PROCEEDINGS OF

THE ROYAL SOCIETY.

VOL. LI. No. 309.

CONTENTS.

Price Three Shillings

JUNE 25, 1892.

Report of the Kew Committee for the Fourteen Months ending December 31, 1891.

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.	The Earl of Rosse, K.P.
Prof. W. G. Adams.	Prof. A. W. Rücker.
Staff-Commander E. W. Creak, R.N.	Mr. R. H. Scott.
Prof. G. C. Foster.	Lieutenant-General R. Strachey, C.S.I.
Admiral Sir G. H. Richards, K.C.B.	General J. T. Walker, C.B.
	Captain W. J. L. Wharton, R.N.

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.

The magnetographs have worked satisfactorily all through since last report. The curves obtained, representing Declination, Horizontal Force, and Vertical Force, have shown a marked increased activity in terrestrial magnetic changes as compared with the preceding year, although no very large disturbances have been registered.

The principal movements occurred on the following dates, viz.:—

March 2—3, and 31, April 8 and 12, May 14, 15, and 16, June 14, September 9—12, October 24, November 20—21, and December 7.

In accordance with the usual practice, determinations of the scale values of all the instruments were made in January last, and the ordinates for the different photographic curves were then found to be as follows:—

Declinometer: 1 inch = 0° 22′·04. 1 cm. = 0° 8′·7.

Bifilar, January 7, 1891, for 1 inch $\delta H = 0{\cdot}0277$ foot grain unit.
„ 1 cm. „ = 0·00050 C.G.S. unit.

Balance, January 8, 1891, for 1 inch $\delta V = 0{\cdot}0275$ foot grain unit.
„ 1 cm. „ = 0·00050 C.G.S. unit.

The following are the principal results of the Magnetic Elements for the years 1890 and 1891:—

Mean Westerly Declination..	1890 ..	17° 50′·6	
„ „ ..	1891 ..	17 41·9	
Mean Horizontal Force.....	1890 ..	0·18173	C.G.S. unit.
„ „	1891 ..	0·18193	„
Mean Dip.....	1890 ..	67° 32′·5	
„	1891 ..	31·2	
Mean Vertical Force.....	1891 ..	0·43962	C.G.S. unit.

Additional observations of the Horizontal Force, Inclination, and Declination have been made each month with the absolute instruments for the purpose of determining with greater precision the zero values of the magnetograph curves.

Information on matters relating to terrestrial magnetism and various data have been supplied to Professors Thorpe and Rücker, Dr. Van Rijckevorsel, Captain Schück, and Professor Stroud.

In January the Kew 9-inch unifilar, by Jones, was sent to Messrs. Elliot Brothers for cleaning, and, at the same time, certain alterations were introduced in order to modernise the instrument. Unfortunately, the heavy brass telescope support was found on examination to be slightly magnetic, and it was therefore discarded, and, on February 12, the magnetometer was restored to its original state, with the exception of a brass tie-piece, which, being found non-magnetic, was retained until the end of the year.

On closely discussing the Declination observations of the preceding years it was found that observations given with the old collimator magnet N.E. were more subject to a variable torsion effect than were those of the collimator marked K.O. 90. The two having been employed in conjunction for one year, it was decided, with the commencement of 1891, to discard altogether the use of the old heavy magnet for the purpose of observing Declination.

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, with the exception of the wet-bulb thermograph.

The readings of the last-named instrument during the winter of 1890–91 became irregular, and it was found to vary considerably from its accompanying standard. It was accordingly decided to dismount the thermometer and to replace it by a new tube, which was done in July last. On examination, the bulb showed the existence of a crack, which eventually extended completely around it.

The scale value of the new tube has been determined by means of nearly 300 comparative readings, and new glass and ivory tabulating scales for it have been constructed at the Meteorological Office.

For controlling these values, an experimental determination of the zero of the instrument was made by means of melting ice.

Experiments were made, unsuccessfully, to use a Richard pen with the Beckley rain gauge, but a BBB black-lead pencil was found to be more reliable in its indications than such a pen.

The standard eye observations for the control of the automatic records have been duly registered.

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, as usual, 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.

Atmospheric Electricity.—The electrograph has been maintained in action during the greater portion of the year. The records were, however, lost for forty-eight days on account of the freezing of the water-jet during frost in winter.

The instrument has failed in sensibility during the last year owing to the large extent of diminution which the 60-cell chloride of silver battery has experienced in its charge, the potential of which has apparently diminished by one-half.

This having been reported to the Meteorological Council, it was decided by them to request Professor J. J. Thomson to examine into the subject of the measurement of Atmospheric Electricity, and, meanwhile, to continue the instrument in action in its present condition.

III. Solar Observations.

Sun-spots.—Sketches of Sun-spots have been made on 170 days, and the groups numbered after Schwabe's method.

Time Signals.—These have been received from Greenwich through the G.P.O. with regularity since last report, with the following exceptions:—

On six occasions, viz., March 10; May 30; August 18, 19, and 27; and September 11, no signal was received either at 10 A.M. or 1 P.M. On January 14 and February 4 it arrived two seconds late, and on October 8, 9, and 10 it did not record itself on the chronograph, but was only observed by the galvanometer.

Transit Observation.—Occasional solar and sidereal transits have been observed as checks upon the Greenwich signalled times.

Violle's Actinometer.—The copies of the observations made during 1890 were duly forwarded to the Meteorological Office in January, and, as the Committee understand, have been handed over by that Office to Mr. H. F. Blanford, who will report on the subject to the Solar Physics Committee.

IV. Experimental Work.

The Committee have had under trial on the roof of the Observatory two new forms of wind registering instruments, the anemo-cinemograph of MM. Richard Frères, of Paris, and the sight-indicating velocity meter by Munro, of London.

The first-named instrument is an improved form of the old windmill vanes anemometer which was used by Smeaton after Rouse and Robins, but is best known as Whewell's. The anemo-cinemograph is similar to that which was employed on the top of the Eiffel Tower at Paris, and the vanes, by running constantly against a train of clockwork, record directly on a sheet of paper the velocity of motion of the wind at any time. Continuous records were obtained for six months, and the result given would seem to show that the indications of the Kew Beckley anemograph are in excess of those given by the new instrument. These are 20 per cent. less than those of the anemograph with winds blowing at 40 miles or upwards per hour, and 12 per cent. less with light winds which blow at from 6 to 10 miles

per hour. A reduction of the Robinson factor from 3 to 2·5 would serve to render the readings of the two instruments more nearly comparable.

As the Richard instrument is designed to record the velocity of the wind in gusts as well as the total run during any definite interval, no detailed comparisons with the Robinson indications are possible; but it may be noted that during the period the cinemograph was under observation gusts of 45 and 43 miles per hour were recorded, whilst simultaneous curve readings of the Robinson gave hourly rates of 55 and 52 miles for quarter of an hour intervals.

The Munro sight-indicating anemometer is a sensitive Robinson cup arrangement, which drives by means of a small centrifugal pump a column of oil up a glass tube. Its height above a fixed zero mark, as shown on a divided porcelain scale at the side, indicates the velocity of rotation of the cups when converted into miles per hour of wind movement. The divisions of the scale have been laid down in accordance with Mr. Dines' experimental deduction. When the instrument was originally set up, it was found incapable of recording a velocity of more than 40 miles per hour, but, during a gale in November, velocities were attained during several gusts of over 70 miles per hour, and accordingly Mr. Munro has found it desirable to change the gearing of the pump so as to enable the higher values to be indicated. The comparisons with the new gearing are not sufficient in number to furnish results suitable for quotation at the present time, but they appear to show, during gusts, rates fully 20 per cent. higher than the cinemograph gives.

The instrument as fitted at present fails to work during frost, owing to congelation of the oil employed.

Dr. E. Van Rijckevorsel, of Rotterdam, visited the Observatory in July for the purpose of making simultaneous magnetic observations with the Kew, his own, and the Utrecht unifilar magnetometers, and of comparing the results with those he had recently made with the magnetometers in use at the Observatories at Parc St. Maur, Wilhelmshafen, and Utrecht.

Professor Rücker has also been investigating the differences found to exist in similar simultaneous readings of his three unifilars; and his assistants, Messrs. Gray and Watson, have visited Kew on numerous occasions in order to make the necessary observations.

Cloud Photographs.—The operations with the cloud cameras have been conducted during the past year solely according to the simplified method of zenith observation, as described in last year's report, and results were obtained on 24 days. A joint paper by General Strachey and the Superintendent, describing the plan of working, was read before the Royal Society in June, and was fully illustrated by photographs shown in the optical lantern. A report, giving a detailed

account of the year's work, was forwarded to the Meteorological Council in November last.

Particulars, with specimens of cloud pictures, were also supplied to Mr. Rotch, of the Blue Hill Observatory, for communication to the Committee of the International Meteorological Conference at Munich.

Experiments were also made with several new lenses kindly lent by Mr. Dallmeyer, in order to select one suitable for giving pictures covering a wider field of view than the R.R. lens hitherto employed, which confines the observer to clouds within 15° of the zenith.

The results of these experiments, as well as others with Eastmann films used instead of glass plates, have been communicated to the Meteorological Council.

In compliance with the request forwarded by Mr. Clayden, secretary to the British Association Committee on Meteorological Photography, for copies of photographs illustrating meteorological phenomena, or their effects, the Committee forwarded a selection of duplicate cloud and other photographs to be added to the collection which has been formed.

V. Verification of Instruments.

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

1 Unifilar magnetometer for the Royal Observatory, Greenwich.
1 Ditto, ditto for the Vatican Observatory, Rome.
1 Ditto, ditto for the Meteorological Department, Brazil.
1 Inclinometer, ditto, ditto.
1 Ditto has been repaired for the Hague.
1 Electrical anemometer for the Observatory, Mauritius.
1 Marine chronometer for the Colába Observatory, Bombay.
1 Richard aneroid, and set of thermometers, for the Richmond Terrace Gardens Committee.
1 Telescope.
1 Set of magnetograph needles for Mauritius Observatory.
1 Ditto dip needles and bar magnets for the Hague.

The total number of other instruments compared between November 1, 1890, and December 31, 1891, was as follows:—

Air-meters	7
Anemometers	19
Aneroids	72
Artificial horizons	10
Carried forward	108

Brought forward	108
Barometers, Marine	111
,, Standard	57
,, Station	39
Binoculars	470
Compasses	22
Hydrometers	224
Inclinometers	3
Photographic Lenses	19
Magnets	2
Navy Telescopes	374
Rain Gauges	17
Rain Measures	39
Sextants	428
,, Shades	7
Sunshine Recorders	1
Theodolites	5
Thermometers, Arctic	133
,, Avitreous or Immisch's	231
,, Chemical	108
,, Clinical	15,692
,, Deep sea	58
,, Meteorological	2,289
,, Mountain	26
,, Solar radiation	1
,, Standards	62
Unifilars	3
Total	20,529

Duplicate copies of corrections have been supplied in 52 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	57
,, ordinary meteorological	27
Various	132

10 Standard Thermometers have also been calibrated, and supplied to 4 applicants during the year; 6 are placed in stock.

There are at present in the Observatory undergoing verification, 9 Barometers, 452 Thermometers, 2 Hydrometers, 23 Sextants, and 15 Telescopes.

Sextant Testing.—The apparatus, consisting of two Mawson and

Swan's glow lamps, lighted by electricity derived from one of Pitkin's storage batteries, has been successfully employed in testing the dark shades of sextants, when requisite, during the past year. It has been found necessary to replace the lamps in two instances; but the initial charge of the battery has proved capable of working them throughout the whole twelvemonths without replenishing.

Telescope Testing.—A second test plate has been procured, and mounted on a portable frame, with a reflector, in order to enable the examination of telescopes to be prosecuted from the optical room as well as from the lawn. A detailed form of certificate has been prepared and issued with telescopes and binoculars examined for the general public.

6 Look-out telescopes have been examined and certified for the Brethren of the Trinity House.

Normal Thermometers.—M. Benoit, the Director of the Conservatoire des Poids et Mesures, Paris, having completed his examination of the three standard thermometers, and submitted his report upon them to the Committee, who have placed it in the hands of Professor Rücker for discussion, proceeded to examine the low-range alcohol thermometer which accompanied them. Whilst conducting this operation, M. Carpenter, the observer, was so unfortunate as to break the tube. M. Benoit, having strongly advised that further comparisons at low temperatures should be made by means of thermometers filled with toluene instead of with alcohol, has been requested by the Committee to order such an instrument of M. Tonnelot, the maker, and compare it with the Sèvres standards before its delivery in England. The mercurial standards were safely returned to the custody of the Observatory by M. Carpenter in May last.

VI. Rating of Watches.

During the fourteen months 709 entries of watches for rating were made. They were sent for testing in the following classes:—

For class A, 468; class B, 153; and class C, 86; subsidiary trial, 2

Of these 161 failed to gain any award; 49 passed with C, 140 with B, 327 with A certificates, and 29 of the latter obtained the highest, class A *especially good.*

In the Appendix will be found statements giving the results of trial of the 29 watches which obtained the highest numbers of marks during the year, the highest position being attained by Messrs. Stauffer, Son, and Co., London. This watch was a keyless tourbillon chronometer, with going barrel, which obtained the very excellent total 91·6 of marks out of a possible 100.

Marine Chronometers.—Certificates showing the mean daily rate

and the variations of rate at three different temperatures have been awarded to 18 marine chronometers after undergoing the 35 days' trial.

The Committee having had their attention drawn to the limited nature of their trials for first-class marine chronometers, decided to establish a second and more rigorous trial for these instruments, and have now organised two classes, which are as follows:—

Class A trial, extending over 55 days, comprising runs at temperatures of 45°, 70°, 95° Faht.; and Class B trials, which last for 35 days, and include readings at temperatures of 55°, 70°, and 85° Faht. only. For Class A tests, the individual runs are 10 days at each temperature; whilst for Class B tests, they are only 7 days each in duration.

The Committee have drawn up a special circular addressed to the directors of steamship companies, calling attention to rating chronometers, and have distributed it to the managers of all the principal companies of vessels sailing from British ports.

As the question of the rate of a chronometer under varying temperatures is intimately related to the behaviour of the lubricating material employed, when heated, the Committee asked Professor T. Thorpe, F.R.S., to favour them with his opinion as to the temperature to which a chronometer may be subjected to without producing a deleterious effect upon its oil.

Non-Magnetic Watches.—Owing to the extension of the use of electrical dynamometers, a class of watches provided with springs and balances of palladium or some alloy, and termed non-magnetic watches, has been brought into more general use; and the Committee have been requested to certify as to the extent in which they may be employed in the vicinity of dynamos without deterioration of their time-keeping properties.

Professor Rücker kindly undertook to arrange to conduct a series of experiments with the dynamos at South Kensington, and two students of the Royal College of Science, Messrs. Edser and Stansfield, have already submitted a preliminary report to the Committee upon the nature and extent of the influence in the magnetic field in the neighbourhood of a dynamo. The experiments are still in progress.

VII. Miscellaneous.

Lens Testing.—In the preliminary operations necessary to conduct the satisfactory examination of photographic lenses, Major L. Darwin, late R.E., has been associated with Captain Abney, and, in accordance with his suggestions, a special camera, capable of working with lenses of 4 inches aperture and 30 inches focal length, has been constructed by Mr. Meagher, and fitted up at the Observatory. A

photometer, on Abney's principle, 13 feet long, has also been fitted for use in the testing operations.

A detailed account of the apparatus and methods employed is in course of preparation by Major Darwin for publication. Meanwhile circulars, respecting the proposed scheme of examination and preliminary certificates, have been printed, and 200 distributed amongst the leading opticians, manufacturers, and secretaries of all the best known photographic societies, both at home and abroad, to call their attention to the intended plan of examination.

A fire- and burglar-proof safe has been purchased and fitted up for the reception and safe custody of the lenses.

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

Other photographic material supplied to Observatories includes developing dishes for Colába and Oxford, as well as a camera and requisite fittings for cloud and lightning photography for Mauritius.

Anemograph sheets have been sent to Coimbra, Hong Kong, and Mauritius, and blank forms for entry of magnetic observations to Padre Denza and Professor Rücker.

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

44 Scientific Societies and Institutions of Great Britain and Ireland, and

114 Foreign and Colonial Scientific Establishments, as well as of numerous private individuals.

House, Enclosure, &c.—A new stove has been obtained, and fitted up in the clinical testing office to replace the one previously fitted, now worn out.

Stone blocks have been laid down on the surface of the lawn, to ensure the erection of the tripods for supporting magnetometers used for occasional observation, approximately in the proper meridian.

The roofs of the Magnetic Observatory, and of the Experimental House have been newly covered with felt, and freshly tarred.

With the view of the protection of the building against fire, and also for sanitary purposes, the Committee have made application to H.M. Office of Works and Public Buildings to have the Observatory connected with the water mains of the Corporation of Richmond, but, owing to the expense of laying down the necessary pipe, the Office has as yet been unwilling to accede to the Committee's request; nor have H.M. Commissioners provided a gas engine for pumping from the wells, capable of furnishing a sufficient quantity of water from the local springs, which they have suggested as an equivalent.

The Committee have also represented to the Office of Woods and Forests, the inconvenience to which they are at present subjected by the greatly increased cattle traffic through the existing entrance to the Old Deer Park, since the change of tenants of the park; H.M. Commissioners have for some time had under consideration the provision of a new entrance to the road leading to the Observatory, which shall avoid the passage through the two unfenced cattle lairs, at Clarence Street, Richmond, with their attendant inconvenience and danger; but no change has, up to the present, been made.

In order to provide additional space for the accommodation of the growing work at the Observatory, the Committee have obtained plans from H.M. Office of Works for the erection of two rooms on the roof of the thermometer testing room in the present west wing. They propose to proceed with building operations during next summer.

The Librarian is still engaged in the preparation of a card catalogue of the library, and has now completed over 1,700 cards, which contain the titles, &c., of all works received by the Committee during the past nine 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.

Mr. T. Fuller, the former lessee of the Old Deer Park, having resigned his tenancy, the Committee have addressed the First Commissioner of Woods and Forests, and he has decided that in future the land attached to the Observatory shall be let direct from the Crown to the Committee, without the intervention of the park tenant.

Exhibition of Instruments.—Several instruments were shown by the Committee at the twelfth annual exhibition of the Royal Meteorological Society, which was composed of Rain Gauges, Evaporation Gauges, &c.

Registration of the Committee under the Companies Act.—The Committee have come to the conclusion that it would be of advantage to them, in the transaction of their business, to obtain registration under Section 23 of the Companies Act, 1867; and they have obtained the sanction of the President and Council to their making application to the Board of Trade for this purpose. The matter is still under consideration.

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 nine other Assistants.

(Signed) FRANCIS GALTON,
March 11th, 1892. *Chairman.*

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
Mr. J. E. Cullum ...	Altazimuth Instrument, by Robinson, C. 42 ..	1891
Mr. C. Eldridge	Chain Anemometer	1890

Kew Observatory. Account of Receipts and Payments for the fourteen months ending December 31st, 1891.

Dr. **RECEIPTS.**

	£	s.	d.	£	s.	d.
To Balance from Year 1889-90				659	2	10
Royal Society (Gassiot Trust)				487	10	0
Meteorological Council:—						
Allowance				400	0	0
Postages, &c.				6	14	4
Researches				106	13	7
Tests:—						
Verifications	1153	14	11			
Rating	475	2	10			
				1628	17	9
Commissions executed for Colonial and Foreign Institutions, &c.				623	4	8
				£3912	3	2

Cr. **PAYMENTS.**

	£	s.	d.	£	s.	d.
By Administration:—						
Superintendent	466	13	4			
Salaries	245	19	6			
Rent, Fuel, and Lighting	61	0	8			
Attendance and cleaning of Building, Repairs, Insurance, Porterages, &c.	229	9	11			
Furniture and Fittings	8	13	3			
				1011	16	8
Normal Observatory:—						
Salaries—Observations, Tabulations, &c.	331	9	6			
Incidental Expenses—Instruments, Postages, &c.	50	19	0			
				382	8	6
Researches:—						
Salaries—Observations, Reductions, &c.	260	7	0			
Incidental Expenses—Instruments, Postages, &c.	28	3	8			
				288	10	8
Tests:—						
Salaries	1035	6	2			
Incidental Expenses—Instruments, Porterages, Printing, &c.	265	12	2			
				1300	18	4
Commissions executed for Colonial and Foreign Institutions, &c.				548	2	2
Cash in Bank of England	£290	1	1			
Cheque outstanding	5	5	0			
Balance:—						
Cash at Bank of England	284	16	1			
,, London and County Bank	80	3	0			
,, Observatory	15	7	9			
				380	6	10
				£3912	3	2

February 4, 1892. Examined and compared with the vouchers, and found correct. (Signed) ROBERT H. SCOTT, *Auditor.*

ESTIMATED ASSETS.

	£	s.	d.	£	s.	d.
By Balance as per Statement				380	6	10
Payments:—						
Meteorological Council—Allowance, Postage, &c.	103	3	11			
Test Fees	367	15	0			
Commissions	14	0	0			
				484	18	11
Stock:—						
Blank Forms and Certificates	44	10	10			
Standard Thermometers	89	0	0			
				133	10	10
				£998	16	7

February 10, 1892.

ESTIMATED LIABILITIES.

	£	s.	d.
To Administration accounts—Gas, Repairs, and Contingencies	40	18	6
Observatory accounts—A.G.B. Paper, Chemicals, &c.	6	11	7
Tests accounts—Fittings, Printing, Stationery, &c.	45	16	10
Unspent Balance of Pendulum Account	117	1	7
Commissions	32	15	3
General Balance	755	12	10
	£998	16	7

(Signed) G. M. WHIPPLE,
Superintendent.

Comparison of Net Expenditure for the 14 months ending December 1890, and for the same period ending December 1891.

Net expenditure.	1889—1890.	1890—1891.	Increase.	Decrease.
Administration—	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Superintendent.....	466 13 4	466 13 4		
Office.....	244 12 9	245 19 6	1 6 9	
Rent, fuel, and lighting.....	74 4 1	61 0 8	..	13 3 5
Alterations to premises, attendance and contingencies.....	306 8 3	238 3 2	..	68 5 1
Normal Observatory—				
Salaries.....	320 8 7	331 9 6	11 0 11	
Incidental expenses..	34 6 1	50 19 0	16 12 11	
Researches—				
Salaries.....	233 9 9	260 7 0	26 17 3	
Incidental expenses..	42 4 10	28 3 8	..	14 1 2
Tests—				
Salaries.....	1,031 1 8	1,035 6 2	4 4 6	
Incidental expenses..	167 18 3	265 12 2	97 13 11	
			157 16 3	95 9 8
			95 9 8	
	2,921 7 7	2,983 14 2	62 6 7	

APPENDIX I.

MAGNETICAL OBSERVATIONS,

Made at the Kew Observatory, Richmond, Lat. 51° 28′ 6″ N. and Long. $0^h\ 1^m\ 15^s{\cdot}1$ W., height 34 feet above mean sea-level, for the year 1891.

The results given in the following tables are deduced from the magnetograph curves which have been standardised by observations of deflection and vibration. These were made with the Collimator Magnet K.C. I. and the Declinometer Magnet marked K.O. 90 in the 9-inch Unifilar Magnetometer by Jones.

The Inclination was observed with the Inclinometer by Barrow, No. 33, and needles 1 and 2, which are $3\frac{1}{2}$ inches in length.

The Declination and Force values given in Tables I to VIII are prepared in accordance with the suggestions made in the fifth report of the Committee of the British Association on comparing and reducing Magnetic Observations.

The following is a list of the days during the year 1891 which were selected by the Astronomer Royal, as suitable for the determination of the magnetic diurnal variations, and which have been employed in the preparation of the magnetic tables.

January	4, 6, 27, 30, 31.
February	4, 8, 18, 21, 22.
March	8, 11, 19, 20, 29.
April.....	5, 15, 19, 25, 30.
May	1, 8, 21, 25, 31.
June	1, 9, 17, 22, 30.
July	2, 8, 12, 26, 31.
August.....	5, 10, 18, 22, 27.
September	5, 6, 18, 19, 25.
October.....	6, 15, 16, 17, 22.
November.....	2, 8, 12, 19, 30.
December.....	3, 6, 18, 26, 29.

Table I.—Hourly Means of Declination at the Kew Observatory, Richmond, as Month during (17° + West).

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Winter.												
1891. Months.	′	′	′	′	′	′	′	′	′	′	′	′
Jan. ..	44·9	45·1	45·5	45·8	45·7	45·4	45·1	44·7	44·5	44·2	45·6	46·7
Feb. ..	44·4	43·8	43·6	43·9	44·0	44·1	43·7	43·6	43·6	43·7	44·7	46·1
March .	42·8	42·8	43·2	43·2	42·7	42·6	42·2	41·5	40·4	41·4	43·2	46·2
Oct. ..	39·2	39·2	39·2	39·9	39·4	39·3	39·1	38·1	36·7	36·6	38·1	41·5
Nov. ..	39·2	40·2	39·9	40·2	40·4	40·3	40·3	39·9	39·2	39·3	40·3	43·0
Dec. ..	39·5	40·1	40·3	40·6	40·8	40·6	40·2	40·1	39·8	39·6	40·7	42·1
Mean	41·7	41·9	42·0	42·3	42·2	42·1	41·8	41·3	40·7	40·8	42·1	44·3
Summer.												
	′	′	′	′	′	′	′	′	′	′	′	′
April..	42·5	42·1	42·0	41·9	41·3	41·3	40·9	39·6	38·9	40·2	42·2	44·9
May ..	40·4	39·4	39·1	39·4	38·7	37·8	37·1	36·8	37·3	39·1	42·2	45·4
June ..	40·8	40·5	40·4	40·3	39·7	38·7	37·5	36·4	36·5	37·6	40·2	42·9
July ..	39·7	39·6	39·6	39·4	38·6	36·8	36·1	35·9	35·7	36·1	38·4	41·2
Aug. ..	39·3	39·1	38·8	38·3	38·4	37·7	36·9	36·1	36·4	37·8	40·5	43·6
Sept. ..	39·5	39·5	39·1	38·7	38·1	38·0	37·5	36·8	36·6	38·1	41·3	44·9
Mean.	40·4	40·0	39·8	39·7	39·1	38·4	37·7	36·9	36·9	38·2	40·8	43·8

Table II.—Solar Diurnal Range of the Kew

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Summer Mean.												
	′	′	′	′	′	′	′	′	′	′	′	′
	−0·7	−1·1	−1·3	−1·4	−2·0	−2·7	−3·4	−4·2	−4·2	−2·9	−0·3	+2·7
Winter Mean.												
	′	′	′	′	′	′	′	′	′	′	′	′
	−1·1	−0·9	−0·8	−0·5	−0·6	−0·7	−1·0	−1·5	−2·1	−2·0	−0·7	+1·5
Annual Mean.												
	′	′	′	′	′	′	′	′	′	′	′	′
	−0·9	−1·0	−1·1	−1·0	−1·3	−1·7	−2·2	−2·9	−3·2	−2·5	−0·5	+2·1

NOTE.—When the sign is + the magnet

determined from the Magnetograph Curves on Five selected quiet Days in each the Year 1891.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
					Winter.							
′	′	′	′	′	′	′	′	′	′	′	′	′
47·9	48·4	47·7	46·6	46·3	46·0	45·8	45·7	45·5	45·1	44·7	44·7	44·9
47·5	47·7	47·4	46·6	45·6	45·3	45·3	44·9	44·7	44·7	44·2	44·1	44·4
48·5	49·3	48·7	47·6	44·9	43·7	43·4	43·2	43·5	43·2	42·8	42·8	42·8
44·5	45·9	45·2	43·6	41·8	41·2	40·6	39·9	39·5	39·4	39·1	39·1	39·2
45·0	45·8	45·3	44·2	42·8	41·7	41·4	41·1	40·5	40·1	39·5	39·6	39·2
42·5	43·0	43·2	42·5	42·3	41·1	40·6	40·1	39·9	39·2	39·1	39·2	39·5
46·0	46·7	46·3	45·2	44·0	43·2	42·9	42·5	42·3	42·0	41·6	41·6	41·7
					Summer.							
′	′	′	′	′	′	′	′	′	′	′	′	′
47·1	48·2	47·0	45·6	44·1	43·1	42·6	41·7	42·3	42·6	42·3	42·4	42·5
47·6	48·4	47·3	45·6	43·1	41·9	41·0	40·8	40·3	40·9	40·9	41·2	40·4
45·6	46·8	46·8	45·8	43·8	42·5	41·3	41·2	41·5	41·6	41·6	41·3	40·8
44·0	46·1	46·6	45·7	43·6	41·7	40·3	39·6	39·8	39·7	39·8	39·9	39·7
46·1	46·4	45·7	44·1	41·8	40·2	39·3	39·6	40·0	39·9	39·4	39·2	39·3
46·8	46·8	45·5	43·4	41·7	40·8	40·0	39·9	40·0	40·1	40·0	39·8	39·5
46·2	47·1	46·5	45·0	43·0	41·7	40·8	40·5	40·6	40·8	40·7	40·6	40·4

Declination as derived from Table I.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
					Summer Mean.							
′	′	′	′	′	′	′	′	′	′	′	′	′
+5·1	+6·0	+5·4	+3·9	+1·9	+0·6	−0·3	−0·6	−0·5	−0·3	−0·4	−0·5	−0·7
					Winter Mean.							
′	′	′	′	′	′	′	′	′	′	′	′	′
+3·2	+3·9	+3·5	+2·4	+1·2	+0·4	+0·1	−0·3	−0·5	−0·8	−1·2	−1·2	−1·1
					Annual Mean.							
′	′	′	′	′	′	′	′	′	′	′	′	′
+4·2	+5·0	+4·5	+3·2	+1·6	+0·5	−0·1	−0·4	−0·5	−0·6	−0·8	−0·9	−0·9

points to the west of its mean position.

Table III.—Hourly Means of the Horizontal Force at the Kew Observatory, Temperature) on Five selected quiet

0·18000 + (C.G.S. units).

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
						Winter.						
1891. Months.												
Jan. ..	184	182	183	185	188	189	189	190	187	180	178	174
Feb. ..	187	187	185	186	186	188	190	192	189	183	179	176
March .	192	190	189	188	189	190	190	187	179	175	168	172
Oct. ..	206	201	200	202	201	202	203	201	195	182	171	170
Nov. ..	190	189	189	190	192	192	194	190	185	175	166	168
Dec. ..	199	202	203	204	205	207	210	212	210	205	200	197
Mean.	193	192	192	193	194	195	196	195	191	183	177	176
						Summer.						
April ..	196	195	193	194	191	190	190	187	179	173	168	169
May ..	200	195	194	194	191	188	185	180	175	169	169	175
June ..	201	199	198	198	199	196	191	185	178	171	170	170
July ..	202	204	202	201	199	198	194	189	183	175	171	174
Aug. ..	212	209	206	208	208	204	201	195	184	177	173	182
Sept. ..	204	200	200	197	197	196	193	186	177	169	164	170
Mean ..	203	200	199	199	198	195	192	187	179	172	169	173

(C.G.S. units.)

Table IV.—Diurnal Range of the Kew

Hours.	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
						Summer mean.						
	+ ·00008	+ ·00005	+ ·00004	+ ·00004	+ ·00003	·00000	− ·00003	− ·00008	− ·00016	− ·00023	− ·00026	− ·00022
						Winter mean.						
	+ ·00003	+ ·00002	+ ·00002	+ ·00003	+ ·00004	+ ·00005	+ ·00006	+ ·00005	+ ·00001	− ·00007	− ·00013	− ·00014
						Annual mean.						
	+ ·00005	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00002	+ ·00001	− ·00002	− ·00007	− 00015	− ·00019	− ·00018

Note.—When the sign is + the

Richmond, as determined from the Magnetograph Curves (corrected for Days in each Month during the Year 1891.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
Winter.												
174	179	184	186	186	188	189	186	185	184	184	183	184
177	179	185	187	186	186	185	186	187	188	187	186	187
176	183	186	190	187	187	188	193	192	193	192	192	192
174	184	192	195	198	202	205	206	209	208	207	207	206
171	173	177	184	186	188	189	194	196	191	191	191	190
197	200	201	202	200	203	206	207	205	203	204	201	199
178	183	188	191	191	192	194	195	196	195	194	193	193
Summer.												
174	180	185	190	192	193	196	196	197	197	196	198	196
181	187	192	199	202	205	208	208	205	205	204	201	200
179	186	193	200	204	209	211	211	208	205	202	203	201
179	190	196	204	209	213	213	212	209	206	204	203	202
191	200	205	210	212	216	218	219	218	218	214	214	212
184	193	199	197	196	198	199	206	205	204	203	203	204
181	189	195	200	203	206	208	209	207	206	204	204	203

Horizontal Force as deduced from Table III.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
Summer mean.												
− ·00014	− ·00006	·00000	+ ·00005	+ ·00008	+ ·00011	+ ·00013	+ ·00014	+ ·00012	+ ·00011	+ ·00009	+ ·00009	+ ·00008
Winter mean.												
− ·00012	− ·00007	− ·00002	+ ·00001	+ ·00001	+ ·00002	+ ·00004	+ ·00005	+ ·00006	+ ·00005	+ ·00004	+ ·00003	+ ·00003
Annual mean.												
− ·00013	− ·00006	− ·00001	+ ·00003	+ ·00004	+ ·00006	+ ·00008	+ ·00010	+ ·00009	+ ·00008	+ ·00006	+ ·00006	+ ·00005

reading is above the mean.

Table V.—Hourly Means of the Vertical Force (corrected for Temperature) at the the Five selected quiet Days in each

0·43000 + (C.G.S. units).

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
					Winter.							
1891. Months.												
Jan. ..	958	967	967	968	967	967	968	967	966	966	967	966
Feb. ..	961	959	959	959	959	959	959	960	960	961	960	960
March	971	964	964	965	966	967	968	970	970	967	961	956
Oct. ..	952	949	949	949	949	949	949	950	950	948	941	939
Nov. ..	944	945	945	945	945	945	945	946	946	945	943	942
Dec. ..	939	944	944	944	943	942	941	941	939	938	937	937
Mean ..	954	955	955	955	955	955	955	956	955	954	952	950
					Summer.							
April ..	965	976	975	974	975	975	977	979	978	971	965	957
May ..	963	964	964	965	968	972	971	970	968	962	956	951
June ..	974	979	979	981	983	984	984	984	979	973	969	964
July ..	969	974	973	974	976	978	978	979	979	975	969	960
Aug. ..	973	974	973	974	974	977	977	977	975	972	966	962
Sept. ..	961	965	965	965	966	968	968	969	967	963	957	956
Mean ..	968	972	972	972	974	976	976	976	974	969	964	958

Table VI.—Diurnal Range of the Kew

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
					Summer mean.							
	− ·0002	+ ·00002	+ ·00002	+ ·00002	+ ·00004	+ ·00006	+ ·00006	+ ·00006	+ ·00004	− ·00001	− ·00006	− ·00012
					Winter mean.							
	− ·00001	·00000	·00000	·00000	·00000	·00000	·00000	+ ·00001	·00000	− ·00001	− ·00003	− ·00005
					Annual mean.							
	− ·0002	+ ·00001	+ ·00001	+ ·00001	+ ·00002	+ ·00003	+ ·00003	+ ·00003	+ ·00002	− ·00001	− ·00005	− ·00009

NOTE.—When the sign is + the

Kew Observatory, Richmond, as determined from the Magnetograph Curves on Month during the Year 1891.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
						Winter.						
966	967	969	969	966	967	965	965	963	961	961	959	958
962	962	964	966	966	963	962	962	961	961	960	959	961
955	961	966	972	976	977	976	975	974	973	972	971	971
940	941	946	952	954	955	954	954	952	953	952	952	952
942	944	947	949	948	947	947	945	944	944	945	944	944
937	937	940	941	942	941	942	941	941	940	939	939	939
950	952	955	958	959	958	958	957	956	955	955	954	954
						Summer.						
956	959	965	971	973	974	976	975	972	970	969	967	965
949	955	962	970	973	977	980	978	976	971	967	964	963
962	964	969	972	976	982	982	981	978	976	975	974	974
956	959	964	967	971	976	976	975	973	972	970	970	969
962	964	969	976	978	979	979	977	974	973	972	973	973
954	956	959	964	966	966	966	966	964	963	962	961	961
956	959	965	970	973	976	976	975	973	971	969	968	968

Vertical Force as deduced from Table V.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
						Summer mean.						
− ·00014	− ·00011	− ·00005	·00000	+ ·00003	+ ·00006	+ ·00006	+ ·00005	+ ·00003	+ ·00001	− ·00001	− ·00002	− ·00002
						Winter mean.						
− ·00005	− ·00003	·00000	+ ·00003	+ ·00004	+ ·00003	+ ·00003	+ ·00002	+ ·00001	·00000	·00000	− ·00001	− ·00001
						Annual mean.						
− ·00009	− ·00007	− ·00003	+ ·00001	+ ·00003	+ ·00005	+ ·00005	+ ·00004	+ ·00002	+ ·00001	·00000	− ·00002	− ·00002

reading is above the mean.

Table VII.—Hourly Means of the Inclination at the Kew Observatory, Five selected quiet

67° +

Hours.	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
					Winter.							
1891. Months.	′	′	′	′	′	′	′	′	′	′	′	′
Jan....	31·6	32·0	31·9	31·8	31·6	31·5	31·6	31·5	31·6	32·1	32·3	32·5
Feb....	31·5	31·4	31·6	31·5	31 5	31·4	31·2	31·1	31·3	31·8	32·0	32·2
March.	31·4	31·4	31·5	31·5	31·5	31·5	31·5	31·7	32·3	32·5	32·8	32·4
Oct....	30·0	30·2	30·3	30·2	30·2	30·2	30·1	30·3	30·7	31·5	32·0	32 0
Nov. ..	30·8	30·9	30·9	30·9	30·7	30·7	30·6	30·9	31·2	31·9	32·4	32·2
Dec....	30·1	30·0	30·0	29·9	29·8	29·6	29·4	29·3	29·4	29·7	30·0	30·2
Mean.	30·9	31·0	31·0	31·0	30·9	30·8	30·7	30·8	31·1	31·6	31·9	31·9
					Summer.							
April..	31·0	31·4	31·5	31·4	31·6	31·7	31·7	32·0	32·5	32·7	32·9	32·6
May...	30·7	31·0	31·1	31·1	31·4	31·7	31·9	32·2	32·5	32·7	32·6	32·0
June ..	30·9	31·2	31·3	31·3	31·3	31·5	31·9	32·3	32·6	32·9	32·8	32·7
July...	30·7	30·7	30·8	30·9	31·1	31·2	31·5	31·9	32·3	32·7	32·8	32·3
Aug. ..	30·2	30·4	30·6	30·5	30·5	30·8	31·0	31·4	32·1	32·5	32·6	31·9
Sept. ..	30·4	30·7	30·7	30·9	31·0	31·1	31·3	31·8	32·3	32·8	32·9	32·5
Mean.	30·7	30·9	31·0	31·0	31·2	31·3	31·6	31·9	32·4	32·7	32·8	32·3

Table VIII.—Diurnal Range of the

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
					Summer Mean.							
	′ −0·5	′ −0·3	′ −0·2	′ −0·2	′ 0·0	′ +0·1	′ +0·4	′ +0·7	′ +1·2	′ +1·5	′ +1·6	′ +1·1
					Winter Mean.							
	′ −0·2	′ −0·1	′ −0·1	′ −0·1	′ −0·2	′ −0·3	′ −0·4	′ −0·3	′ 0·0	′ +0·5	′ +0·8	′ +0·8
					Annual Mean.							
	′ −0·3	′ −0·2	′ −0·2	′ −0·2	′ −0·1	′ −0·1	′ 0·0	′ +0·2	′ +0·6	′ +1·0	′ +1·2	′ +1·0

NOTE.—When the sign is +

calculated from the Horizontal and Vertical Forces derived from the Days in each Month.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
					Winter.							
′	′	′	′	′	′	′	′	′	′	′	′	′
32·5	32·2	31·9	31·8	31·7	31·6	31·5	31·7	31·7	31·7	31·7	31·7	31·6
32·2	32·1	31·7	31·6	31·7	31·6	31·7	31·6	31·5	31·4	31·5	31·5	31·5
32·1	31·8	31·7	31·6	31·9	31·9	31·9	31·5	31·5	31·4	31·5	31·4	31·4
31·8	31·1	30·7	30·7	30·6	30·3	30·1	30·0	29·8	29·9	29·9	29·9	30·0
32·0	32·0	31·8	31·4	31·2	31·0	31·0	30·6	30·4	30·8	30·8	30·7	30·8
30·2	30·0	30·0	29·9	30·1	29·9	29·7	29·6	29·7	29·8	29·8	30·0	30·1
31·8	31·5	31·3	31·2	31·2	31·1	31·0	30·8	30·8	30·8	30·9	30·9	30·9
					Summer.							
32·2	31·9	31·7	31·6	31·5	31·5	31·3	31·3	31·1	31·1	31·1	30·9	31·0
31·6	31·3	31·2	30·9	30·8	30·7	30·6	30·6	30·7	30·6	30·5	30·6	30·7
32·1	31·6	31·3	30·9	30·8	30·6	30·5	30·5	30·6	30·7	30·9	30·8	30·9
31·9	31·2	31·0	30·5	30·3	30·2	30·2	30·2	30·4	30·5	30·6	30·7	30·7
31·3	30·7	30·5	30·4	30 3	30·1	29·9	29·8	29·8	29·8	30·0	30·0	30·2
31·5	31·0	30·6	30·9	31·0	30·9	30·8	30·4	30·4	30·4	30·5	30·4	30·4
31·8	31·3	31·1	30·9	30·8	30·7	30·6	30·5	30·5	30·5	30·6	30·6	30·7

Inclination as deduced from Table VII.

Noon.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.
					Summer Mean.							
′	′	′	′	′	′	′	′	′	′	′	′	′
+0·6	+0·1	−0·1	−0·3	−0·4	−0·5	−0·6	−0·7	−0·7	−0·7	−0·6	−0·6	−0·5
					Winter Mean.							
′	′	′	′	′	′	′	′	′	′	′	′	′
+0·7	+0·4	+0·2	+0·1	+0·1	0·0	−0·1	−0·3	−0·3	−0·3	−0·2	−0·2	−0·2
					Annual Mean.							
′	′	′	′	′	′	′	′	′	′	′	′	′
+0·7	+0·3	+0·1	−0·1	−0·2	−0·3	−0·4	−0·5	−0·5	−0·5	−0·4	−0·4	−0·3

the reading is above the mean.

APPENDIX II.—Table I.

Mean Monthly Results of Temperature and Pressure for Kew Observatory. 1891.

Months.	Thermometer.								Barometer.*					Mean vapour-tension.
	Mean.	Means of—			Absolute Extremes.				Mean.	Absolute Extremes.				
		Max.	Min.	Max. and Min.	Max.	Date.	Min.	Date.		Max.	Date.	Min.	Date.	
1891.	°	°	°	°	°	d. h.	°	d. h.	ins.	ins.	d. h.	ins.	d. h.	in.
Jan.....	34·3	38·5	29·5	34·0	51·4	31 3 P.M.	13·3	11 2 A.M.	30·155	30·737	11 10 A.M.	29·402	20 10 P.M.	·165
Feb.	37·8	44·4	32·0	38·2	57·1	28 2 ,,	25·2	26 6 ,,	30·473	30·739	4 10 P.M.	29·882	1 2 A.M.	·194
March..	40·4	46·3	35·0	40·7	55·9	2 2 ,,	23·9	12 7 ,,	29·830	30·449	4 1 A.M.	29·250	11 4 ,,	·187
April...	44·1	51·6	37·2	44·4	62·4	28 2 ,,	27·0	1 6 ,,	29·981	30·312	20 11 ,,	29·547	5 4 P.M.	·210
May ...	50·0	58·1	42·6	50·4	75·9	13 3 ,,	32·2	17 4 ,,	29·795	30·246	12 8 ,,	29·284	18 8 A.M.	†
June ...	59·5	68·1	51·7	59·9	75·9	18 3 ,,	42·3	10 4 ,,	30·023	30·438	12 11 P.M.	29·732	4 5 P.M.	†
July ...	59·7	67·8	51·7	59·8	78·8	17 3 ,,	45·7	28 4 ,,	29·943	30·305	13 Midt.	29·587	29 6 ,,	·391
Aug....	58·5	65·6	51·9	58·8	73·6	14 3 ,,	42·5	30 5 ,,	29·825	30·165	8 9 A.M.	29·182	21 5 A.M.	·390
Sept....	57·9	66·3	49·8	58·1	78·5	13 3 ,,	42·4	24 6 ,,	30·015	30·352	16{9 ,, 10 ,,}	29·445	1 3 ,,	·389
Oct.....	50·7	57·1	44·1	50·6	64·3	9 11 A.M.	30·9	31 6 ,,	29·782	30·684	31 Midt.	29·071	13 10 P.M.	·312
Nov.	43·3	47·7	37·8	42·8	55·8	19 2 P.M.	27·9	28 0·21 ,,	29·858	30·639	5 10 A.M.	28·466	11 11 A.M.	·246
Dec.	40·8	45·7	35·2	40·5	56·3	5 2 ,	18·5	22 0·23 ,,	29·993	30·724	19 10 ,,	29·131	13 Noon	·219
Yearly Means	48·1	54·8	41·5	48·2	..	....	..	....	29·973	..	....	..	....	·270‡

This Table is compiled from "Hourly Means," vol. 1891, of the Meteorological Office.

* Reduced to ° at M.S.L. † Wet-bulb instrument out of action. ‡ Mean for 10 months only.

Meteorological Observations.—Table II.

Kew Observatory.

Months.	Mean amount of cloud (0=clear, 10=overcast).	Rainfall.*			Weather. Number of days on which were registered							Wind.† Number of days on which it was								
		Total.	Maximum.	Date.	Rain. ‡	Snow.	Hail.	Thunderstorms.	Clear sky.	Overcast sky.	Gales.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
1891.		in.	in.																	
January.....	6·4	1·605	0·435	30	11	3	1	..	6	12	..	7	1	4	2	3	8	3	3	5
			(Dew)	15–17 18–23																
February....	4·8	0·090	0·010	24	..	..	..	..	10	8	..	4	2	9	1	2	7	3	..	14
March.....	7·3	1·320	0·460	7	17	9	..	..	..	14	2	5	4	2	1	2	5	7	5	1
April.....	7·3	0·995	0·435	4	9	..	1	..	1	16	1	6	7	6	2	1	4	1	3	1
May.....	7·1	2·520	0·575	17	19	2	2	1	4	16	1	6	8	7	1	3	4	1	1	3
June.....	6·4	1·750	0·600	22	11	..	..	2	3	10	..	5	6	4	..	4	5	2	4	3
July.....	6·8	2·735	0·805	19	19	..	..	3	2	12	..	4	2	1	..	5	9	7	3	3
August.....	7·5	4·055	1·155	20	23	..	..	3	1	18	..	3	..	..	1	4	15	6	2	3
September...	6·4	1·040	0·195	19	15	..	2	1	4	11	..	2	..	4	1	6	12	3	2	4
October.....	6·2	5·885	0·720	7	21	..	1	2	5	10	2	..	5	1	1	10	11	2	1	4
November...	7·6	1·935	0·450	10	17	..	1	..	1	16	1	4	5	1	2	5	4	5	4	7
December ...	6·8	2·915	0·610	1	20	..	1	..	5	13	5	2	..	..	7	5	11	6	..	8
Totals and means.....	6·7	26·845			182	14	9	12	42	156	12	48	40	39	19	50	95	46	28	56

* Measured at 10 A.M. daily by gauge 1·75 feet above ground. † As registered by the anemograph.

‡ The number of rainy days are those on which 0·01 rain or melted snow were recorded.

Meteorological Observations.—Table III.

Kew Observatory.

Months.	Bright Sunshine.				Maximum temperature in sun's rays. (Black bulb *in vacuo*.)			Minimum temperature on the ground.			Horizontal movement of the air.*		
	Total number of hours recorded.	Mean percentage of possible sunshine.	Greatest daily record.	Date	Mean.	Highest.	Date.	Mean.	Lowest.	Date †	Average hourly velocity.	Greatest hourly velocity.	Date.
1891.	h. m.		h. m.		deg.	deg.		deg.	deg.		miles.	miles.	
January	73 54	28	6 18	19, 21	66	90	30	24	9	8–10, 11	10·8	32	20
February	61 12	22	7 6	15	66	92	11	28	20	2–26, 27	6·0	27	1
March	97 48	26	9 12	30	89	106	11	30	14	12	14·0	50	9
April	117 30	28	11 48	24	98	119	28	30	17	1	11·6	39	23
May	161 48	34	13 30	31	114	127	13, 31	38	24	17	9·8	37	1
June	194 18	39	13 18	1	125	137	5	47	35	12	10·3	31	1
July	175 24	35	14 0	2	125	136	17	46	40	28	9·0	26	6
August	138 48	31	10 54	29	122	134	14	48	40	30	10·3	32	25
September	151 54	40	10 36	8	116	127	2, 9	46	37	28	9·3	29	1
October	110 12	33	9 12	2	95	113	3	39	22	31	12·0	40	14
November	42 12	16	5 30	26, 27	72	92	12, 20	32	21	28	9·1	45	11
December	41 54	17	5 48	19	70	86	31	29	15	20	12·9	43	10
Totals and Means	1366 54	29	..	..	96	..	..	36	..	..	10·4	..	..

* As indicated by a Robinson's anemograph, 70 feet above the general surface of the ground.
† Read at 10 A.M., and entered to same day.

Table IV.

Summary of Sun-spot Observations made at the Kew Observatory.

Months.	Days of observation.	Number of new groups enumerated.	Days apparently without spots.
1891.			
January	16	4	9
February.....	15	6	1
March.....	13	3	2
April.....	15	8	0
May.....	15	12	0
June	19	13	0
July.....	16	8	0
August	9	8	1
September.....	16	12	0
October.....	14	11	0
November.....	10	9	0
December	12	10	0
Totals for 1891	170	104	13

APPENDIX III.—Table I.

RESULTS OF WATCH TRIALS. Performance of the 29 Watches which obtained the highest number of marks during the year.

Watch deposited by	Number of watch.	Balance spring, escapement, &c.	Mean daily rate. — +Gaining. −Losing.	Mean variation of daily rate. ±	Mean change of rate for 1° F.	Difference of mean daily rate				Difference between extreme gaining and losing rates.	Marks awarded for			Total Marks. 0—100.
						Between pendant up and dial up.	Between pendant up and pendant right.	Between pendant up and pendant left.	Between dial up and dial down.		Daily variation of rate.	Change of rate with change of position.	Temperature compensation.	
			secs.	secs.	secs.	secs.	secs.	secs.	secs.	secs.				
Stauffer, Son, & Co., London.....	136862	Single overcoil, g.b., tourbillon chronometer	+0·2	0·3	0·03	−0·3	+0·2	+0·3	+0·4	3·0	34·4	39·3	17·9	91·6
Baume & Co., London	103011	Single overcoil, g.b., tourbillon chronometer	−1·2	0·25	0·04	−0·8	0·0	+0·2	−3·0	5·2	35·1	35·2	17·2	87·5
A. E. Fridlander, Coventry	52720	Single overcoil, d.r., g.b. lever	−0·8	0·4	0·04	−0·5	+0·7	−1·0	+3·7	6·2	32·4	35·4	17·6	85·4
A. E. Fridlander, Coventry	52730	Single overcoil, s.r., g.b.	+3·8	0·4	0·04	+2·2	+2·6	+4·0	+2·5	7·2	32·3	34·6	17·7	84·6
E. F. Ashley, London	04107	Single overcoil, s.r., fusee	−0·3	0·4	0·06	+1·9	+2·5	+1·0	−0·1	5·2	31·8	36·9	15·7	84·4
E. F. Ashley, London	04047	Single overcoil, s.r., fusee	+0·3	0·5	0·07	+1·0	+0·9	+0·2	+0·4	5·5	30·5	38·1	15·2	83·8
Usher & Cole, London.....	24390	Single overcoil, s.r., g.b.	+1·4	0·5	0 05	−0·6	+0·7	+2·6	−0·1	7·0	30·6	36·0	16·9	83·5
A. E. Fridlander, Coventry	52339	Single overcoil, d.r., g.b.	−0·6	0·5	0·03	+0·1	−2·7	−4·2	−1·5	6·2	30·7	34·2	18·3	83·2
T. R. Russell, Liverpool	86600	Single overcoil, s.r., g.b.	+1·1	0·7	0·01	+1·4	−0·4	+0·6	−0·6	5·2	25·8	37·8	19·4	83·0
W. Holland, Rock Ferry.....	3690	Single overcoil, s.r., g.b.	+3·4	0·5	0·03	+1·2	+2·1	+4·2	+1·3	6·8	29·1	35·5	18·2	82·8
Jos. White & Son, Coventry	32142	Single overcoil, d.r., g.b.	−0·9	0·5	0·08	+1·9	+1·3	+1·4	−1·6	5·3	30·1	37·4	15·0	82 5
Jos. White & Son, Coventry	31926	Single overcoil, d.r., fusee	+3·8	0·4	0·09	−0·1	−1·8	+2·3	+0·2	7·5	31·2	36·5	14·3	82·0
Rotherham & Sons, Coventry ...	86529	Single overcoil, s.r., g.b.	+1·9	0·5	0·04	+2·3	+2·8	+1·4	+0·8	8·5	29·0	35·4	17·5	81·9
A. E. Fridlander, Coventry	13113	Single overcoil, s.r., g.b.	−2·7	0·5	0·06	+0·8	−1·7	+2·0	+1·6	6·3	30·5	35·0	16·0	81·5
Jos. White & Son, Coventry.....	32256	Single overcoil, d.r., g.b.	+0·1	0·4	0·06	+0·3	−3·1	−2·8	−0·4	5·0	31·2	34·3	16·0	81·5
J. Newsome & Co., Coventry.....	108491	Single overcoil, s.r., g.b	−3·5	0·6	0·03	−2·0	−0·6	+0·7	+0·1	7·0	27·5	36·1	17·7	81·3
Rotherham & Sons, Coventry ...	88064	Single overcoil, s.r., g.b.	−0·6	0·6	0·05	−1·0	+0·3	−1·6	+1·4	6·0	27·2	37·0	17·0	81 2
A. E. Fridlander, Coventry	52704	Single overcoil, d.r., g.b.	−2·8	0·6	0·02	−2·6	+0·6	−2·4	+4·7	7·3	28·8	33·5	18·8	81·1
E. F. Ashley, London	03968	Single overcoil (palladium), s.r., g.b. ...	−0·2	0·5	0·11	−0·8	−2·1	−0·9	+0·5	7·2	30·6	37·9	12·5	81·0
Rotherham & Sons, Coventry ...	86764	Single overcoil, s.r., g.b.	+1·9	0·6	0·05	+0·1	+3·1	−0·7	−0·6	7·2	28·7	35·6	16·7	81·0
A. E. Fridlander, Coventry	52706	Single overcoil (palladium), d.r., g.b., non-magnetic	−1·8	0·5	0·03	−1·2	−2·9	−1·4	+4·3	7·0	29·2	33·6	18·0	80·8
H. Golay, London.....	2001	Double overcoil, s.r., g.b.....	+0·3	0·4	0·08	+3·9	+0·9	−0·3	−1·0	5·8	32·0	33·7	15·0	80·7

Table I—*continued.*

Watch deposited by	Number of watch.	Balance spring, escapement, &c.	Mean daily rate. — +Gaining. —Losing.	Mean variation of daily rate. ±	Mean change of rate for 1° F.	Difference of mean daily rate				Difference between extreme gaining and losing rates.	Marks awarded for			Total Marks. 0—100.
						Between pendant up and dial up.	Between pendant up and pendant right.	Between pendant up and pendant left.	Between dial up and dial down.		Daily variation of rate.	Change of rate with change of position.	Temperature compensation.	
			secs.	secs.	secs.	secs.	secs.	secs.	secs.	secs.				
E. F. Ashley, London	04022	Single overcoil, d.r., fusee	+0·1	0·6	0·06	+0·9	+1·0	+0·7	−2·9	5·0	28·2	36·4	16·0	80·6
E. F. Ashley, London	04028	Single overcoil, s.r., fusee	−0·7	0·5	0·09	+0·9	−2·3	−1·5	−2·5	5·7	30·7	35·6	14·3	80·6
Jos. White & Son, Coventry	33438	Single overcoil, d.r., g.b.	+0·2	0·7	0·04	−1·6	−1·9	−1·4	+1·1	5·5	25·6	37·4	17·5	80·5
A. E. Fridlander, Coventry	52683	Single overcoil, d.r., g.b.	−2·4	0·4	0·07	−0·7	+1·7	−3·2	−2·0	6·5	31·5	33 6	15·3	80·4
Rotherham & Sons	86526	Single overcoil, s.r., g.b.	+0·8	0·6	0·06	+2·1	+2·9	+1·0	+0·8	6·0	28·3	35·8	16·3	80·4
A. E. Fridlander, Coventry	52686	Single overcoil, d.r., g.b.	−0·9	0·6	0·04	−1·4	+0·4	+0·1	+4·5	7·2	27·1	35·7	17·4	80·2
T. R. Russell, Liverpool	87023	Single overcoil, s.r., g.b.	−0·5	0·5	0·06	+2·8	+4·1	+2·5	−2·4	7·3	29·9	34·4	15·9	80·2

In the above List, the following abbreviations are used, viz.:—s.r. for single roller; d.r. for double roller; g.b. for going barrel.

APPENDIX III.—Table II.

Highest Records obtained by Complicated Watches during the year.

Description of watch.	Number.	Deposited by	Marks awarded for			Total marks, 0—100.
			Variation.	Position.	Temperature.	
Minute and split seconds chronograph, and minute repeater	2286	Jos. White and Son, Coventry	22·9	37·5	16·0	76·4
" " " "	2970	Baume and Co., London	27·8	31·7	10·7	70·2
Minute and seconds chronograph and minute repeater	2968	Baume and Co., London	28·1	35·3	15·1	78·5
" " " "	52733	Fridlander, Coventry	29·7	28·4	18·0	76·1
" " " "	26516	Usher and Cole, London	27·9	30·4	14·1	72·4
Minute and split seconds chronograph	86764	Rotherham and Sons, Coventry	28·7	35·6	16·7	81·0
" " "	86522	" " "	27·2	35·3	16·3	78·8
" " "	34920	S. Smith and Son, London	25·6	29·1	18·0	72·7
Minute and seconds chronograph	52683	Fridlander, Coventry	31·5	33·6	15·3	80·4
" " "	1868	G. Edward and Sons, London	26·3	36·5	15·5	78·3
" " "	60183	Antoine Frères, Besançon	27·3	31·4	19·3	78·0
Ordinary seconds chronograph	92485	Rotherham and Sons, Coventry	26·2	34·8	18·3	79·3
" " " "	1986	Golay, London	30·2	31·8	11·3	73·3
" " " "	98764	Rotherham and Sons, Coventry	22 1	32·9	16·7	71·7
Minute repeater	36693	S. Smith and Son, London	26·0	34·4	7·9	68·3
" "	52756	Fridlander, Coventry	23·7	26·8	14·7	65·2
" "	9694	W. Clarke, London	16·7	32·2	15·1	64·0