
Sunshine Recorders.....	3
Theodolites .....	5
Thermometers, Arctic.....	71
,, Avitreous or Immisch's .....	346
,, Chemical .....	63
,, Clinical .....	12536
,, Deep sea.....	40
,, Meteorological .....	4901
,, Mountain .....	24
,, Solar radiation .....	44
,, Standards .....	100
Unifilars .....	3
	<hr/>
Total.....	19770

Duplicate copies of corrections have been supplied in 63 cases.

The number of instruments rejected on account of excessive error, or which from other causes did not record with sufficient accuracy, was as follows:—

Thermometers, clinical .....	23
,,           ordinary meteorological.....	20
Various .....	150

3 Standard Thermometers have also been calibrated, and supplied to 3 applicants during the year.

There are at present in the Observatory undergoing verification, 4 Barometers, 777 Thermometers, 51 Hydrometers, 14 Sextants, and 42 Telescopes.

The increase in the number of sextants verified during the past year has been considerable, 346 instruments of that kind having been tested, whereas the greatest number in any previous year has been 292.

#### VI. RATING OF WATCHES.

During the year 513 entries of watches for rating were made. They were sent for testing in the following classes:—

For class A, 450 ; class B, 49 ; and class C, 9 ; subsidiary trial, 5.

Of these 128 failed to gain any award ; 10 passed with C, 41 with B, 329 with A certificates, and 34 of the latter obtained the highest, class A *especially good*.

In the Appendix will be found statements giving the results of trial of the 26 watches which obtained the highest numbers of marks during the year, the highest position being attained by Mr. A. E. Fridlander, of Coventry. His watch was a keyless double roller with going barrel, which obtained 86·1 marks out of a possible 100.

At the request of several watch makers, the Committee have slightly modified the regulation for the granting of certificates for watches which have been rated. The chief alteration is in the conditions requisite for affixing the words *especially good* to a Class A certificate. These are now simplified so that all watches which have 80 marks and upwards awarded to them after trial are entitled to be characterised as *especially good*.

*Marine Chronometers*.—Certificates showing the mean daily rate and the variations of rate at three different temperatures have been awarded to 3 marine chronometers after undergoing the 35 days' trial.

An Astronomical Regulator for the Observatory at Akassa, Royal Niger Company's Territory, has also been rated at temperatures of 60° and 80° Faht.

## VII. MISCELLANEOUS.

Plans have been prepared and estimates obtained for the construction of the necessary apparatus to enable the examination of photographic lenses for cameras to be prosecuted at the Observatory, with the view of granting certificates to the owners or purchasers of such articles. It is in contemplation to adopt a system of examination of lenses, which shall provide, first, for a comparatively rough or cursory trial which will enable a person to form a general idea of the capabilities of a lens, and, second, for a more lengthy and careful trial, for which a higher fee will be charged, which will give full particulars as to the various qualities an acquaintance with which is necessary to possess a full knowledge of the instrument. Captain Abney and other gentlemen have rendered the Committee much assistance in the practical arrangement of the details of this lens testing.

*Toronto University.*—An appeal having been received from the librarian of this institution, recently destroyed by fire, for books to replace those lost, the Committee forwarded a parcel of such duplicates as they could spare from the Observatory library, which has been duly acknowledged by the President of the College.

On the occasion of the eleventh annual exhibition of the Royal Meteorological Society, which was devoted to illustrations of the applications of Photography to Meteorology, several instruments and photographs were exhibited, and Mr. Whipple read a paper on the subject, illustrating it by means of the optical lantern.

*Building, &c.*—A new window has been fitted to light the staircase leading into the Dome, a new stove fitted to the Library in place of the gas stove, and Fletcher's hot water heaters placed in both East and West Rooms for use in verification operations.

The West Room, Library, and Superintendent's rooms have been painted and ceilings whitened.

Prepared photographic paper has been procured and supplied to the Observatories at Aberdeen, Batavia, Colába, Falmouth, Lisbon, Toronto, Oxford, Mauritius, St. Petersburg, and Stonyhurst, as well as to the Meteorological Office for Valencia and Fort William.

Anemograph sheets have been sent to Mauritius and Madras, and blank forms for entry of observations, &c., distributed to various applicants.

*Library.*—During the year the library has received as presents the publications of—

- 25 Scientific Societies and Institutions of Great Britain and Ireland, and
- 118 Foreign and Colonial Scientific Establishments, as well as of numerous private individuals;

The Librarian is still engaged in the preparation of a card catalogue of the library, on the model of that of the Meteorological Office, and has now completed over 1,400 cards, which contain the titles, &c., of all works received by the Committee during the past eight years, together with those of a like title which had been received previously.

The publications not yet catalogued formed part of Sir E. Sabine's Magnetic Office collection, and are chiefly excerpts from foreign publications and reports.

*Workshop.*—The machine tools procured for the use of the Kew Observatory by grants from the Government Grant Fund or the Donation Fund have been duly kept in order.

#### PERSONAL ESTABLISHMENT.

The staff employed is as follows:—

G. M. Whipple, B.Sc., Superintendent.  
 T. W. Baker, Chief Assistant.  
 H. McLaughlin, Librarian.  
 E. G. Constable, Observations and Rating.  
 W. Hugo, Verification Department.  
 J. Foster           "           "  
 T. Gunter           "           "  
 W. J. Boxall, and seven other Assistants.

(Signed)

FRANCIS GALTON,  
*Chairman of the Kew Committee.*

*November 29th, 1890.*

Dr. RECEIPTS.

To Balance from 1888-89 .....	£	s.	d.
Royal Society (Gasnot Trust) .....	562	5	11
Meteorological Office (Allowance) .....	487	10	0
Experimental Work .....	400	0	0
Verifications .....	21	7	6
Rating of Watches and Chronometers .....	1158	13	5
Commissions for Colonial and Foreign Institutions .....	438	10	8
Miscellaneous—Times' Diagrams and Standard Thermometers .....	351	5	6
Meteorological Office for Postages and Portrages .....	45	0	0
	2	15	7

£3467 8 7

November 15, 1890.

Examined and compared with Balance Sheet, and found correct.

(Signed) ETTBICK W. CREAK, Auditor.

ESTIMATED ASSETS.

Balance as per Statement .....	£	s.	d.
Payments:—	659	2	10
Meteorological Office Allowance, Experimental, &c. ...	91	16	7
Verification and Rating Fees .....	187	1	4
Commissions .....	46	12	0
	325	9	11

Stock:—

Photographic Paper .....	2	10	0
Blank Magnetic Forms and Certificates .....	43	16	0
Standard Thermometers .....	90	10	6
	135	16	6

£1121 9 3

November 15, 1890.

(Signed) G. M. WHIPPLE, Superintendent.

PAYMENTS.

By Magnetic Observations, including estimated proportion of Working Expenses .....	£	s.	d.
Meteorological Observations, including estimated proportion of Working Expenses .....	190	3	6
Solar Observations, including estimated proportion of Working Expenses .....	298	0	5
Experimental work, including estimated proportion of Working Expenses .....	74	16	11
Verifications, including estimated proportion of Working Expenses ..	144	16	0
Rating of Watches &c. ....	1042	16	4
Commissions for Colonial and Foreign Institutions .....	355	9	8
Alterations, Repairs, &c., of Building .....	307	3	6
Miscellaneous:—	50	4	0
General Maintenance, Library, Office Work; Care, Lighting, and Heating .....	319	7	10
Exhibition, 'Times' Diagrams, &c., Pendulum .....	21	10	8
Meteorological Office for Postages and Portrages .....	3	16	11
Balances—Bank of England .....	574	12	8
London and County Bank .....	71	13	9
Cash in hand .....	12	16	5
	659	2	10

£3467 8 7

ESTIMATED LIABILITIES.

To Gas, Instruments, Experimental, and Contingencies .....	£	s.	d.
Rating and Verifications .....	19	16	8
Pendulum Account—Unspent Balance .....	3	12	0
Commissions .....	120	14	4
	31	14	0
General Balance .....	945	12	3

£1121 9 3





## APPENDIX II.

List of Instruments, Apparatus, &c., the Property of the Kew Committee, at the present date out of the custody of the Superintendent, on Loan.

To whom lent.	Articles.	Date of loan.
G. J. Symons, F.R.S.	Portable Transit Instrument . . . . .	1869
The Science and Art Department, South Kensington.	The articles specified in the list in the Annual Report for 1876, with the exception of the Photo-Heliograph, Pendulum Apparatus, Dip-Circle, Unifilar, and Hodgkinson's Actinometer.	1876
Lieutenant A. Gordon, R.N.	Unifilar Magnetometer by Jones, No. 102, complete, with three Magnets and Deflection Bar. Dip-Circle, by Barrow, one Pair of Needles, and Magnetizing Bars. One Bifilar Magnetometer. One Declinometer. Two Tripod Stands.	1883
Professor W. Grylls Adams, F.R.S.	Unifilar Magnetometer, by Jones, No. 101, complete. Pair 9-inch Dip-Needles with Bar Magnets . . .	1883 1887
Professor O. J. Lodge, F.R.S.	Unifilar Magnetometer, by Jones, No. 106, complete. Barrow Dip-Circle, No. 23, with two Needles, and Magnetizing Bars. Tripod Stand.	1883
Captain W. de W. Abney, F.R.S.	Mason's Hygrometer, by Jones . . . . .	1885
Prof. T. E. Thorpe, F.R.S.	Tripod Stand . . . . .	1886
Lord Rayleigh, F.R.S.	Standard Barometer (Adie, No. 655) . . . . .	1885