THE

NATIONAL PHYSICAL LABORATORY.

REPORT FOR THE YEAR 1901.

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REPORT OF THE EXECUTIVE COMMITTEE, FROM OCTOBER 1, 1900, TO DECEMBER 31, 1901, APPROVED BY THE GENERAL BOARD AT THEIR MEETING ON MARCH 19, 1902.

At the date of their last Report the Committee were able to announce that the Government, with the approval of Her late Majesty, proposed to allot Bushy House for the purposes of the Laboratory.

The details of the scheme under which the site and buildings are held were shortly afterwards settled, and arrangements made to carry out the necessary alterations and to erect some further buildings. This work is now practically complete; its cost has been largely in excess of that originally estimated. Twice during the year it has been necessary for the Executive Committee to ask H.M. Treasury to sanction additional grants amounting in all to £5,000, and the Committee are glad to recognize the liberality with which their approaches were met. The accounts are not yet complete, but the total sum expended will reach about £19,000. In addition to this, the Committee have authorised the expenditure of over £3,000 on apparatus and fittings. This has been provided out of the sum saved during the past two years from the grant for annual expenditure.

The Committee are indebted to the officials of the Office of Works, and particularly to Mr. E. G. Rivers, Surveyor-in-Charge, for their care and attention in giving effect to the plans.

The basement and ground floor of Bushy House have been transformed into a Physical Laboratory, while the upper floors form offices and a residence for the Director, in whose salary a corresponding reduction has been made. The basement is covered with a brick groining on which the main building rests, but the more important Laboratories are in four large wings, one at each corner, and these have no basement below: thus steady supports are everywhere possible.

One wing, containing the original dining-room and library, has been fitted as an electrical and magnetic laboratory. All iron has been, as far as possible, removed from the structure, and, with a view of preventing a stray magnetic field from any currents which may be used, concentric wiring has been employed for all large currents, while the wires for smaller currents have been twisted.

In this room will be placed the Lorenz apparatus which the Drapers' Company have recently with great generosity given to the Laboratory in memory of the distinguished services to science and to education of the late Principal J. V. Jones, F.R.S., of Cardiff.

Along with this there will be other apparatus for the absolute measurement of current and of electromotive force.

Another wing has been fitted for thermometric work. A special study will be made of high temperature thermometers, and the Laboratory owes to the generosity of Sir A. Noble the means for installing a number of electric ovens for testing thermopiles and other instruments for the measurement of temperature up to 1000° or 1200° Centigrade.

In a third wing a metallurgical laboratory has been fitted in which to continue the work begun at the Mint by Sir William Roberts Austen and the Alloys Research Committee. For this purpose apparatus for cutting and polishing sections, and further photo-micrographical examination, has been obtained. The Committee have to thank Mr. Stead for his assistance in arranging this.

The fourth wing is fitted as a chemical laboratory.

In the basement are a number of constant temperature rooms.

Sir Andrew Noble's fund, referred to in the last report, has provided a measuring machine, a dividing engine, and a comparator which will be placed in some of the basement rooms. In an adjoining room the resistance measurements of the B. A. Committee will be continued, while in another apparatus for the production of liquid air is being set up.

The testing of pressure gauges will form an important branch of the work, and for this a mercury column some 50 feet in height has been erected in one corner of the house.

Gas and water have been laid on freely throughout the building—also electricity. A 100-volt circuit is connected to the main dynamo and battery in the power-house, and supplies light. Numerous plug points enable a supply to be taken off for lights for experimental purposes or for small motors. For experimental work a special battery of fifty-five cells has been installed. This is divided into groups of five. Wires run from the switchboard to the various rooms in such a way that one or more of these groups can be switched on to any circuit. Thus voltages between 10 and 110 volts can be obtained as required.

The house is heated on the Webster low-pressure system by steam from a Lancashire boiler in the boiler house at a distance of about 100 yards.

The boiler also supplies steam to one of Parson's 60-Kilowatt Turbo-generators, which is the main source of power. The power-house also contains an 18-H.P. Crossley gas engine, driving a 12-Kilowatt dynamo by T. Parker and Co. This serves as a stand-by, and for charging the main battery of 58 chloride cells.

The Engineering Laboratory, a building 80 feet by 50 feet, adjoins the power-house. This is divided into two bays ; a shaft, driven by a motor supplied by Mather and Platt, runs along one, and in it will be placed the lathes, drilling machine, planing machine, and other tools.

The other bay is for experimental work. It is traversed by a 2-ton crane, and will contain a testing machine and machinery for testing steam-pressure gauges, indicators, and such instruments. For this purpose a valuable instrument has been given by Messrs. Willans and Robinson.

During the year work has been continued at the Kew Observatory, now the Observatory department of the Laboratory, and further details of this are given in the Director's report. The number of instruments tested was 29,184, about 1,100 in excess of those tested last year, and very greatly in excess of any previous year. The increase has been chiefly in ordinary thermometers, telescopes, and sextants. Vessels used in the Babcock milk test have been examined for the first time. The number of these has been 527. There has been a fall in the number of lenses, watches, and chronometers examined.

A considerable amount of time was occupied during the year in testing apparatus for the Antarctic Expedition, and in giving instruction to some of the observers, and arrangements have been made during the coming year to co-operate with the Expedition in special magnetic observations.

The Committee have to thank various donors for gifts.

The Drapers' Company have undertaken to provide the sum of £700 to meet the cost of a Lorenz apparatus. This will be placed in the Laboratory in memory of the late Principal Viriamu Jones, and will bear a tablet stating that it has been given by the Company for this purpose. Messrs. Willans and Robinson are providing apparatus for testing steam-pressure gauges and indicators, while in a number of cases very advantageous terms have been granted to the Committee by manufacturers of tools and machinery. The Committee have to thank Lord Rayleigh, Lord Kelvin, Mrs. Hopkinson, and the Syndics of the Cambridge University Press for gifts of valuable books.

The financial position continues to cause the Committee considerable anxiety.

The accounts for the year, which accompany this report, show a balance of £1,528 13*s*. 3*d*.,* but no additional members of the staff, beyond the Director, were appointed until September last, and Bushy House has been occupied for only one quarter of the year. Moreover, the number of the staff is not yet complete, and the occupation of the house is only partial.

Still, enough experience has been gained to show that the expenditure on internal maintenance, cleaning, heating, and lighting will be very heavy, while the receipts from fees can grow but slowly. Hence the Committee can only conclude by again expressing their opinion, in the words of their resolution of last year, to the effect that—

* This sum, as already stated, has been devoted to the scientific equipment.

"The Committee cannot, however, conceal from themselves that it will be very difficult for them to maintain and administer a National Physical Laboratory on the Bushy site for the amount annually allowed by the Treasury, and they fear that it may be necessary for them to press in the near future for an addition to that allowance."

In accordance with a resolution adopted at the last Meeting of the General Board, this report is made up to December 31, 1901.

STAFF OF THE LABORATORY.

Director—R. T. Glazebrook, D.Sc., F.R.S.

Observatory Department.

Superintendent—C. Chree, LL.D., F.R.S.
Chief Assistant—T. W. Baker.
Senior Assistants—E. G. Constable, W. Hugo, J. Foster, T. Gunter, W. J. Boxall.
Junior Assistants—E. Boxall, G. Badderley,
with eight other assistants.

Physics Department.

Assistants—J. A. Harker, D.Sc.; A. Campbell, B.A.; H. C. H. Carpenter, M.A., Ph.D.
Junior Assistants—B. F. E. Keeling, B.A.; F. E. Smith, Roy. Coll. Sci.

Engineering Department.

Superintendent—T. E. Stanton, D.Sc.
Junior Assistants—C. Jakeman, S. W. Melsom,
with four mechanics and engineers.

Clerk and Accountant—G. E. Bailey.

Statement of Work for the Year 1902, approved by the General Board at their Meeting on March 19, 1902.

Work at Bushy House.

The new staff is now settled at Bushy House, and work in the various departments has begun.

The first task appears to be to set up and test the new apparatus. Much of this will require careful examination and calibration before it can be used for standard investigations.

With regard to research work, in accordance with the scheme approved last year, the first place will be given to continuing the investigations of the Alloys Research Committee.

Dr. Carpenter, who will be in charge of the chemical side of this, has had the great advantage of working, during the past four months, in Sir William Roberts

Austen's laboratory. Unfortunately, the funds at the disposal of the Committee have not been sufficient at present to purchase the complete outfit of apparatus required. The automatic recording instrument devised by Sir William Roberts Austen and his assistants has yet to be bought, as well as some high-temperature furnaces. The apparatus for cutting and polishing sections and for their photo-microscopical examination is reasonably complete. On the mechanical and magnetic side of the investigation, Dr. Carpenter will have the assistance of Mr. Keeling, who, after a distinguished course with Prof. Ewing, at Cambridge, has, by the kindness of Sir W. G. Armstrong, Whitworth & Co., spent some months in their works at Openshaw.

Another investigation referred to in the last Report was the measurement of wind pressure. Dr. Stanton hopes before long to attack this problem.

In thermometry, Dr. Harker will continue his investigations. During the past year, Sir A. Noble's air thermometer has been set up at Kew, and a number of mercury thermometers have been standardised for the range 100° C. to 200° C. It was not possible with the arrangements at Kew to work above this range, but a bath giving temperatures between 200° C. and 600° C. has been constructed. It is proposed now to set up the air thermometer and the baths at Bushy, and to proceed with the construction of electric ovens suitable for the range between 500° C. and 1200° C. When this is done it will be possible to standardise platinum thermometers, thermopiles, and other apparatus for the measurement of high temperatures up to about 1200° C. Some means of measuring temperatures up to, say, 2000° C., remains to be found.

The electrical and magnetic work will, for the present, consist chiefly in making and testing the standards to be used in the standardizing work. Mr. Campbell and Mr. Melsom have for some time been busy with this, and there is much to be done in setting up standards of induction and capacity, and for the magnetic testing.

Apparatus has been provided for the measurement of resistance, current, and electromotive force, and it is hoped before long that the Laboratory will be able to undertake the measurement of resistance and insulation tests, as well as the usual magnetic tests, on iron and steel.

For some time past Mr. F. E. Smith has been making preparations for the construction of mercury resistance standards. This work will be pushed on, and the new Lorenz apparatus, given by the Drapers' Company, set up and got into order under the personal supervision of the Director

In the Engineering Department again, work is required to fit the gauge-testing apparatus for use. The mercury column enables pressures up to 250 lbs. to the square inch to be read directly. Messrs. Willans and Robinson's apparatus will carry the pressure to 400 lbs. For the measurement of pressures above that amount apparatus has to be constructed. Mr. Jakeman will probably attend to this branch of the work.

As to the commercial testing work, the following list will indicate its scope, though until the Laboratory standards have been more thoroughly studied it is hardly possible to do much on a large scale :—

Tests of pressure gauges and steam indicators.

Tests of measuring appliances and gauges for use in engineering shops, &c.

Test of screw gauges.

Tests of thermometers for the measurement of high or low temperature, the platinum thermometer, thermopiles, &c.

Photo-micrographic tests on metals, steel rails, &c.

Measurement of the insulation resistance and dielectric capacity of insulators.

Measurement of the electrical resistance of conductors.

Tests of capacity and induction and of various forms of electrical measuring apparatus.

Tests on the magnetic properties of iron, &c.

Standardisation of glass vessels, flasks, burettes, &c., used in chemical laboratories and in various industries—*e.g.*, the dairy trade.

Standardisation of weights and scales for laboratory purposes.

Testing of photographic and other lenses.

The Director hopes before long to issue a pamphlet giving some account of these various tests, together with a statement of fees charged.

Work in the Observatory Department.

The testing of meteorological and other apparatus, which is described in the Annual Report of this department, will be continued.

The attention of the Committee is called to the Test Pamphlet, which was issued last year, and gives a full account of the work done.

The various magnetic and meteorological observations will also be continued; although, in consequence of the electric trams the former have lost much of their value, it is desirable to continue them until the new magnetic observatory, the establishment of which is engaging the attention of the Committee, is in working order.

Investigations into some matters connected with terrestrial magnetic measurements will be continued. There are also some questions of thermometry under discussion.

DIRECTOR'S REPORT FOR THE YEAR ENDING DECEMBER 31, 1901.

In presenting his Report for the year 1901, the Director has to call attention to the fact that Bushy House was not occupied until the end of September, and that the work described in the Report has been carried out entirely in the buildings of the Observatory Department, at the Kew Observatory, Richmond.

The Report contains the usual report made to the Director by the Superintendent of the Observatory Department as to the details of the tests and observations undertaken, with a brief account of some experimental researches by various assistants.

Much time was given during the year to the verification of the apparatus for the British Antarctic Expedition. In the course of this work a series of observations were made with the half-second pendulums, lent to the Expedition by the Board of Education. These are briefly described by Mr. E. G. Constable. The Eschenhagen magnetographs for the expedition were set up and tested, and in connection with these a number of observations were made by Dr. Harker as to the earth currents produced by the various electric traction systems in the neighbourhood.

Dr. Harker's main work, however, consisted of experiments with the air thermometer presented by Sir A. Noble. These are briefly described in the Report.

Dr. Chree published in the 'Philosophical Magazine,' for November and December, 1901, an important paper on 'Applications of Elastic Solids to Metrology.' Some of the results have been applied by him and Mr. Smith to the alteration in length of the bar of a magnetometer caused by flexure. An account of this work is given in the Report.

During the year a number of observations on the resistance standards of the British Association have been made by the Director and Mr. Smith, but the temperature conditions in the temporary building at Kew made very exact work difficult, and the results can best be discussed in connection with those to be obtained later at Bushy.

I. Gravity Observations at the National Physical Laboratory in 1901, in connection with the National Antarctic Expedition. (*Mr. Constable.*)

The Antarctic Expedition was furnished with a complete installation for the determination of the value of g, consisting of three half-second pendulums of the "Helmert" type; a cylindrical air-tight case, fitted with suspension brackets, prisms, and mirrors; and an observing telescope with seconds flash box.

This apparatus was loaned by the Board of Education.

In addition a special half-second zinc and steel pendulum clock was built to the order of the Laboratory, fitted with electric contacts on the escape wheel arbor, and a supplementary escape giving seconds.

This was intended for use with the pendulums at a fixed station; and a fine sidereal chronometer with electric contacts was provided for use with sledge parties.

Both these were examined and rated at the Laboratory; also the resistance box, and shunt for clock and chronometer.

The three pendulums, Nos. 36, 37, and 38, were set up in the "pendulum room," on the site where the U.S. Coast and Geodetic Survey pendulums were recently swung, and a few feet north of the position formerly occupied by the "Kater" pendulums.

Experimental and preliminary observations were carried out during April, May, and June, and several members of the expedition received instruction in the use of the apparatus and pendulums.

During June and July six groups of observations were made with the three pendulums, each group consisting of six sets of six coincidences, the sets lasting for about 8 hours, and the swings continued over 24 hours.

Observations were also made with the spare pendulum, No. 39.

The mean results gave for each pendulum the following period, but these values are somewhat provisional, being subject to final checking and more complete corrections :—

Pendulum 36.		Pendulum 37.		Pendulum 38.	
Face M.	Face R.	Face M.	Face R.	Face M.	Face R.
sec.	sec.	sec.	sec.	sec.	sec.
0·5088432	0·5088426	0·5088568	0·5088558	0·5088505	0·5088517
0·5088429		0·5088563		0·5088511	

Investigations were also made to obtain the corrections to the pendulum "period" for

(α) changes of temperature—(standard 15° C.).
(β) ,, ,, pressure—(standard 60 mm. of mercury at 0° C.).

The observations for (α) gave the following results :—

Change of "period" for a change of 1° C.			
No. 36.	No. 37.	No. 38.	Mean value.
sec. 0·0000445	sec. 0·0000468	sec. 0·0000465	sec. 0·000046

Pressure Correction.

	Change of "period" for a change of 1 mm. pressure.			
	No. 36.	No. 37.	No. 38.	Mean value.
	sec.	sec.	sec.	sec.
Below 300 mm.	0·000000090	0·000000072	0·000000081	0·00000008
Above 300 mm.	79	86	78	0 00000008

Some observations were also made to test the "flexure" of the stand used in the above operations, but time did not permit sufficient swings.

Antarctic Expedition. Meteorological Department.

In addition to the pendulum work, several members of the expedition received instruction in the use of meteorological instruments, both self-recording and for eye observations, including ordinary dry and wet, maximum and minimum, and solar-radiation thermometers, recording barometers, thermometers, and hair hygrometers, cup anemometers; Dines's pressure-tube recorder, and "sight" pressure tubes; Piche's evaporimeter, and Assman's aspirator thermometers; and in the manipulation and care of Lord Kelvin's portable electrometer, and Exner's electroscope.

II. MAGNETOGRAPHS. (*Dr. Harker.*)

A set of Eschenhagen recording magnetographs, ordered by the Admiralty for the National Antarctic Expedition, were sent to Kew to be tested during the summer. In this type of instrument the traces of D, H, and V with their zero lines, together with the trace of a recording thermograph, are all to be arranged on one sheet of photographic paper without crossing or interfering with one another. The drum is fitted to make one revolution in either 2 or 24 hours as desired. One source of light, a small oil lamp, serves for all the instruments, and the adjustment of the whole to obtain all the traces simultaneously good is a somewhat delicate matter, especially when working at the high speed.

However, during the short time the instruments were at Kew, they were got into order, and traces were obtained with different degrees of sensitiveness, which were quite sharp in definition, and on the whole satisfactory. Some of these, including some high-speed traces showing clearly the effects of electric traction disturbances, were exhibited by the Director at the British Association Meeting at Glasgow.

Mr. Bernacchi, the magnetic observer attached to the expedition, had an opportunity of studying the working of the instruments as already set up, and also of dismounting and replacing them unaided in full working order.

III. Earth Currents. (*Dr. Harker.*)

In November, 1900, to aid in a study of the disturbances in the earth's magnetic forces, caused by electrically worked traction systems, an apparatus lent to the Laboratory by Mr. A. P. Trotter, of the Board of Trade, was fitted up, and records have been taken by its means almost without interruption for over 6 months. The apparatus consisted of two small dead-beat moving coil galvanometers (only one of which was used for the greater part of the time), whose indications were registered on a narrow strip of photographic paper rotated by clockwork. For most of the experiments the arrangement was to use a drum rotating once in 24 hours, an hour covering a length of about 12 mm. The earth plates employed were of thick sheet iron 60 cm. square, and were buried about 1 metre deep in adjacent corners of the Observatory inclosure 200 metres apart. To each plate was soldered a thick insulated copper wire, which above ground was connected by a line of No. 14 copper telephone wire strung on insulators above the fence to the Laboratory. The line connecting the plates was almost due north and south.

For most of the experiments the galvanometer was employed as a recording voltmeter, a resistance of 10,000 or 20,000 ohms being placed in series with it. It was found that there was a permanent difference of potential between the plates of about 0·2 volt in one direction, which seemed very persistent. The influence of artificial electrical disturbances, due to traction systems in operation at that time, was to cause a continual oscillation of the galvanometer system, the average amplitude of which at the commencement of the observations was about 0·03 volt. The time of magnetic peace in the early hours of the morning, during which the curve traced by the instrument was quite sharp, and generally an almost absolutely straight line, was almost identical from day to day, and it became evident from the records that any special experiments to be made could only be of value if performed between these specified hours.

Under the direction of the Board of Trade and the Observatories Protection Committee experiments were made on several nights as to the effect on the magnetic elements at Kew of definite currents generated at the Chiswick power-house of the London United Tramways Company, and the traces obtained by means of the earth-current apparatus were found to be of distinct value in differentiating between these artificial and true natural disturbances.

IV. Thermometric Investigations. (*Dr. Harker.*)

During the past year the gas thermometer presented to the Laboratory by Sir Andrew Noble, which was erected during the previous autumn in a room in an outbuilding at Kew, has been got into working order, and the necessary apparatus has been constructed for the determination of the fixed points 0° and 100°, and of the volumes and pressure coefficients of the reservoirs employed.

At first considerable difficulty was experienced in making a reliable and permanent joint between the reservoir and the platinum capillary forming the connection to the manometer. The difficulty was at length surmounted by drawing down a short length of the platinum capillary to a slightly smaller diameter.

A number of determinations of the fixed points were made with well dried atmospheric nitrogen at different initial pressures in order to gain experience in the manipulation of the instrument and to form an estimate of the kind of accuracy attainable. On the whole the concordance of the individual experiments was quite satisfactory, considering the nature of the irregular temperature changes to which the room was subject.

An oil bath, constructed according to our designs, has proved very useful for comparisons up to 200° C.

Eight standard mercury thermometers of various ranges and lengths have been constructed to our order by Mr. Hicks, and, after having been subjected to a long annealing process extending over nearly a year, all of these have been standardised by comparison in the oil-bath with the working standard platinum thermometer K_7 at every five degrees of the scale, the observations being repeated several times on different days. Four of the thermometers with a range of from 100° to 200°, graduated into fifths of a degree, have also been compared with the platinum thermometer K_8, which was one of the platinum standards whose scale was compared by Chappuis and Harker with the international thermometric standards at Sèvres.

Several series of direct comparisons of the same mercury thermometers have also been made with our own gas thermometer at 130°, 160°, and 190°.

The results of the reduction of all these observations are—

1. That these four mercury thermometers, which are now intended to be used as secondary standards for verification work between 150° and 200°, have at length reached a steady state, and may be depended upon to give consistent readings between these temperatures to about 0°·05 C.

2. That their corrections as obtained from platinum thermometer K_7, assuming for the boiling point of sulphur Callendar's value 444°·5 C. on the constant pressure air scale, are in almost exact agreement (to about 0°·01 C.) with what is obtained from platinum thermometer K_8, accepting as the boiling point of sulphur on Chappuis's constant volume nitrogen scale the value 444°·7 C.*

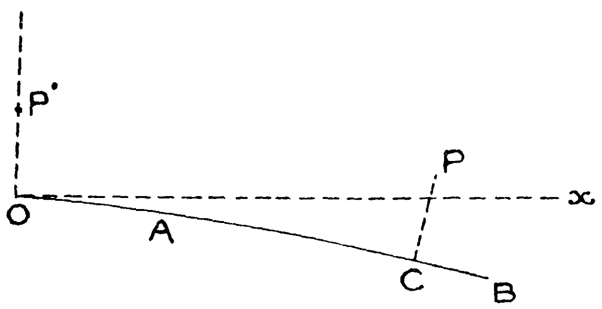
3. That the direct comparison of the same thermometers with our own gas thermometer showed an agreement within the limits of experimental error, considering that the dilatation of the reservoir used was not determined directly, and that the gas thermometer itself was designed rather for experiments over a very wide range than extreme accuracy at lower temperatures.

V. Deflection Bars of Magnetometers. (*Dr. Chree and Mr. Smith.*)

The deflection bar of a magnetometer is generally a brass or bronze rod about a meter long. When in use, it is supported symmetrically at two points whose distance apart is only a small fraction of the length. In the deflection experiment, forming part of a determination of horizontal magnetic force, the bar carries on one side of its centre a magnet in a carriage—sometimes with a thermometer and a protecting box—and on the other side there is, or should be, an equal counterpoise, at an equal distance from the centre. The bar bends under its own weight and that of the magnet, carriage, &c., and this tends to make the distance between the centres of the deflecting and deflected magnets greater than it would be if the bar were absolutely rigid. The most convenient plan in practice is to measure the bar under conditions such that its length is not appreciably affected by bending, and then by combined experiment and calculation to determine the influence of bending under the circumstances of actual use.

The influence of bending is two-fold. Owing to the curvature introduced, the length measured along the arc formed by the bent bar exceeds its horizontal projection. This difference between chord and arc is, however, generally quite negligible in a magnetometer bar. The second effect is more important. All longitudinal "fibres" in the bar, with the exception of those in the median or *neutral* plane—*i.e.*, the horizontal plane containing the centres of gravity of the cross-sections—are altered in length. Those above the neutral plane are stretched, the stretching being proportional to the distance above the plane.

Fig. 1.



In the figure the bent line represents the neutral or central axis of the bar, the bending being greatly exaggerated. P is the centre of the deflecting magnet, P′ that of the deflected magnet, which is in the vertical through O the centre of the bar, and at the same vertical height as P. The magnet is so supported that however the bar bends P is constrained to remain on a fixed normal to the bar. The difference between chord and arc being, as already explained, negligible, and the central line of the bar remaining of invariable length, it is clear that the horizontal distance of P from P′ exceeds the distance shown by the graduation on the bar, at the level of the central line, by the amount $h \sin \psi$, where h is the perpendicular distance of P from the central line, and ψ

* Harker and Chappuis's determination of the boiling point of sulphur depends on an extrapolated value of the coefficient of expansion of porcelain, which has since been shown to be probably too great. Direct determinations of the expansion made on porcelain of the same kind indicate tha their original number 445°·2 C. should be lowered to about 444°·7 C.

the inclination of the bent central line to the horizontal. In practice, ψ is so small that we may replace $\sin\psi$ by $\tan\psi$, the latter being more convenient mathematically. The influence of the vertical shift of P and of the slight tilting of the magnet is negligible.

The notation used in the subsequent short sketch of the theory involved is as follows :—

ω = area of cross-section of bar.
$2l$ = total length.
$2a$ = distance apart of supports.
E = Young's modulus.
ρ = density.
w = $g\rho\omega$ = weight of bar per unit length.
$\omega\kappa^2$ = moment of inertia of the cross-section about the perpendicular through the C.G. to the plane of bending.
y = vertical displacement due to bending, at a distance x along the median line from O, the middle point of the bar.

Supposing first that the bar bends under its own weight alone, then between the support A and the corresponding end B of the bar we have*

$$y = \left(\frac{w}{\mathrm{E}\omega\kappa^2}\right)\tfrac{1}{24}\{4la^3 - l^4 + 4lx(l^2 - 3a^2) + (l-x)^4\} \quad \text{.............. (1),}$$

$$\frac{dy}{dx} = \left(\frac{w}{\mathrm{E}\omega\kappa^2}\right)\tfrac{1}{6}\{l(l^2 - 3a^2) - (l-x)^3\} \quad \text{.............................. (2).}$$

It should be noticed that $\dfrac{dy}{dx}$ is equivalent to what was denoted above by $\tan\psi$.

If now an additional load W be applied to the bar at a point C (OC $= c$), intermediate between A and B, further bending results, and the increase in the vertical displacement being y', we find* for distances x not greater than c nor less than a,

$$y' = \left(\frac{\mathrm{W}}{\mathrm{E}\omega\kappa^2}\right)\tfrac{1}{6}\{a^3 - 3a^2x + 3cx^2 - x^3) \quad \text{....................... (3),}$$

$$\frac{dy'}{dx} = \left(\frac{\mathrm{W}}{\mathrm{E}\omega\kappa^2}\right)\tfrac{1}{2}(-a^2 + 2cx - x^2) \quad \text{................................ (4).}$$

If we suppose W to represent the weight of the magnet itself with its carriage, &c., and x to define its position on the bar, then from what precedes we see that the distance between the centres of the deflecting and deflected magnets when the bar bends under its own weight and that of the magnet, &c., combined, exceeds the distance answering to perfect rigidity in the bar by the amount

$$\delta x = h\left(\frac{dy}{dx} + \frac{dy'}{dx}\right),$$

with x written for c in the value (4) of dy'/dx. Thus we have in full

$$\delta x = \frac{h/2}{\mathrm{E}\omega\kappa^2}[\tfrac{1}{3}w\{l(l^2 - 3a^2) - (l-x)^3\} + \mathrm{W}(x^2 - a^2)] \quad \text{.............. (5).}$$

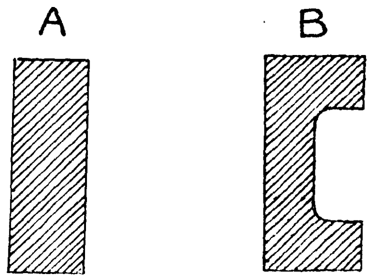
The weights and distances involved in (5) being determined—they do not require

* 'Phil. Mag.,' Dec. 1901, equations (70) p. 598 and (87) p. 604.

to be found with any great precision—it only remains to determine $E\omega\kappa^2$, or what is generally known as the *stiffness* of the bar.

To render the method of determining $E\omega\kappa^2$ intelligible, reference must now be made to the shape of the cross sections of the bars and the modes of carrying the deflecting magnet. The two most common forms of section are those denoted A and B in fig. 2; the longer dimension is that which is vertical in use.

FIG. 2.



Bars of type A are usually graduated on a vertical face, and the magnet carriage, which possesses a groove sliding on the bar, bears a reference mark—answering to the centre of the magnet—which is brought into coincidence with the scale divisions.

Bars of type B have holes drilled into their upper surface, into which fit plugs attached to the magnet carriage.

In both types of bars $E\omega\kappa^2$ was determined by observing the increase in horizontal distance between two "points" carried by the bar, at equal distances from the centre on opposite sides of it, when two equal loads, W, were applied symmetrically. In bars of type A, each "point" was the centre of a red cross on a small ivory disc, temporarily attached to a magnet resting on a magnet carriage; in bars of type B the ivory discs were carried by brass plugs fitting into the holes drilled in the upper surface of the bar. In both cases the bar was supported in its magnetometer, exactly as when in ordinary use, and the heights of the discs above the bar approached closely to that of the deflecting magnet in a horizontal force experiment. In all the bars dealt with, the supports are at the level of the median line.

If h' represent the height of the crosses above the central line of the bar, the increase in the distance $2x$ between the crosses is by (4)

$$2h'\frac{dy'}{dx} = \frac{Wh'}{E\omega\kappa^2}(-a^2 + 2cx - x^2) \quad \ldots\ldots\ldots\ldots \quad (6),$$

with c representing the distance of each of the weights W from the middle point of the bar. This increase of distance was observed, for at least two different values of x, by means of two microscopes focussed, the one on the one ivory disc, the other on the other.

The following is an example of the calculations in a particular case:—

$c = 50$ cms., $a = 6\cdot6$ cms.. $h' = 5\cdot1$ cms., $W = 431$ grammes,
and so $Wh' = 2200$ approximately.

distance x	=	25 cms.	40 cms.
$-a^2 + 2cx - x^2$	=	1831	2356
observed increase in $2x$	=	·0113 cm.	·01395 cm.
$E\omega\kappa^2$	=	$(2200 \times 1831) \div \cdot0113$	$(2200 \times 2356) \div \cdot01395$
	=	356×10^6 approx.	372×10^6 approx.

This gives for $E\omega\kappa^2$ the mean value 364×10^6, where E is supposed to be measured in grammes *weight* per sq. cm.

Inserting the value found for $E\omega\kappa^2$ in (5), we can calculate the effects of bending for the magnetometer concerned, for the distances usually employed in actual determinations of horizontal force.

Though not required for the present purpose, the value of Young's modulus E may of course be derived from that of $E\omega\kappa^2$, when the form of the section permits of the determination of $\omega\kappa^2$ with the necessary accuracy. In bars of type A the section is usually very uniform, and $\omega\kappa^2$ is easily found; with bars of type B there is more uncertainty.

Table I gives particulars as to the bars dealt with. Table II gives the results of the experimental determination of $E\omega\kappa^2$. Table III gives, *inter alia*, the corrections deduced for the influence of bending under the circumstances of actual use.

Table I.—Particulars as to Bars.

Maker.	Bar No.	Weight of bar, $2wl$.	Length, $2l$.	Cross-section. Height.	Cross-section. Breadth. Greatest.	Cross-section. Breadth. Least.	Height C.G. of magnet above median line, h.	Distance between supports.
		grammes.	cm.	cm.	cm.	cm.	cm.	cm.
Cooke	7	1058	88·8	2·15	0·928	0·47	6·6	6·0
,, ...	8	1057	88·9	2·15	0·925	0·45	,,	,,
Cooke-Elliott ...	16	837	101·8	2·08	0·452		6·0	13·2
,, ...	17	796	,,	2·08	0·428		,,	13·1
,, ...	20	808	,,	2·04	0·445		,,	12·9
Camb. Inst. Co.	1	832	101·4	2·07	0·469		5·2	13·2

Table II.

Bar.	Load applied	Extension noted at	Calculated Value of $E\omega\kappa^2 \times 10^{-6}$.	Mean $E\omega\kappa^2 \times 10^{-6}$.
		cm.		
Cooke 7	at ends	22·5 30	552 564	558
,, 8	,,	30 35	545 527	536
Cooke-Elliott 16 ...	,,	26·25 40	375 370	372
,, 17 ...	,,	26·25 40	338 348	343
,, 20 ...	,,	26·25 40	328 335	332
Camb. Inst. Co. 1 ..	,,	25 40	356 372	364

Table III.—Summary of Results.

Maker.	No.	Type of bar.	$(E\omega\kappa^2)\times 10^{-7}$.	$E\times 10^{-7}$.	Effect (cm.) on length at				
					22·5 cm.	26·25 cm.	30 cm.	35 cm.	40 cm.
Cooke	7	B	56	—	0·0030	0·0035	0·0041	0·0048	0·0057
,, ...	8	B	54	—	0·0031	0·0036	0·0042	0·0050	0·0059
Cooke-Elliott ...	16	A	37	110	0·0041	0·0048	0·0056	0·0068	0·0081
,,	17	A	34	107	0·0044	0·0052	0·0061	0·0073	0·0088
,,	20	A	33	105	0·0046	0·0054	0·0063	0·0076	0·0090
Camb. Inst. Co.	1	A	36	106	—	—	0·0031	0·0036	0·0040

The Cooke bars Nos. 7 and 8 were probably bronze rather than brass. The bars Nos. 16, 17, 20 were modified old Elliott bars belonging to magnetometers supplied many years ago to India. They seem much alike in elastic quality as well as in pattern.

It is satisfactory to note in Table II that the larger of the two values of $E\omega\kappa^2$ answers sometimes to the greater and sometimes to the smaller experimental distance, and that the differences between the two values are all small. The corrections in Table III have been calculated to one figure further than is required in actual use. It will be noticed that, roughly speaking, the correction varies as the distance from the centre of the bar. This should, however, be regarded as an accidental phenomenon.

The correction is of course a small quantity, but it is by no means negligible, especially in the case of the bars 17 and 20. In these two cases the neglect of the correction—supposing deflections made at the two usual distances, 30 and 40 cm.—would lead to an error of 0·00006 C.G.S. unit in the value of the horizontal force in England, and to an error about twice as big in India.

It only remains to add that the lengths of the bars as they would be if unaffected by bending were determined by comparison with a standard meter divided on its neutral surface, the supports of the bars being in this case at a distance apart equal to 0·56 of the whole length. In a bar thus supported the effects of bending are negligible to the degree of accuracy aimed at in magnetic measurements.

In conclusion, the Director wishes to express his obligation to the various members of the staff for their very cordial co-operation in the work of the Laboratory.

R. T. GLAZEBROOK,
Director.

REPORT ON THE OBSERVATORY DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1901, MADE BY THE SUPERINTENDENT TO THE DIRECTOR.

The work at the Kew Observatory in the Old Deer Park at Richmond, now forming the Observatory Department of the National Physical Laboratory, has been continued during the year 1901 as in the past.

This work may be considered under the following heads:—

I. Magnetic observations.
II. Meteorological observations.
III. Seismological observations.
IV. Experiments and Researches in connexion with any of the departments.
V. Verification of instruments.
VI. Rating of Watches and Chronometers.
VII. Miscellaneous.

I. Magnetic Observations.

The Magnetographs have been in constant operation throughout the year, and the usual determinations of the Scale Values were made in April.

The ordinates of the various photographic curves representing Declination, Horizontal Force, and Vertical Force were then found to be as follows:—

Declinometer: 1 cm. $= 0° 8'{\cdot}7$.

Bifilar, April, 1901, for 1 cm. $\delta H = 0{\cdot}00051$ C.G.S. unit.

Balance, April, 1901, for 1 cm. $\delta V = 0{\cdot}00049$ C.G.S. unit.

On April 1 the magnetograph clock was dismounted and cleaned, the recording parts and lenses also received due attention.

On July 31, and again in December, the dots of light of the vertical-force curves had become too close together for safe registration, and, in consequence, their position was altered by readjusting the zero mirror.

The curves throughout the whole of the year have been free from any large fluctuations. The principal movements that were recorded took place on the following days:—

January 22—23, March 24, May 10, August 14—15, and September 10.

The disturbances, due to the extension of electric traction in the neighbourhood of London, have become serious, more especially in the case of the vertical force. As yet, the disturbances apparent in the declination curves are comparatively insignificant but with the fresh developments of electric traction contemplated to the west of the Observatory, more serious trouble may be anticipated. The hourly means and diurnal inequalities of the magnetic elements for 1901, for the quiet days selected by the Astronomer Royal, have been tabulated as usual, and the results will be found in Appendix I. Owing, however, to the tram disturbances, some uncertainty attaches to the results for the last 6, and especially the last 3 months of the year.

A correction has been applied for the diurnal variation of temperature, use being made of the records from a Richard thermograph as well as of the eye observations of a thermometer placed under the vertical-force shade.

The mean values at the noons preceding and succeeding the selected quiet days are also given, but these of course are not employed in calculating the daily means or inequalities.

The following are the mean results for the entire year:—

Mean Westerly Declination..................	16° 48′·9
Mean Horizontal Force	0·18451 C.G.S. unit.
Mean Inclination	67° 9′·5
Mean Vertical Force...........................	0·43804 C.G.S. unit.

Observations of absolute declination, horizontal intensity, and inclination have been made weekly as a rule.

A table of recent values of the magnetic elements at the Observatories whose publications are received at Kew will be found in Appendix IA to the present Report.

During the second half of the year electric trams have been running out to Hounslow, the route coming within about 1200 yards of the Observatory. The effect has been hardly appreciable on the declination, distinctly appreciable on the horizontal force, and very considerable on the vertical force. In the last case the trace, which, when undisturbed, has a width of about 3 mm., widens out to about 6 mm., when the trams are running. In addition to rapid oscillation about a mean position—possibly slightly dependent on the trams—there are usually during each day one or more considerable dislocations on the V.F. trace. In the tabulation such dislocations have been allowed for, with, it is believed, considerable success, and it is hoped that the mean values of the elements for the year and the diurnal variations given in the tables are not seriously affected by the trams. The effect on the *amplitudes* of the diurnal variations is certainly small in all the elements, but the details are exposed to some measure of uncertainty, especially in the case of the vertical force and inclination.

For the investigation of small natural disturbances—an object to which considerable attention is now being given—the traces are absolutely useless. Further, with the extension of the running of the trams to Twickenham and Teddington, a large increase in the disturbance is probable in the near future. The provision of a new magnetic observatory on an undisturbed site is thus becoming urgent.

A set of self-recording magnetographs, Kew pattern, constructed by Adie, of London, for the Survey Department, New Zealand, and self-recording declination and horizontal force magnetographs, Mr. W. Watson's pattern, constructed by the Cambridge Scientific Instrument Company for India, have been examined and forwarded to their destination.

At the request of the Superintendent of the U.S. Coast and Geodetic Survey, a direct comparison has been undertaken between the Kew standard inclinometer and an inclinometer with six needles belonging to the Survey.

A course of practical instruction in the taking of magnetic observations has been given to Lieutenants Chetwynd, Day, and Dannreuther, of the Royal Navy, and to Mr. W. Shackleton. Instruction has also been given to Lieutenant Armitage, R.N.R., and other officers of the National Antarctic Expedition.

In August, Dr. Van Rijckevorsel visited the Observatory, and observed with his magnetic instruments, according to his scheme for the intercomparison of standard instruments in different countries.

In a paper recently published in the 'Philosophical Magazine,' the Superintendent concluded that the bending of magnetometer deflection bars when in use, under their own weight and that of the magnet with its carriage, must appreciably increase the distance between the deflecting and deflected magnets in a horizontal-force observation. Direct experiments having confirmed this conclusion, it has been decided in future cases to allow for the effect in the tables of constants supplied on magnetometer certificates. The neglect of this correction leads to a small over-estimate of the horizontal force, the error varying directly as the force at the place of observation.

In the verification of a series of magnetometers, to be employed in the magnetic survey of India, a somewhat large divergence was noted between the values supplied for the horizontal force by these instruments and by the Kew standard, the values obtained with the latter being uniformly the larger.

After a good deal of research, the main part at least of this difference was traced to want of homogeneousness in the inertia bars supplied with the Indian magnetometers. These had been cast, and under the conditions of casting the density tended to be greater at the ends of the bar than in the middle. Thus the value calculated for the moment of inertia of the bar on the hypothesis of uniform density was invariably too small. In ascertaining the cause of the discrepancy, the makers of the instruments afforded valuable assistance, and on its discovery they supplied a complete new set of inertia bars.

Owing to the large number of instruments verified, and the number of observers instructed, the work of the magnetic department during the year has been exceptionally heavy.

1901.

II. Meteorological Observations.

The several self-recording instruments for the continuous registration of Atmospheric Pressure, Temperature of Air and Wet-bulb, Wind (direction, pressure and velocity), Bright Sunshine, and Rain have been maintained in regular operation throughout the year, and 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 Institute of Mining Engineers, and the editor of 'Symons' Monthly Meteorological Magazine.' On the initiative of the Meteorological Office, some special cloud observations have been made in connection with the International scheme of balloon ascents.

Bright Sunshine.—In previous years, in the Meteorological Observations, Table III, the entries for the several months under the heading "Mean percentage of possible sunshine," have been the means of the 28 to 31 percentages for the individual days of the month. Similarly, the mean entered at the foot of the column has been the arithmetic mean of the 12 mean values attributed to the several months. While a perfectly logical way of presenting the facts, this differs from the practice usually followed, which is equivalent to defining the mean percentage for any period of n days—whether a month or a year—as 100 × (total recorded hours of bright sunshine in the n days) ÷ (total possible hours in the n days). To facilitate correct comparison with other places, Table III in the present Report gives the monthly and annual percentages both according to the old and to what may be termed the "new" point of view. In accordance with advice from the Meteorological Office, it is intended to publish the results from both methods for some years before finally adopting the new method. In 1901—as in 1900—the new method gives for the annual mean percentage a value greater than that given by the old in the proportion roughly of 11 to 10. This arises from the fact that the new method allows less weight than the old to the winter months.

Electrograph.—This instrument worked in a satisfactory manner until September, when the action became indifferent, and the whole of the instrument, inside and outside, including tank, Mascart insulators, &c., was taken down and thoroughly cleaned and dried, and thereafter the working was much improved. The bifilar suspension was found broken on November 27; this was at once repaired.

Scale-value determinations were made on May 10, September 23, December 6, and December 10, and the potential of the battery has been tested weekly. Forty cells only have been employed during the year, giving about 30 volts.

Inspections.—In compliance with the request of the Meteorological Council, the following Observatories and Anemograph Stations have been visited and inspected:—Stonyhurst, Armagh, Dublin, Valencia, and Falmouth, by Mr. Baker; and Radcliffe Observatory (Oxford), Glasgow, Aberdeen, Deerness (Orkney), Fort William, and Yarmouth, by Mr. Constable.

III. Seismological Observations.

Professor Milne's "unfelt tremor" pattern of seismograph has been maintained in regular operation throughout the year; particulars of the time of occurrence and the amplitude in millimetres and in seconds of arc of the largest movements are given in Table I, Appendix III.

The largest disturbances recorded took place on June 24, when the maximum amplitude was 8·4 mm., or 6·7 seconds of arc, and on August 9, when the maximum was 8·0 mm. or 6·0 seconds of arc.

A detailed list of the movements recorded from January 1 to December 31, 1901, was made and sent to Professor Milne, and will be found in the 'Report' of the British Association for 1902, "Seismological Investigations Committee's Report."

IV. Experimental Work.

Fog and Mist.—The observations of a series of distant objects, referred to in previous Reports, have been continued. A note is taken of the most distant of the selected objects which is visible at each observation hour.

At the request of the Meteorological Council, extra observations of surface fog and darkness have been made in connection with the investigation of London fogs, undertaken by the Office and the London County Council.

Atmospheric Electricity.—The comparisons of the potential, at the point where the jet from the water-dropper breaks up, and at a fixed station on the Observatory lawn, referred to in previous Reports, have been continued, and the observations have been taken every day when possible, excluding Sundays and wet days. The ratios of the "curve" and the "fixed station" readings have been computed for each observation, and these have thrown considerable light upon the action of the self-recording electrometer, especially with reference to the insulation problem.

Owing to pressure of work in connection with the Antarctic Expedition, the experiments on insulators of glass, sulphur, and paraffin wax, referred to in last year's Report, have not been continued, but it is hoped that further investigations may be made.

Quartz and Phosphor-bronze Suspensions.—Experiments on the relative advantages of quartz and phosphor-bronze as a suspension for the magnetic system of horizontal force magnetographs have been carried out in co-operation with Mr. W. Watson, F.R.S., in the Experimental House. Two similar magnet systems were suspended, the one by a quartz thread, the other by phosphor-bronze. An examination of a month's magnetograms from each system showed that the phosphor-bronze gave much the smaller temperature coefficient, but that it exhibited a sensible elastic "creep." Only one specimen of each kind was tried.

Thermometer Glass.—Further experiments have been carried out on various kinds of new glass made by Messrs. Powell. These experiments are still in progress.

Deterioration of Sunshine-recorder Glass Lenses.—Mr. W. Marriott, Secretary of the Royal Meteorological Society, having at his disposal a Stokes-Campbell recorder that had been discarded from use at Regent's Park, owing to visible deterioration of the surface of the glass sphere, offered to send it to Kew for investigation. The offer was accepted, and the recorder was set up near the Observatory recorder, and records were obtained from time to time throughout the year. Comparisons were also made of the Regent's Park sphere with the Kew one, with the aid of the photometer used in the verification of photographic lenses.

V. Verification of Instruments, Exclusive of Watches and Chronometers.

The subjoined is a list of the instruments examined in the year 1901, compared with a corresponding return for 1900:—

	Number tested in the year ending December 31. 1900.	1901.
Air-meters	9	13
Anemometers	1	14
Aneroids	197	222
Artificial horizons	27	10
Barometers, Marine	139	111
„ Standard	57	65
„ Station	23	29
Binoculars	963	669
Compasses	51	11
Declinometers	1	—
Deflectors	1	29
Hydrometers	173	120
Hypsometers	—	2
Inclinometers	17	15
Photographic Lenses	136	9
Levels	—	2
Magnets	1	3
Milk-test apparatus	—	527
Rain Gauges	4	19
Rain-measuring Glasses	29	33
Scales	1	—
Sextants	813	938
Sunshine Recorders	3	—
Telescopes	1,345	2,029
Theodolites	12	11
Thermometers, Avitreous or Immisch's	—	6
„ Clinical	20,476	20,389
„ Deep sea	83	112
„ High Range	40	62
„ Hypsometric	66	54
„ Low Range	33	72
„ Meteorological	2,786	3,077
„ Electrical Resistance	—	3
„ Solar radiation	2	12
„ Standard	61	111
Unifilars	5	15
Vertical Force Instruments	14	—
Total	27,569	28,794

Duplicate copies of corrections have been supplied in 43 cases.

The number of instruments rejected in 1900 and 1901 on account of excessive error, or for other reasons, was as follows :—

	1900.	1901.
Thermometers, clinical	116	163
„ ordinary meteorological	79	114
Sextants	122	155
Telescopes	116	139
Binoculars	31	18
Various	28	78

There were at the end of the year in the Observatory, undergoing verification, 7 Barometers, 315 Thermometers, 17 Sextants, 68 Telescopes, 33 Binoculars, 1 Inclinometer, and 5 Unifilar Magnetometers.

VI. Rating of Watches and Chronometers.

The number of watches sent for trial this year is slightly less than in 1899, the total entries being 363, as compared with 403 in the preceding year, the diminution being principally in the class B entries.

The "especially good" class A certificate was obtained by 95 movements, and the high degree of excellence to which attention was called in last year's Report has been fully maintained.

The following figures show the percentage number of watches obtaining the distinction "especially good," as compared to the total number obtaining class A certificates :—

Year	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Percentage "especially good"	16·6	30·5	28·0	22·1	26·6	35·4	35·5

The 363 watches received were entered for trial as below :—

For class A, 305 ; class B, 31 ; 20 for the subsidiary trial ; and 7 for a special trial carried out on behalf of the North Eastern Railway Company. Of these, 260 were awarded class A certificates, 25 obtained class B certificates, 18 passed the subsidiary test, 53 failed from various causes to gain any certificate, while a table of mean rates only was issued for the 7 watches entered for the special test.

In Appendix IV will be found a table giving the results of trial of the 50 watches which gained the highest number of marks during the year. The highest place was taken by H. Williamson, Limited, of London and Coventry, with the keyless going-barrel Karrusel lever watch, No. 56,365, which obtained 91·3 marks out of a maximum of 100.

This is the first English lever watch to reach 91 marks, and its performance is the best of any watch since 1892.

Marine Chronometers.—During the year, 33 chronometers have been entered for the Kew A trial and 3 for the B trial. Of these, 29 gained A certificates, 3 B certificates and 4 failed.

VII. Miscellaneous.

Commissions.—The following instruments have been procured, examined, and forwarded to the various Observatories on whose behalf they were purchased:—

For Coimbra, a Milne seismograph, No. 31, complete.

For Mauritius, a Mason's hygrometer, ordinary maximum and minimum thermometers, and a solar maximum thermometer, a large scale Richard aneroid, and an eight-day clock.

For the Surveyor-General, New Zealand, a self-recording Kew pattern magnetograph, also a unifilar magnetometer, and a dip circle complete, with tripod stands.

Paper.—Prepared photographic paper has been supplied to the Observatories at Hong Kong, Mauritius, Lisbon, Stonyhurst, Oxford (Radcliffe); and through the Meteorological Office to Aberdeen, Fort William, and Valencia.

Photographic paper has also been sent in quarterly instalments to the India Office for use at Colaba (Bombay), Calcutta, and Madras.

Anemograph and Sunshine Sheets have been sent to Hong Kong, Mauritius, and St. Petersburg; and Seismograph rolls to Mauritius.

Tests and Certificates.—The last edition of the pamphlet descriptive of tests and certificates issued by the Kew Committee in 1890 having been practically exhausted, a new edition was prepared and issued in the course of the year. The opportunity was taken of laying down more exact rules for the standard of excellence required to obtain a certificate by certain classes of instruments, especially barometers, hydrometers, and thermometers. In the case of aneroid barometers the test has been considerably altered, in view of the experimental results described in the 'Phil. Trans.,' A, for 1898, p. 441.

"*Southern Cross*" *Antarctic Expedition.*—The inclinometer lent to Sir George Newnes for the use of this expedition was returned in the beginning of the year. The magnetic results obtained in the Antarctic—mostly at Cape Adare—have been discussed by the Superintendent with the assistance of Mr. L. Bernacchi, one of the observers on the "Southern Cross." The discussion will be published in due course.

Chronometer-testing Arrangements.—At the request of the Chilian Admiralty the 'Escuela Naval,' Valparaiso, has been furnished with drawings and a description of the chambers used for the testing of marine chronometers at high and low temperatures.

Visitors.—On May 22 the Observatory was visited by the Vice-President and a considerable number of members of the Horological Institute. Amongst other visitors may be mentioned Captain T. Imaidzumi, I.J.N., who was shown, at the request of the Japanese Embassy, the apparatus and methods employed in testing instruments, especially those for use at sea.

Library.—During the year the Library has received publications from:—

20 Scientific Societies and Institutions of Great Britain and Ireland,
89 Foreign and Colonial Scientific Establishments,

as well as from several private individuals.

The card catalogue has been proceeded with.

(Signed) C. CHREE,
Superintendent.

List of Instruments, Apparatus, &c., the Property of the National Physical Laboratory Committee, at the present date out of the custody of the Director, on Loan.

To whom lent.	Articles.	Date of loan.
The Science and Art Department, South Kensington.	Articles specified in the list in the Annual Report for 1893........................	1876
Professor W. Grylls Adams, F.R.S.	Unifilar Magnetometer, by Jones, No. 101, complete..............................	1883
	Pair 9-inch Dip Needles with Bar Magnets ...	1887
Lord Rayleigh, F.R.S.	Standard Barometer (Adie, No. 655)	1885
Mr. P. Baracchi (Melbourne University).	Unifilar Magnetometer, by Jones, marked N.A.B.C., complete......................	1899
	Dip Circle, by Barrow, with one pair of Needles and Bar Magnets................	1899
	Tripod Stand	1899

APPENDIX I TO REPORT OF SUPERINTENDENT.

MAGNETICAL OBSERVATIONS, 1901.

Made at the Kew Observatory, Old Deer Park, Richmond, Lat. 51° 28′ 6″ N. and Long. $0^h\ 1^m\ 15^s{\cdot}1$ W.

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 $3\frac{1}{2}$ 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 1901 which were selected by the Astronomer Royal, as suitable for the determination of the magnetic diurnal inequalities, and which have been employed in the preparation of the magnetic tables :—

January	3, 12, 13, 19, 31.
February	4, 11, 15, 16, 25.
March	10, 11, 16, 17, 28.
April	4, 6, 12, 17, 30.
May	4, 5, 16, 28, 30.
June	3, 5, 17, 25, 27.
July	2, 3, 21, 28, 29.
August	1, 6, 11, 26, 28.
September	6, 7, 15, 20, 28.
October	2, 3, 18, 24, 27.
November	1, 8, 15, 22, 30.
December	6, 11, 17, 18, 22.

Table I.—Hourly Means of the Declination, as determined from the

Hours	Preceding noon.	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
	(16° +) West					Winter.							
1901. Months.	′	′	′	′	′	′	′	′	′	′	′	′	′
Jan. ..	52·1	50·3	50·4	50·7	50·6	50·6	50·5	50·2	50·1	49·7	49·3	50·0	50·9
Feb. ..	52·5	50·4	50·5	50·5	50·7	50·7	50·6	50·3	49·9	49·5	49·2	50·0	51·3
March.	53·7	49·4	49·4	49·3	49·4	49·2	49·1	49·0	48·3	47·6	47·4	48·9	51·9
Oct. ..	51·4	47·5	47·5	47·6	47·5	47·7	47·6	47·1	46·4	45·5	45·6	47·6	50·0
Nov. ..	50·0	46·9	47·2	47·5	47·5	47·6	47·5	47·3	47·1	46·7	46·3	47·5	49·1
Dec. ..	48·9	46·8	47·0	47·0	47·0	46·9	46·7	46·7	46·6	46·4	46·3	46·8	47·6
Means	51·4	48·6	48·7	48·8	48·8	48·8	48·7	48·4	48·1	47·6	47·4	48·5	50·1
						Summer.							
	′	′	′	′	′	′	′	′	′	′	′	′	′
April..	52·8	49·3	49·5	49·3	49·2	49·0	48·8	48·2	47·0	45·6	45·5	47·7	50·6
May ..	54·3	49·5	49·4	49·3	49·0	48·4	47·4	46·7	45·9	45·6	46·2	48·0	50·9
June ..	51·8	48·4	48·0	48·0	47·7	47·1	45·9	45·0	44·5	45·0	45·8	47·6	49·9
July ..	52·1	48·3	48·0	47·8	47·7	47·2	46·0	45·1	44·9	44·8	45·5	47·4	50·1
Aug. ..	52·7	47·7	47·6	47·5	47·4	46·9	46·0	45·0	44·8	45·2	46·7	48·8	50·9
Sept. ..	53·2	47·5	47·6	47·5	47·1	47·1	47·1	46·4	45·8	45·4	46·1	47·7	49·9
Means	52·8	48·4	48·3	48·2	48·0	47·6	46·9	46·1	45·5	45·3	46·0	47·9	50·4

Table II.—Diurnal Inequality of the

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

NOTE.—When the sign is + the magnet
” ” − ”

selected quiet Days in 1901. (Mean for the Year = 16° 48′·9. West.)

Noon	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.	Succeeding noon.
Winter.													
′	′	′	′	′	′	′	′	′	′	′	′	′	′
51·8	52·8	53·0	52·1	51·2	50·9	50·7	50·5	50·3	50·2	50·1	49·9	50·2	51·8
52·1	52·5	52·5	51·7	51·1	51·1	50·9	50·7	50·6	50·5	50·3	50·4	50·5	52·8
53·8	54·7	54·0	52·4	50·8	50·2	50·2	50·1	49·8	49·6	49·6	49·6	49·4	53·7
51·7	52·2	51·4	49·7	48·4	48·1	48·0	47·6	47·5	47·5	47·3	47·3	47·3	51·4
50·0	50·1	49·2	48·3	48·1	48·0	47·5	47·3	47·1	46·9	46·8	46·7	46·9	50·1
48·1	48·3	47·7	47·0	46·6	46·4	46·2	46·1	46·1	46·1	46·1	46·3	46·6	47·8
51·3	51·8	51·3	50·2	49·4	49·1	48·9	48·7	48·6	48·5	48·4	48·4	48·5	51·3
Summer.													
′	′	′	′	′	′	′	′	′	′	′	′	′	′
53·8	55·1	54·6	53·0	51·3	49·9	49·3	49·1	49·4	49·4	49·4	49·4	49·1	53·3
53·6	54·4	53·4	51·8	50·6	49·5	49·0	48·9	48·9	49·2	49·5	49·5	49·5	54·0
52·3	53·2	53·3	52·0	50·3	49·3	48·4	48·3	48·4	48·2	48·4	48·1	48·1	51·4
51·6	52·7	52·8	51·9	50·0	48·2	47·9	48·0	48·2	48·2	48·3	48·3	48·0	52·7
52·7	53·6	52·7	51·1	49·1	48·1	47·7	48·2	48·2	48·2	48·2	47·8	47·9	51·8
52·4	52·8	51·7	49 9	48·6	47·9	47·8	47·7	47·8	47·5	47·5	47·4	47·4	52·3
52·7	53·6	53·1	51·6	50·0	48·8	48·4	48·4	48·5	48·4	48·5	48·4	48·3	52·6

Kew Declination as deduced from Table I.

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

points to the west of its mean position.
" east " "

TABLE III.—Hourly Means of the Horizontal Force in C.G.S. units (corrected
(The Mean for the

Hours	Preceding noon.	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
	0·18000 +					Winter.							
1901. Months.													
Jan. ...	435	442	442	443	443	444	445	447	447	445	442	437	435
Feb. ...	434	447	447	447	448	449	450	451	451	448	445	442	440
March..	434	449	449	449	448	448	450	451	451	449	443	437	438
Oct. ...	439	458	460	459	460	459	460	460	458	449	440	435	434
Nov. ...	448	459	458	458	459	461	460	460	459	455	449	443	445
Dec. ...	454	462	463	465	466	466	467	466	466	466	462	459	458
Means..	441	453	453	453	454	454	455	456	455	452	447	442	442
						Summer.							
April...	426	449	450	449	449	448	448	448	444	439	429	420	418
May ...	437	453	453	453	452	451	450	446	442	437	433	431	433
June ...	440	456	456	455	455	456	455	451	445	441	433	426	428
July ...	443	458	458	457	458	458	458	453	449	444	436	435	434
Aug. ...	445	459	459	459	459	458	456	452	447	440	436	437	440
Sept. ...	439	458	459	460	460	459	457	454	452	447	442	439	439
Means..	438	456	456	456	456	455	454	451	447	441	435	431	432

Table IV.—Diurnal Inequality of the

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
						Summer Means.						
	+ ·00005	+ ·00005	+ ·00005	+ ·00005	+ ·00004	+ ·00003	·00000	− ·00004	− ·00010	− ·00016	− ·00020	− ·00019
						Winter Means.						
	+ ·00001	+ ·00001	+ ·00002	+ ·00002	+ ·00003	+ ·00003	+ ·00004	+ ·00003	·00000	− ·00005	− ·00010	− ·00010
						Annual Means.						
	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00002	− ·00001	− ·00005	− ·00011	− ·00015	− ·00014

NOTE.—When the sign is + the

for Temperature) as determined from the selected quiet Days in 1901.
Year = 0·18451.)

Noon	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.	Succeeding noon.
							Winter.						
435	436	438	439	441	442	441	441	441	441	441	441	441	437
440	440	441	443	446	447	449	449	448	448	448	447	449	440
440	443	447	450	451	450	451	453	452	452	452	451	450	441
440	449	453	456	455	457	459	460	460	461	460	461	461	441
448	451	455	457	457	459	461	460	460	460	459	460	460	450
459	461	464	465	466	467	466	466	467	466	464	464	464	460
444	447	450	452	453	454	454	455	455	455	454	454	454	445
							Summer.						
423	431	439	444	447	451	452	453	453	452	452	453	453	428
438	445	449	452	455	456	456	458	457	456	456	454	454	436
434	439	446	450	455	458	461	463	463	463	463	460	458	433
440	447	455	462	461	462	462	466	465	464	462	461	462	450
446	445	458	459	458	458	460	462	464	463	463	462	461	441
445	452	454	455	454	455	457	460	461	462	461	461	461	454
438	443	450	454	455	457	458	460	461	460	460	459	458	440

Kew Horizontal Force as deduced from Table III.

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

reading is above the mean.

Table V.—Hourly Means of the Kew Vertical Force in C.G.S. units (corrected
(The Mean for the

Hours	Preceding noon.	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
	0·43000 +				Winter.								
1901. Months.													
Jan. ...	797	803	802	802	802	801	801	801	801	801	801	798	798
Feb. ...	813	818	818	816	816	816	816	815	815	816	815	814	814
March ..	793	810	809	808	807	808	806	806	806	805	802	796	791
Oct. ...	780	793	793	796	795	795	794	794	795	794	792	788	783
Nov. ...	784	791	791	793	793	792	791	790	789	788	788	785	784
Dec. ...	814	820	821	822	823	821	819	820	818	817	817	816	815
Means	797	806	806	806	806	805	804	804	804	803	802	799	797
						Summer.							
April ...	793	810	809	807	807	807	807	809	811	809	804	796	791
May ...	809	830	828	827	827	827	826	825	823	821	817	812	806
June ...	807	823	821	820	819	821	821	821	822	819	815	811	809
July ...	772	779	781	781	782	782	781	781	781	779	777	774	767
Aug. ...	800	814	813	815	814	814	814	814	814	810	806	801	797
Sept. ...	776	790	789	792	793	792	791	791	790	787	784	780	776
Means	793	808	807	807	807	807	807	807	807	804	800	796	791

Table VI.—Diurnal Inequality of the

Hours	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
						Summer Means.						
	+ ·00003	+ ·00002	+ ·00002	+ ·00002	+ ·00002	+ ·00002	+ ·00002	+ ·00002	− ·00001	− ·00004	− ·00009	− ·00014
						Winter Means.						
	+ ·00002	+ ·00002	+ ·00002	+ ·00002	+ ·00001	·00000	·00000	− ·00001	− ·00001	− ·00002	− ·00005	− ·00007
						Annual Means.						
	+ ·00002	+ ·00002	+ ·00002	+ ·00002	+ ·00002	+ ·00001	+ ·00001	+ ·00001	− ·00001	− ·00003	− ·00007	− ·00010

Note.—When the sign is + the

for Temperature), as determined from the selected quiet Days in 1901.
Year = 0·43804.)

Noon	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.	Succeeding noon.
							Winter.						
796	796	801	803	803	803	802	801	801	801	801	801	800	795
814	815	817	819	820	820	819	819	818	818	818	817	817	808
792	798	804	809	812	812	813	812	813	812	812	811	810	793
783	786	792	796	798	798	797	796	795	795	794	794	793	785
785	786	789	792	791	789	788	787	786	786	786	786	786	779
815	816	819	820	821	821	820	819	819	818	818	818	819	817
797	799	804	806	807	807	806	806	805	805	805	804	804	796
							Summer.						
789	793	801	809	813	815	815	816	815	814	813	813	812	791
806	810	819	823	830	833	834	833	832	830	829	827	826	805
812	816	820	823	828	829	830	829	829	827	827	824	822	806
768	771	781	786	787	789	787	785	783	783	782	780	779	764
799	801	808	811	814	814	813	812	811	808	810	809	809	796
777	778	782	785	790	790	790	790	791	789	789	790	790	778
792	795	802	806	810	812	811	811	810	808	808	807	806	790

Kew Vertical Force as deduced from Table V.

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

reading is above the mean.

Table VII.—Hourly Means of the Inclination, calculated from the Horizontal

Hours	Preceding noon.	Mid.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
		67° +					Winter.						
1901. Months.	′	′	′	′	′	′	′	′	′	′	′	′	′
Jan....	10·4	10·1	10·1	10·0	10·0	9·9	9·8	9·7	9·7	9·8	10·0	10·2	10·4
Feb.....	10·9	10·2	10·2	10·1	10·0	10·0	9·9	9·8	9·8	10·0	10·2	10·4	10·5
March..	10·3	9·8	9·8	9·7	9·8	9·8	9·6	9·6	9·6	9·7	10·0	10·2	10·0
Oct.....	9·6	8·7	8·6	8·7	8·7	8·7	8·6	8·6	8·8	9.3	9·9	10·1	10·0
Nov. ...	9·2	8·6	8·7	8·7	8·7	8·5	8·5	8·5	8·5	8·8	9·2	9·5	9·4
Dec.....	9·6	9·2	9·2	9·1	9·0	9·0	8·9	9·0	8·9	8·9	9·1	9·3	9·3
Means..	10·0	9·4	9·4	9·4	9·4	9·3	9·2	9·2	9·2	9·4	9·7	10·0	9·9
							Summer.						
	′	′	′	′	′	′	′	′	′	′	′	′	′
April...	10·9	9·8	9·7	9·7	9·7	9·8	9·8	9·8	10·2	10·4	11·0	11·3	11·3
May....	10·6	10·1	10·0	10·0	10·1	10·2	10·2	10·4	10·6	10·9	11·1	11·1	10·8
June ...	10·3	9·7	9·7	9·7	9·7	9·7	9·7	10·0	10·4	10·6	11·0	11·4	11·2
July....	9·1	8·3	8·4	8·5	8·4	8·4	8·4	8·7	9·0	9·3	9·7	9·7	9·6
Aug. ...	9·8	9·2	9·2	9·3	9·2	9·2	9·4	9·7	10·0	10·4	10·6	10·3	10·0
Sept....	9·5	8·6	8·5	8·6	8·6	8·6	8·7	8·9	9·0	9·3	9·6	9·6	9·5
Means..	10·0	9·3	9·3	9·3	9·3	9·3	9·4	9·6	9·9	10·2	10·5	10·6	10·4

Table VIII.—Diurnal Inequality of the

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

Note.—When the sign is +

and Vertical Forces (Tables III and V). (The Mean for the Year = 67° 9′·5.)

Noon	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	Mid.	Succeeding noon.
						Winter.							
′	′	′	′	′	′	′	′	′	′	′	′	′	
10·3	10·3	10·3	10·3	10·2	10·1	10·1	10·1	10·1	10·1	10·1	10·1	10·1	10·2
10·5	10·5	10·5	10·4	10·3	10·2	10·1	10·1	10·1	10·1	10·1	10·1	10·0	10·3
9·9	9·8	9·8	9·7	9·7	9·8	9·8	9·6	9·7	9·6	9·6	9·7	9·7	9·9
9·7	9·1	9·0	9·0	9·1	8·9	8·8	8·7	8·7	8·6	8·6	8·6	8·5	9·6
9·2	9·0	8·8	8·8	8·7	8·5	8·4	8·4	8·4	8·4	8·5	8·4	8·4	8·9
9·3	9·2	9·1	9·0	9·0	8·9	8·9	8·9	8·9	8·9	9·0	9·0	9·1	9·3
9·8	9·7	9·6	9·5	9·5	9·4	9·4	9·3	9·3	9·3	9·3	9·3	9·3	9·7
						Summer.							
′	′	′	′	′	′	′	′	′	′	′	′	′	′
10·9	10·5	10·2	10·1	10·0	9·8	9·7	9·7	9·7	9·7	9·7	9·6	9·6	10·7
10·4	10·1	10·1	10·0	10·0	10·0	10·0	9·9	9·9	9·9	9·9	9·9	9·9	10·5
10·9	10·6	10·3	10·1	9·9	9·7	9·6	9·4	9·4	9·3	9·3	9·5	9·5	10·8
9·2	8·8	8·6	8·3	8·4	8·4	8·3	8·0	8·0	8·1	8·2	8·2	8·1	8·4
9·7	9·8	9·2	9·2	9·3	9·3	9·2	9·0	8·8	8·8	8·9	8·9	9·0	9·9
9·1	8·7	8·7	8·7	8·9	8·8	8·7	8·5	8·5	8·4	8·4	8·4	8·4	8·6
10·0	9·8	9·5	9·4	9·4	9·3	9·2	9·1	9·1	9·0	9·1	9·1	9·1	9·8

Kew Inclination as deduced from Table VII.

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

the reading is above the mean.

APPENDIX IA.

MEAN VALUES, for the years specified, of the Magnetic Elements at Observatories whose Publications are received at the National Physical Laboratory.

Place.	Latitude.	Longitude.	Year.	Declination.	Inclination.	Horizontal Force. C.G.S. Units.	Vertical Force C.G.S. Units.
	° ′	° ′		° ′	° ′		
Pawlowsk	59 41 N.	30 29 E.	1899	0 34·1 E.	70 38·8 N.	·16536	·47078
Katharinenburg	56 49 N.	60 38 E.	1899	9 59·6 E.	70 39·7 N.	·17795	·50706
Kasan	55 47 N.	49 8 E.	1897	7 54·8 E.	68 34·8 N.	·18616	·47454
Copenhagen	55 41 N.	12 34 E.	1900	10 12·2 W.	68 39·0 N.	·17513	·4480
Stonyhurst	53 51 N.	2 28 W.	1901	18 9·7 W.	68 45·7 N.	·17348	·44638
Hamburg	53 34 N.	10 3 E.	1900	11 18·1 W.	—	·18152	—
Wilhelmshaven	53 32 N.	8 9 E.	1900	12 27·7 W.	67 44·0 N.	·18095	·44193
Potsdam	52 23 N.	13 4 E.	1900	9 56·3 W.	66 33·7 N.	·18844	·43466
Irkutsk	52 16 N.	104 16 E.	1899	2 1·5 E.	70 13·7 N.	·20133	·56009
de Bilt (Utrecht)	52 5 N.	5 11 E.	1899	13 54·7 W.	—	·18502	—
Kew	51 28 N.	0 19 W.	1901	16 48·9 W.	67 9·5 N.	·18451	·43804
Greenwich	51 28 N.	0 0	1900	16 29·0 W.	67 8·5 N.	·18450	·43764
Uccle (Brussels)	50 48 N.	4 21 E.	1900	14 13·6 W.	66 9·8 N.	·18952	·42896
Falmouth	50 9 N.	5 5 W.	1900	18 29·1 W.	66 45·2 N.	·18689	·43507
Prague	50 5 N.	14 25 E.	1900	9 7·0 W.	—	·19947	—
St. Helier (Jersey)	49 12 N.	2 5 W.	1901	16 56 5 W.	65 42·7 N.	—	—
*Parc St. Maur (Paris)	48 49 N.	2 29 E.	1898	14 53·8 W.	64 58·3 N.	·19676	·42140
Vienna	48 15 N.	16 21 E.	1898	8 24·1 W.	—	·20797	—
O'Gyalla (Pesth)	47 53 N.	18 12 E.	1901	7 23·4 W.	—	·21175	—
Odessa	46 26 N.	30 46 E.	1898	4 41·5 W.	62 30·5 N.	·22033	·42341
Pola	44 52 N.	15 51 E.	1900	9 25·3 W.	60 15·9 N.	·22202	·38871
Nice	43 43 N.	7 16 E.	1899	12 4·0 W.	60 11·7 N.	·22390	·39087
Agincourt (Toronto)	43 47 N.	79 18 W.	1899	5 27·8 W.	74 33·5 N.	·16503	·59744
			1900	5 28·8 W.	74 32·5 N.	·16512	·59709
†Perpignan	42 42 N.	2 53 E.	1898	13 47·0 W.	60 1·7 N.	·22386	·38818
Tiflis	41 43 N.	44 48 E.	1898	2 5·5 E.	55 50·6 N.	·25635	·37784
Capodimonte (Naples)	40 52 N.	14 15 E.	1900	9 10·2 W.	—	—	—
Madrid	40 25 N.	3 40 W.	1898	15 51·3 W.	—	—	—
			1899	15 48·4 W.	—	—	—
Coimbra	40 12 N.	8 25 W.	1900	17 20·1 W.	59 24·3 N.	·22768	·38506
			1901	17 16·1 W.	59 19·6 N.	·22805	·38449
Lisbon	38 43 N.	9 9 W.	1900	17 18·0 W.	57 54·8 N.	·23516	·37484
Tokio	35 41 N.	139 45 E.	1897	4 29·9 W.	49 2·8 N.	·29816	·34356

* Owing to the introduction of a correction neglected in previous years the horizontal force is ·00067 less, and the vertical force ·00144 less than if the old method of reduction had been retained.

† Owing to the introduction of a correction neglected in previous years the horizontal force is ·00088 less, and the vertical force ·00153 less than if the old method of reduction had been retained.

APPENDIX IA—*continued.*

Place.	Latitude.	Longitude.	Year.	Declination.	Inclination.	Horizontal Force. C.G.S. Units.	Vertical Force. C.G.S. Units.
Zi-ka-wei	° ′ 31 12 N.	° ′ 121 26 E.	1899	° ′ 2 20·3 W.	° ′ 45 47·6 N.	·32825	·33747
Havana.......	23 8 N.	82 25 W.	1900	3 7·8 E.	52 36·0 N.	·30948	·4048
Hong Kong....	22 18 N.	114 10 E.	1900	0 18·5 E.	31 24·7 N.	·36728	·22430
Tacubaya......	19 24 N.	99 12 E.	1895	7 45·6 E.	44 22·2 N.	·33428	·32764
Colaba (Bombay)	18 54 N.	72 49 E.	1898	0 28·6 E.	21 6·2 N.	·37445	·14451
			1899	0 25·4 E.	21 13·9 N.	·37448	·14549
Manila........	14 35 N.	120 59 E.	1899	0 51·9 E.	16 19·9 N.	·37981	·11130
			1900	0 52·1 E.	16 16·0 N.	·38029	·11096
Batavia	6 11 S.	106 49 E.	1898	1 14·9 E.	29 47·4 S.	·36752	·21040
Dar-es-salem ..	6 49 S.	39 18 E.	1898	8 18·1 W.	36 56·8 S.	·28966	·21785
Mauritius	20 6 S.	57 33 E.	1899	9 32·9 W.	54 16·8 S.	·23854	·33171
Rio de Janeiro .	22 55 S.	43 11 W.	1900	7 55·7 W.	13 17·0 S.	·2504	·0592
Melbourne.....	37 50 S.	144 58 E.	1898	8 20·1 E.	67 22·4 S.	·23364	·56050

APPENDIX II.—Table I.

Mean Monthly Results of Temperature and Pressure for Kew Observatory.
1901.

Months.	Thermometer.										Barometer.*							Mean vapour-tension.
	Mean.	Means of—			Absolute Extremes.						Mean.	Absolute Extremes.						
		Max.	Min.	Max. and Min.	Max.	Date.	Hour.	Min.	Date.	Hour.		Max.	Date.	Hour.	Min.	Date.	Hour.	
1901.	°	°	°	°	°			°			ins.	ins.			ins.			in.
January ...	39·2	43·7	34·6	39·2	54·5	27	2 P.M.	19·0	9	2 A.M.	30·046	30·647	23	10 A.M.	29·266	27	3 & 5 P.M.	·207
February ..	36·4	40·5	32·3	36·4	51·0	28	3 ,,	21·5	14	7 & 8 A.M.	30·065	30·632	15	8 P.M.	29·164	27	7 A.M.	·175
March.....	39·9	45·2	34·8	40·0	54·9	5	1 ,,	25·7	28	6 ,,	29·777	30·510	23	10 A.M.	29·099	1	8 ,,	·192
April.....	48·4	56·8	39·9	48·4	73·0	23	5 ,,	30·8	2	5 ,,	29·849	30·319	18	8 ,,	29·348	1	0 ,,	·238
May	53·4	62·9	44·1	53·5	80·4	29	3 ,,	35·7	1	6 ,,	30·087	30·447	12	10 P.M.	29·288	7	2 P.M.	·277
June	59·1	68·6	50·1	59·4	78·6	9	3 ,,	40·2	19	4 ,,	30·053	30·435	26	8 A.M.	29·567	14	1 A.M.	·325
July	65·3	75·7	55·9	65·8	87·6	19	2 ,,	48·4	8	4 ,,	29·996	30·292	17	7 ,,	29·485	24	5 P.M.	·431
August	62·5	71·8	53·8	62·8	82·0	25	3 ,,	46·4	28	5 ,,	30·052	30·442	20	8 ,,	29·448	26	3 ,,	396
September..	58·0	65·7	50·5	58·1	74·8	8	2 ,,	40·6	16	6 & 7 ,,	29·920	30·327	27	8 ,,	29·354	17	2 ,,	·370
October ...	50·1	57·1	43·4	50·3	72·0	1	3 ,,	30·9	27	7 ,,	29·931	30·411	27	9 ,,	29·117	6	1 ,,	·308
November..	40·4	45·4	35·2	40·3	54·4	11	1 ,,	21·1	17	8 ,,	30·169	30·661	25	10 ,,	29·048	12	5 ,,	·211
December ..	39·4	44·1	34·0	39·1	55·3	7	3 ,,	23·2	17	7 & 8 ,,	29·654	30·452	4	11 ,,	28·657	24	11 ,,	·214
Means	49·3	56·5	42·4	49·4	..	..	..	..	..	..	29·967	..	..	..	..	..	..	·279

* Reduced to 32° at M.S.L.

This table haa been compiled at the Meteorological Office from values intended for publication in the volume of "Hourly Means" for 1901.

Meteorological Observations.—Table II.

Kew Observatory.

Months.	Mean amount of cloud (0=clear, 10=overcast).	Rainfall.* Total.	Rainfall.* Maximum.	Rainfall.* Date.	Weather. Number of days on which were registered: Rain. ‡	Snow.	Hail.	Thunderstorms.	Clear sky.	Overcast sky.	Gales.§	Wind.† Number of days on which it was: N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.‖
1901.		ins.	ins.																	
January	7·8	0·850	0·185	8	14	4	1	0	2	20	2	1	4	7	2	4	5	7	1	6
February	7·6	1·055	0·450	4	8	5	0	0	2	16	0	6	3	2	1	2	4	6	4	3
March	7·5	1·860	0·445	30	15	3	1	0	1	15	4	7	9	1	0	2	6	3	3	2
April	5·6	2·120	0·580	3	16	0	1	0	6	7	5	3	2	3	3	4	9	5	1	2
May	5·0	0·450	0·260	9	7	0	1	1	10	12	0	10	7	2	0	3	4	2	3	5
June	6·4	1·360	0·575	30	11	0	0	1	3	9	1	4	3	5	0	4	4	7	3	0
July	5·6	2·025	0·905	25	9	0	0	1	8	10	0	4	4	10	1	2	4	4	2	8
August	5·1	1·875	0·515	27	9	0	0	0	6	5	0	2	2	6	1	5	6	7	2	1
September	6·8	1·530	0·485	16	7	0	0	0	3	13	1	5	4	3	1	8	5	2	2	6
October	6·7	1·885	0·205	1	15	0	0	0	3	15	1	1	4	2	3	5	8	6	2	14
November	5·9	0·470	0·220	13	6	0	0	0	9	15	1	4	4	5	0	1	7	7	2	11
December	7·2	3·255	0·775	12	14	4	1	0	2	16	0	3	1	2	2	3	10	9	1	5
Totals and means	6·5	18·735	..	..	131	16	5	3	55	153	15	50	47	48	14	43	72	65	26	63

* 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 inch rain or melted snow was recorded.
§ In a "gale" the mean wind velocity has exceeded 35 miles an hour in at least one hour of the twenty-four.
‖ In a "calm" the mean wind velocity for the twenty-four hours has not exceeded 5 miles an hour.

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.
		Old method.	New method.											
1901.	h. m.			h. m.		°	°		°	°		miles.	miles.	
January	42 24	16	16	5 42	10	63	85	10	29	15	15	11·3	49	27
February	45 48	17	17	6 54	12	69	99	28	24	8	14	9·0	26	5, 15
March	70 6	19	19	8 6	27	87	105	5	28	10	29	15·3	39	30
April	215 48	52	52	13 30	26	110	124	22, 23	30	17	2	13·0	38	8
May	250 30	52	52	14 36	15	118	138	29	34	24	1, 5	10·0	29	22, 23, 24
June	240 00	49	49	14 24	10	127	139	3	41	26	19	11·1	36	29
July	236 48	47	48	14 0	18	125	147	17	47	36	9	6·9	27	2
August	233 36	52	52	13 54	11	123	136	10	44	37	22, 23	9·1	27	10, 26
September	115 24	30	30	11 6	4	111	127	8	41	28	6	8·6	41	4
October	86 24	26	26	8 18	7	92	120	1	34	25	24	7·7	40	31
November	38 42	15	15	5 30	1	63	85	1	29	14	16, 23	9·3	36	12
December	50 18	21	21	5 42	18	62	82	1, 2	27	15	19	11·5	33	8, 31
Totals and Means	1625 48	33	36	..	..	..	..	..	..	..	..	10·2	..	..

* As indicated by a Robinson's anemograph, 70 feet above the general surface of the ground, the original factor 3 being used.

† Read at 10 A.M., and entered to previous day. ‡ Read at 10 A.M., and entered to same day.

APPENDIX III.—Table I

Register of principal Seismograph Disturbances. 1901.

No. in Kew register.	Date.	Commencement of P.T.'s.*	Duration of P.T.'s.*	First maximum.	Second maximum.	Maximum amplitude.		Total duration of disturbance.
						mm.	Secs. of arc.	
		h. m.	m.	h. m.	h. m.			h. m.
267	Jan. 7	0 38·3	42·2	1 21·2	1 52·0	1·0	0·7	2 44
271	„ 18	4 56·8	22·8	5 21·5	5 23·8	3·1	2·3	1 23
284	Mar. 5	11 1·5	28·7	11 31·8	11 36·5	1·0	0·8	1 44
285	„ 16	12 12·2	18·6	12 36·3	—	2·0	1·6	1 35
288	„ 25	11 47·4	29·2	12 19·0	—	1·0	0·8	0 44
289	„ 31	7 14·7	9·1	7 27·3	7 32·8	3·0	2·4	0 49
290	Apr. 5–6	23 13·4	67·6	0 32·8	0 39·6	4·8	3·8	3 30
291	„ 6	21 16·9	25·8	21 53·7	21 59·5	0·8	0·6	1 22
299	May 25	1 5·2	53·2	2 14·0	—	1·0	0·8	2 6
302	June 17	14 54·0	16·2	15 26·2	15 47·0	1·0	0·8	1 30
303	„ 24	7 13·8	40·8	8 4·6	8 11·2	8·4	6·7	2 12
311	Aug. 9	9 36·0	10·5	10 15·6	10 21·8	7·5	5·6	2 52
312	„ 9	13 23·8	51·0 ?	Time	uncertain.	6·1	4·6	3 35
313	„ 9	18 50·0 ?	?	19 28·5	—	8·0	6·0	2 47
320	Sept. 30	10 28·5	34·5	11 14·5	—	1·3	1·0	1 33
321	Oct. 8	2 36·8	20·4	3 5·2	3 21·5	1·5	1·2	1 48
336	Nov. 18	0 19·2	14·0	0 38·5	—	1·0	0·8	1 4
341	Dec. 9	2 38·3	17·0	3 7·0	3 13·3	3·0	2·4	1 18
342	„ 14–15	23 15·7	39·2	0 2·3	0 10·5	1·8	1·4	1 15
346	„ 31	9 24·7	27·8	9 56·7	—	1·2	1·0	2 22

* P.T.'s = preliminary tremors. The times recorded are G.M.T.; midnight = 0 or 24 hours. The figures given above are obtained from the photographic records of a Milne Horizontal Pendulum; they represent E—W displacements.

APPENDIX IV.—Table I.

RESULTS OF WATCH TRIALS. Performance of the 50 Watches which obtained the highest number of marks during the year.

Watch deposited by	Number of watch.	Escapement, balance spring, &c.	Mean daily rate. Pendant up.	Pendant right.	Pendant left.	Dial up.	Dial down.	Mean variation of daily rate. ±	Mean change of rate for 1° F.	Difference between extreme gaining and losing rates.	Marks awarded for Daily variation of rate. 0—40	Change of rate with change of position. 0—40	Temperature compensation. 0—20	Total Marks. 0—100.
			secs.	secs.	secs.	secs.	secs.	secs.	secs.	secs.				
H. Williamson, Ltd., London	56365	S.r., g.b., s.o., "Karrusel"	−2·4	−2·4	−2·9	−2·5	−2·1	0·3	0·03	2·7	34·3	39·2	17·8	91·3
,, ,, ,,	56371	S.r., g.b., s.o., "Karrusel"	−0·6	−0·3	−1·3	−0·4	−0·6	0·3	0·04	3·0	33·6	39·0	17·3	89·9
S. Smith & Son, London	1901–22	D.r., fusee, d.o., "Tourbillon" lever	+0·7	−0·1	+0·2	+0·2	−1·7	0·2	0·06	4·2	36·1	37·4	16·3	89·8
H. Golay, London	7557	D.r., g.b., s.o., "Annular Tourbillon"	+0·6	+1·2	+1·3	+1·6	+1·4	0·3	0·06	3·5	34·7	39·0	15·8	89·5
Montandon-Robert, Geneva	1171	D.r., g.b., s.o., minute repeater	−1·6	−0·7	−1·9	−0·2	−1·4	0·3	0·04	2·7	33·1	37·8	17·5	88·4
J. Adams, Coventry	9174	S.r., g.b., s.o., "Karrusel"	+0·2	+0·4	+0·6	+1·4	−0·4	0·25	0·08	4·0	35·0	38·2	14·9	88·1
A. E. Fridlander, Coventry	25619	S.r., g.b., s.o., "Karrusel"	+1·4	+1·6	+1·7	+0·9	+3·6	0·3	0·04	5·7	33·6	37·1	17·2	87·9
S. Yeomans, Coventry	85225	S.r., g.b., s.o., "Karrusel"	−1·5	−1·4	−1·4	+0·9	+1·9	0·2	0·03	4·5	35·2	34·5	17·8	87·5
W. Matthews, Coventry	39079	S.r., g.b., s.o., "Karrusel"	+0·7	−1·0	+3·2	+0·4	+0·2	0·3	0·04	6·0	33·9	36·0	17·5	87·4
H. Golay, London	7558	D.r., g.b., s.o., "Annular Tourbillon"	+2·2	+2·3	+2·5	+2·1	−0·3	0·3	0·04	3·7	33·4	36·6	17·4	87·4
W. Vasel, London	1670	S.r., g.b., s.o., "Tourbillon"	+1·5	+1·2	+1·7	+1·8	+3·1	0·3	0·05	5·0	33·1	38·0	16·3	87·4
G. E. Hurcomb, London	06760	S.r., g.b., s.o., "Karrusel"	−0·1	−0·2	−0·1	−1·7	−0·4	0·4	0·04	5·2	31·9	38·1	17·1	87·1
R. Milne, Sale	1296	S.r., g.b., s.o., "Karrusel"	−2·2	−1·8	−1·7	−0·9	−2·2	0·4	0·05	4·0	31·4	38·5	16·9	86·8
W. Matthews, Coventry	101021	S.r., g.b., s.o., "Karrusel"	+1·0	+1·6	+2·6	+2·2	+2·4	0·5	0·03	4·5	30·4	37·9	18·3	86·6
,, ,,	38994	S.r., g.b., s.o., "Karrusel"	−0·1	−0·2	+0·3	+0·6	+1·4	0·4	0·07	5·2	32·8	38·2	15·3	86·3
A. E. Fridlander, Coventry	25560	S.r., g.b., s.o., "Karrusel"	+0·8	+0·5	+0·2	+1·5	+4·2	0·3	0·05	6·0	34·1	35·5	16·6	86·2
W. Matthews, Coventry	101025	S.r., g.b., s.o., "Karrusel"	+0·2	0·0	+1·1	−0·8	−0·3	0·4	0·05	5·5	31·8	38·0	16·3	86·1
Usher & Cole, London	30605	S.r., g.b., s.o., "Karrusel"	+1·0	+0·5	+1·1	+0·8	+1·4	0·5	0·03	5·0	29·3	39·0	17·7	86·0
H. Golay, London	1565	S.r., g.b., s.o., "Karrusel"	−3·7	−3·7	−4·6	−2·2	−5·0	0·35	0·07	5·2	33·0	37·0	15·7	85·7
A. E. Fridlander, Coventry	25603	S.r., g.b., s.o., "Karrusel" non-magnetic	−2·9	−1·9	−2·7	−0·3	−0·9	0·5	0·02	6·0	30·8	36·3	18·5	85·6
Carley & Co., London	50726	S.r., g.b., d.o., "Karrusel"	−0·9	−2·3	−2·0	−2·3	+1·8	0·4	0·03	6·5	32·6	34·9	17·9	85·4
S. Smith & Son, London	193–387 / 25566	S.r., g.b., s.o., "Karrusel"	−1·1	−1·0	−0·4	+1·2	−1·3	0·4	0·05	4·0	31·7	37·1	16·6	85·4
Wright & Craighead, London	8205	S.r., g.b., s.o., "Karrusel"	+1·4	+1·7	+1·7	+3·6	+0·1	0·3	0·08	4·7	34·0	36·9	14·4	85·3
Baume & Co., London	12854	S.r., g.b., d.o.	−0·1	+1·8	+0·4	+1·1	+2·5	0·4	0·06	4·5	32·8	36·8	15·7	85·3
A. E. Fridlander, Coventry	25596	S.r., g.b., s.o., "Karrusel"	−1·6	−1·1	−1·3	−0·4	+0·9	0·4	0·06	5·8	32·1	37·0	16·1	85·2
J. Player & Son, Coventry	29696	S.r., g.b., s.o., "Karrusel"	+4·7	+3·9	+4·0	+2·5	+4·6	0·4	0·05	6·7	31·1	37·6	16·5	85·2

Table I—*continued.*

Watch deposited by	Number of watch.	Escapement, balance spring, &c.	Mean daily rate. Pendant up.	Mean daily rate. Pendant right.	Mean daily rate. Pendant left.	Mean daily rate. Dial up.	Mean daily rate. Dial down.	Mean variation of daily rate. ±	Mean change of rate for 1° F.	Difference between extreme gaining and losing rates.	Marks awarded for Daily variation of rate. 0—40	Marks awarded for Change of rate with change of position. 0—40	Marks awarded for Temperature compensation. 0—20	Total Marks. 0—100.
			secs.	secs.	secs.	secs.	secs.	secs.	secs.	secs.				
G. E. Hurcomb, London	06761	S.r., g.b., s.o., "Karrusel"	+1·0	−0·3	+0·8	+2·9	+2·5	0·25	0·09	5·0	35·1	35·8	14·2	85·1
A. E. Fridlander, Coventry	25609	S.r., g.b., s.o., "Karrusel"	+1·0	+1·6	+1·0	−2·2	+2·0	0·4	0·04	6·8	32·2	35·4	17·5	85·1
J. White & Son, Coventry	36908	D.r., g.b., s.o.	+0·6	−0·5	+1·7	+0·2	+2·5	0·4	0·04	5·0	31·2	36·0	17·7	84·9
E. Dent & Co., Ltd., London	51625	S.r., g.b., d.o.	−3·3	−1·1	−2·0	−2·2	+0·8	0·4	0·05	8·0	32·1	35·5	16·8	84·4
H. Williamson, Ltd., London	55935	S.r., g.b., s.o., "Karrusel"	−2·4	0·0	+1·0	−0·3	−0·8	0·6	0·01	6·5	28·4	36·5	19·5	84·4
S. Smith & Son, London	1900A	G.b., d.o., chronometer, "Karrusel"	0·0	−0·3	−0·1	+2·7	+2·2	0·4	0·04	5·0	31·6	35·0	17·5	84·1
J. Hewitt, Coventry	57033	S.r., g.b., s.o., "Karrusel"	−1·1	−1·0	−1·0	+0·5	+2·9	0·3	0·07	6·7	33·4	34·8	15·5	83·7
J. White & Son, Coventry	36465	D.r., g.b., s.o.	+2·3	+0·7	+1·9	+2·6	+3·4	0·5	0·06	5·5	30·5	37·2	16·0	83·7
Newsome & Co., Coventry	130854	S.r., g.b., s.o., "Karrusel"	−2·9	−3·3	−2·7	−2·2	−2·1	0·5	0·07	5·2	30·2	38·4	15·1	83·7
S. Yeomans, Coventry	76661	S.r., g.b., s.o., "Karrusel"	−0·7	−1·2	−1·9	−4·1	−2·4	0·5	0·03	6·0	29·1	36·2	18·2	83·5
A. E. Fridlander, Coventry	25602	S.r., g.b., s.o., "Karrusel" non-magnetic	−7·0	−5·6	−5·0	−7·0	−7·5	0·4	0·07	6·5	31·6	36·5	15·2	83·3
H. Golay, London	2494	S.r., fusee, d.o., "Karrusel" chronograph	−0·1	+0·5	−0·5	+2·5	−1·1	0·5	0·06	4·5	31·0	36·0	16·3	83·3
W. Matthews, Coventry	101020	S.r., g.b., s.o., "Karrusel"	−2·0	−3·0	−2·1	+1·0	−0·5	0·3	0·08	5·0	33·9	34·9	14·4	83·2
Baume & Co., London	260517	D.r., g.b., s.o., chronograph	+3·1	+6·5	−1·0	+2·8	+5·0	0·4	0·02	9·2	32·6	32·0	18·5	83·1
R. Milne, Sale	1297	S.r., g.b., s.o., "Karrusel"	+1·4	+0·6	+1·8	+2·8	+2·3	0·5	0·07	5·2	30·1	37·5	15·5	83·1
W. Matthews, Coventry	38603	S.r., g.b., s.o., "Karrusel"	−1·7	−2·4	−3·2	+0·4	−1·7	0·4	0·10	5·0	33·1	36·4	13·5	83·0
,, ,,	101038	S.r., g.b., s.o., "Karrusel"	+1·5	+1·0	+2·7	+2·4	+2·2	0·4	0·10	6·0	32·1	37·8	13·1	83·0
Newsome & Co., Coventry	130853	S.r., g.b., s.o., "Karrusel"	−0·1	−0·3	+1·6	−0·8	−0·5	0·6	0·04	6·0	28·2	37·4	17·4	83·0
W. Matthews, Coventry	101022	S.r., g.b., s.o., "Karrusel"	−3·7	−3·5	−3·4	−0·2	−0·5	0·4	0·06	5·0	32·8	33·8	16·3	82·9
Baume & Co., London	13120	S.r., g.b., d.o.	+1·7	+0·5	+4·3	+3·3	+2·5	0·4	0·08	5·8	32·6	35·6	14·7	82·9
W. Matthews, Coventry	38442	S.r., g.b., s.o., "Karrusel"	+0·9	+1·5	+0·7	+3·8	+3·2	0·5	0·06	4·3	31·4	35·3	16·2	82·9
S. Smith & Son, London	1900–4	S.r., fusee, d.o., "Tourbillon" calendar repeater	+0·8	+0·4	+0·7	+2·0	+3·8	0·4	0·07	7·2	31·4	35·8	15·5	82·7
Russells, Ltd., Liverpool	88126	S.r., g.b., s.o.	+0·9	+1·6	+2·4	−0·7	+0·6	0·5	0·05	6·2	29·1	36·7	16·9	82·7
S. Smith & Son, London	193–399 / 25616	S.r., g.b., s.o., "Karrusel"	−3·8	−3·0	−3·1	+0·7	−1·4	0·3	0·08	5·8	33·3	34·4	14·7	82·4

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; s.o. for single overcoil; d.o. for double overcoil; + for gaining rate; − for losing rate.

Table II.

Highest Marks obtained by Complicated Watches during the year.

Description of watch.	Number.	Deposited by	Marks awarded for: Variation.	Marks awarded for: Position.	Marks awarded for: Temperature.	Total marks.
			0—40	0—40	0—20	0—100.
Minute and split seconds chronograph, repeater, perpetual calendar, with phases of the moon, and tourbillon	1900–1	S. Smith and Son, London	31·2	36·3	13·4	80·9
" " " (without chronograph)	1900–4	" " "	31·4	35·8	15·5	82·7
Minute and split seconds chronograph, and minute repeater	1901–17	S. Smith and Son, London	32·7	31·0	12·8	76·5
" " " (not split seconds)	153–101	" " "	29·8	31·7	9·2	70·7
Minute and split seconds chronograph	2494	H. Golay, London	31·0	36·0	16·3	83·3
" " "	160–2	S. Smith and Son, London	30·0	32·5	17·8	80·3
" " "	1901–20	" " "	32·8	32·8	11·9	77·5
Minute and seconds chronograph	5613	Army and Navy C.S., Ltd., London	30·6	34·6	16·2	81·4
" " " (non-magnetic)	260536	Baume and Co., London	25·6	35·8	18·0	79·4
" " " " "	260531	" " "	32·6	28·7	17·4	78·7
" " " " "	260530	" " "	27·5	33·3	17·7	78·5
Minute repeater	1171	Montandon-Robert, Geneva	33·1	37·8	17·5	88·4
" " (and clock)	1900–2	S. Smith and Son, London	31·0	34·0	16·4	81·4
" " "	37015	Jos. White and Son, Coventry	33·6	34·4	11·7	79·7
" " "	10365	Nicole Nielsen and Co., London	30·3	30·2	16·1	76·6
Non-magnetic	25603	Fridlander, Coventry	30·8	36·3	18·5	85·6
"	25602	" "	31·6	36·5	15·2	83·3
"	189–256	S. Smith and Son, London	31·8	36·5	13·7	82·0
"	192c–227	" "	30·7	33·9	17·3	81·9

APPENDIX A.

Report of the Executive Committee for the year, October 1, 1899, to September 30, 1900.

In presenting their Report to the General Board of the Laboratory the Executive Committee have to express their regret that, in consequence of the delay in determining on the site, the progress made during the year has not been as great as they had hoped for.

The following, however, is a brief record of the main events :—

After a conference with the Commissioners of Woods and Forests, some members of the Executive Committee visited various sites suggested by the Commissioners, and reported strongly in favour of the site originally suggested by the Treasury Committee, in the Old Deer Park at Richmond.

Further interviews were held with the Commissioners, and, subject to the approval of the Treasury, terms were arranged by which an area of about 15 acres was provisionally secured to the Committee for the purposes of the Laboratory.

The terms of the agreement were laid before the General Board at a meeting, on February 9, 1900, and a resolution was passed approving them.

Meanwhile it had been agreed to approach the Office of Works, with a view to having the building constructed by them, and a Building Committee was appointed to prepare plans.

In the early part of the year the Director visited the Reichs-Anstalt in Berlin, and the Bureau International at Sèvres, in order to make himself acquainted with the arrangement of these two institutions before the plans were drawn up. The Committee are glad to have this opportunity of recognising the courtesy with which he was received by the authorities of these two institutions.

During the autumn of 1899 various sub-committees had reported on the work which might be usefully undertaken by the Laboratory, and the Building Committee were instructed to have regard to these reports in the preparation of the plans.

From the consideration of these it appeared that it would be desirable to erect two buildings at some distance apart. In the one which it was proposed to call the Physics Laboratory, experiments requiring great stability and freedom from disturbance would be carried out; the other, which might conveniently be placed nearer a main road, would be an Engineering Laboratory.

Accordingly, plans for a Physics building, at an estimated cost of £6000, and an Engineering Laboratory, at an estimated cost of £4000, were approved by the Executive Committee. These were submitted to the General Board at their meeting on June 25, 1900.

Meanwhile, questions had been asked in Parliament with regard to the site, and Mr. Hanbury received a deputation from persons opposed to placing the Laboratory in the Old Deer Park. This was followed by a deputation from the Royal Society, who urged that the scheme proposed by the Treasury Committee, and adopted in its general features by the Treasury in a letter to the President, dated October 7, 1898, should be carried out.

At their meeting held on October 24 the Executive Committee received a semi-official communication from the Treasury stating that the Government, with Her Majesty's approval, had determined to allot the Bushy site.

A copy of the communication, which the Executive Committee have addressed to the Council of the Royal Society, is appended for the information of the General Board.

The exact terms under which Bushy House is to be held have not been settled, but at the request of the Treasury an estimate has been made by the Office of Works of the cost necessary to make it suitable for a Laboratory. This estimate, which amounts to £14,296, includes the provision of a new Engineering Laboratory, and the erection of a Boiler House and Engine Room, together with the cost of an engine and dynamo for the supply of light and power. The Committee have been informed that in view of this expenditure the Government intend to ask Parliament to increase their Grant for capital outlay from £12,000 to £14,000.

Work, in the meantime, has been going on in the buildings of the Kew Observatory. The control of the work carried on by the Kew Committee of the Royal Society, appointed under the provisions of the Gassiot Trust Deed of June 29, 1871, was taken over by the Executive Committee from the 1st of January, and the property held by that Committee was handed over to the Royal Society for the purposes of the Laboratory as from that date.

The Committee, which was incorporated as a Public Company, has since been dissolved. The work at Kew Observatory has been continued in all its branches. A detailed account will be published later. It may, however, be stated that the total number of instruments tested up to the end of September is largely in excess of the corresponding number for any previous year.

Among the pieces of work which have increased in importance during the year may be mentioned the testing of telescopic sights for the naval guns. The Director has also been in correspondence with the War Office authorities with regard to the testing of aneroids and watches. The magnetic work has grown, and the facilities for it have been greatly improved by the erection of a second house for magnetic observations. Captain Denholm Frazer, R.E., who is in charge of the Indian Magnetic Survey, has been working at the Laboratory during a great part of the summer, making himself acquainted with the methods of measurement, and testing the instruments to be used in India.

A new workshop and packing-house have been built, and the space thus set free, with the adjacent platinum thermometer room built in 1897, has been utilized as a Laboratory for the Director. Some of the electrical apparatus of the British Association has been fitted up in this room, and during the summer a series of comparisons of the standard coils was made. Experiments in platinum thermometry have been continued, and valuable results are being accumulated. The air thermometer, given by Sir Andrew Noble, has been erected in this Laboratory by Dr. Harker, and is now nearly ready for use.

The new workshop has been fitted with certain necessary tools, and a mechanic has been for some little time at work making apparatus for use in the Laboratory.

The Committee have to thank various donors for gifts. Sir Andrew Noble has contributed £1,000 for the purchase of apparatus. Dr. Isaac Roberts has given a spectroscope and two very valuable induction coils. Dr. Common has provided apparatus for determining the magnifying power and testing the collimation error of the telescopic sights, and has promised a large flat surface for optical work. Mrs. Sworn has given the collection of thermometers used by her late husband.

The financial position is for the present satisfactory; the financial year closes on December 31, and the audited accounts will be presented later. During the past year the erection of the workshop and magnetic room, and the fitting of the Laboratory, have been a cause of exceptional expenditure, amounting to about £475, while about £250 has been spent in apparatus and tools; but the additional staff appointed since the Kew Observatory was taken over consists only of the Director and a mechanic. Thus the income for the year will be in excess of the expenditure; there is every prospect, moreover, that the fees for testing will show an increase.

In accordance with the scheme of organisation this Report is made up to September 30, 1900. The Executive Committee desire to bring before the General Board the suggestion that in future their Report should end with the close of the calendar year, being brought down to December 31 in each year. It would then be possible to include audited copies of the accounts, and a complete statement of the results of the year's work.

Copy of Resolution adopted by the Executive Committee for transmission to the Council of the Royal Society at their meeting on October 24, 1900:—

"That a copy of Sir F. Mowatt's semi-official communication be forwarded by this Committee to the Council of the Royal Society: that the Executive Committee report to the Council of the Royal Society that, while they consider that there are several reasons for preferring the site in the Old Deer Park at Richmond—which was recommended by the Treasury Committee and approved by the Treasury—the Committee are of opinion that a reasonably satisfactory National Physical Laboratory can be provided on the Bushy site, and they do not recommend the Royal Society to further oppose the arrangement which the Treasury, with the approval of Her Majesty, have adoped.

"The Executive Committee note with satisfaction that the Lords Commissioners propose to ask Parliament to grant an additional £2,000, in order to provide for capital outlay in the next financial year.

"They cannot, however, conceal from themselves that it will be very difficult for them to maintain and administer a National Physical Laboratory on the Bushy site for the amount annually allowed by the Treasury, and they fear that it may be necessary for them to press in the near future for an addition to that allowance."

October, 1900.

APPENDIX B.

REPORT OF MAGNETICAL OBSERVATIONS FOR THE YEAR 1901. MADE AT FALMOUTH OBSERVATORY, LATITUDE 50° 9′ 0″ N., LONGITUDE 5° 4′ 35″ W., HEIGHT 167 FEET ABOVE MEAN SEA-LEVEL.

Photographic curves of magnetic declination and of horizontal and vertical force variations have been regularly taken during the year.

The scale values of the instruments were determined on 20th December, 1901. The following values of the ordinates of the photographic curves were then found :—

Declination, 1 cm. = 0° 11′·7.
Bifilar, 1 cm. δ H. = 0·00052 C.G.S. unit.
Balance, 1 cm. δ V. = 0·00058 C.G.S. unit.

The sensibility of the balance magnet was increased and the scale value re-determined, the result then being :—

Balance, 1 cm. δ V. = 0·00048 C.G.S. unit.

The magnetic curves during the past year have shown very few large fluctuations; the principal variations recorded took place on the following dates:—February 22; March 24; May 10; July 12; August 14, 15; September 10.

Observations with the absolute instruments have been made about three times a month, of which the following is a summary :—

Determinations of	horizontal intensity,	37.
,,	inclination,	38 sets of four.
,,	declination,	38.

Following the method adopted in the ten previous years, the observations have been reduced, and the declination and horizontal force curves for five quiet days in each month of the year—selected by the Astronomer Royal—have been tabulated and prepared for publication, in accordance with the international scheme.

The results of the magnetic elements for the year 1901 are as follows :—

Mean horizontal force, 0·18720 C.G.S. unit. Mean westerly declination 18° 25′·5, both deduced from the photographic curves; and mean inclination 66° 42′·8 derived from the absolute observations.

The whole of the instruments have been maintained in good order; and the magnetic chamber and the magnetic hut in the garden have been kept in a thoroughly satisfactory condition, the latter having been re-painted throughout.

The Declination and the Horizontal Force are deduced from hourly readings of the photographic curves, and so are corrected for the diurnal variation.

The results in the following tables, Nos. I, II, III, IV, are deduced from the magnetograph curves, which have been standardised by observations of deflection and vibration. These were made with the Collimator Magnet, marked 66A, and the Declinometer Magnet, marked 66C, in the Unifilar Magnetometer No. 66, by Elliott Brothers, of London. The temperature correction to the horizontal force (which is probably very small) has not been applied.

In Table V, H is the mean of the absolute values observed during the month (generally three in number), uncorrected for diurnal variations and for any disturbance. V is the product of H and of the tangent of the Observed Dip (uncorrected likewise for diurnal variation).

In Table VI the Inclination is the mean of the absolute observations, the mean time of which is 3 P.M. The Inclination was observed with the Inclinometer No. 86, by Dover, of Charlton, Kent, and needles 1 and 2, which are 3½ inches in length.

The Declination and the Horizontal Force values, given in Tables I to IV, 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, and the time given is Greenwich Mean Time, which is 20 minutes 18 seconds earlier than local time.

The following is a list of the days during the year 1901 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	3, 12, 13, 19, 31.	February	4, 11, 15, 16, 25.
March	10, 11, 16, 17, 28.	*April	4, 6, 12, 17, 30.
May	4, 5, 16, 28, 30.	June	3, 5, 17, 25, 27.
July	2, 3, 21, 28, 29.	August	1, 6, 11, 26, 28.
September	6, 7, 15, 20, 28.	October	2, 3, 18, 24, 27.
November	1, 8, 15, 22, 30.	December	6, 11, 17, 18, 22.

EDWARD KITTO,

Magnetic Observer.

* 4th, 6th, and 30th, only available.

Table I.—Hourly Means of Declination at the Falmouth on Five selected quiet Days in each Month

(18° + West.)

Hours	Mid.	1	2	3	4	5	6	7	8	9	10	11
Winter.												
1901.	′	′	′	′	′	′	′	′	′	′	′	′
Jan. ..	26·0	26·3	26·5	26·5	26·5	26·5	26·3	26·3	26·0	25·3	25·7	26·5
Feb. ..	27·7	28·0	28·1	28·4	28·5	28·4	28·1	27·8	27·4	27·0	27·4	28·4
March .	26·1	25·9	25·8	25·9	25·8	25·9	25·7	25·4	24·5	23·9	25·0	27·8
Oct. ..	23·8	23·8	23·9	23·9	24·1	23·9	23·6	23·0	21·9	21·7	23·0	25·2
Nov. ..	22·8	23·0	23·3	23·4	23·4	23·5	23·1	22·9	22·4	22·0	22·9	24·1
Dec. ..	23·8	24·0	24·1	24·3	24·3	24·0	23·8	23·8	23·7	23·6	23·8	24·4
Means	25·0	25·2	25·3	25·4	25·4	25·4	25·1	24·9	24·3	23·9	24·6	26·1
Summer.												
1901.	′	′	′	′	′	′	′	′	′	′	′	′
*April..	26·8	26·9	26·8	26·7	26·5	26·3	25·7	24·5	23·1	22·5	24·0	26·7
May ..	25·6	25·5	25·3	25·1	24·7	23·9	22·9	22·1	21·5	21·6	23·2	25·5
June ..	25·6	25·4	25·4	25·2	24·7	23·8	22·7	22·2	22·0	22·4	24·1	26·2
July ..	24·0	23·8	23·7	23·7	23·4	22·4	21·2	20·8	20·3	20·6	22·1	24·2
August.	24·1	24·1	24·0	24·0	23·5	22·9	21·8	21·5	21·4	22·3	24·5	26·7
Sept. ..	24·4	24·4	24·4	24·3	24·1	23·9	23·5	22·8	22·2	22·4	23·6	25·7
Means	25·1	25·0	24·9	24·8	24·5	23·9	23·0	22·3	21·8	22·0	23·6	25·8

* Mean of three days—4th, 6th, 30th.

Table II.—Diurnal Inequality of the Falmouth

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

Note.—When the sign is + the magnet points

Observatory, determined from the Magnetograph Curves during 1901. (Mean for the year 18° 25′·5 W.)

Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.	Mean
Winter.													
′	′	′	′	′	′	′		′	′	′	′	′	
27·5	28·6	29·1	28·2	27·3	26·9	26·5	26·4	26·2	26·1	26·1	26·0	26·1	
29·6	30·2	30·1	29·8	28·9	28·5	28·3	28·0	27·8	27·6	27·5	27·6	27·7	
30·3	31·6	31·4	30·0	28·3	27·3	27·2	27·0	26·7	26·6	26·6	26·4	26·4	
27·4	28·4	28·1	26·7	25·0	24·3	24·3	24·0	23·9	23·9	23·9	23·7	23·8	
25·5	25·9	25·5	24·5	24·1	23·8	23·5	23·0	22·9	22·8	23·0	22·8	22·9	
25·1	25·8	25·4	24·6	24·1	23·8	23·7	23·5	23·5	23·5	23·6	23·6	23·8	
27·6	28·4	28·3	27·3	26·3	25·8	25·6	25·3	25·2	25·1	25·1	25·0	25·1	25·6
Summer.													
′	′	′	′	′	′	′	′	′	′	′	′	′	
30·1	32·2	32·6	31·5	29·5	27·7	26·9	26·5	26·7	26·5	26·8	26·5	26·6	
28·7	30·0	30·2	28·5	27·1	26·1	25·5	25·2	25·1	25·4	25·6	25·8	25·7	
29·2	30·5	30·4	29·5	28·2	26·8	25·8	25·6	25·7	25·4	25·7	25·4	25·3	
26·4	27·7	28·4	28·0	26·5	24·6	23·5	23·4	23·6	23·7	23·9	23·8	23·7	
29·0	30·0	29·7	28·2	26·3	24·9	24·3	24·5	24·6	24·4	24·5	24·3	24·3	
28·4	29·5	28·6	27·1	25·8	24·9	24·8	24·8	24·8	24·7	24·7	24·5	24·6	
28·6	30·0	30·0	28·8	27·2	25·8	25·1	25·0	25·1	25·0	25·2	25·1	25·0	25·3

Declination as deduced from Table I.

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

to the west of its mean position.

Table III.—Hourly Means of the Horizontal Force at Falmouth on Five selected quiet Days in each Month

0·18000 + (C.G.S. units).

Hours	Mid.	1	2	3	4	5	6	7	8	9	10	11
Winter.												
1901.												
Jan. ..	708	708	708	703	709	711	712	712	712	708	703	701
Feb. ..	707	708	708	709	709	710	711	711	710	707	702	699
March .	718	717	716	715	716	717	718	718	717	712	710	703
Oct. ..	726	726	725	725	726	727	727	725	719	711	704	704
Nov. ..	730	731	729	729	731	731	731	730	728	721	717	715
Dec. ..	727	726	727	728	730	731	731	731	731	726	722	723
Means	719	719	719	719	720	721	722	721	720	714	710	708
Summer.												
*April.	714	715	715	716	715	715	715	714	709	700	688	680
May ..	715	714	714	714	713	713	709	706	702	698	695	694
June ..	732	731	730	730	729	731	728	723	719	712	704	704
July ..	730	727	727	728	728	727	724	720	715	710	707	705
Aug. ..	741	739	739	738	737	736	731	727	721	715	714	718
Sept. ..	725	723	723	722	722	721	720	717	713	707	703	701
Means	726	725	725	725	724	724	721	718	713	707	702	700

* Mean of three days—4th, 6th, 30th.

Table IV.—Diurnal Inequality of the Falmouth

Hours	Mid.	1	2	3	4	5	6	7	8	9	10	11
Summer mean.												
	+ ·00005	+ ·00004	+ ·00004	+ ·00004	+ ·00003	+ ·00003	·00000	− ·00003	− ·00008	− ·00014	− ·00019	− ·00021
Winter mean.												
	+ ·00001	+ ·00001	+ ·00001	+ ·00001	+ ·00002	+ ·00003	+ ·00004	+ ·00003	+ ·00002	− ·00004	− ·00008	− ·00010
Annual mean.												
	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00003	+ ·00002	·00000	− ·00003	− ·00009	− ·00014	− ·00016

Note.—When the sign is + the reading

Observatory, determined from the Magnetograph Curves during 1901. (Mean for the year ·18720.)

Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.	Mean
Winter.													
700	701	702	704	706	707	707	708	708	708	707	708	707	
698	698	701	703	704	707	710	712	712	711	711	710	710	
705	710	714	717	719	718	718	721	721	721	720	719	719	
707	714	720	723	724	725	728	730	730	731	729	729	728	
716	722	724	726	728	730	732	732	732	732	731	731	730	
723	725	727	729	729	731	731	731	731	731	730	728	728	
708	712	715	717	718	720	721	722	722	722	721	721	720	718
Summer.													
684	697	706	715	717	718	718	721	722	721	721	720	721	
698	704	710	713	716	719	719	721	721	720	719	718	716	
708	714	718	726	732	735	738	740	742	741	740	738	735	
710	715	723	729	733	731	733	737	739	736	734	732	732	
724	732	735	738	738	737	739	743	746	741	741	741	740	
707	713	715	716	716	719	722	724	726	726	726	726	725	
705	713	718	723	725	727	728	731	733	731	730	729	728	721

Horizontal Force as deduced from Table III.

Noon	1	2	3	4	5	6	7	8	9	10	11	Mid.
Summer mean.												
– ·00016	– ·00008	– ·00003	+ ·00002	+ ·00004	+ ·00006	+ ·00007	+ ·00010	+ ·00012	+ ·00010	+ ·00009	+ ·00008	+ ·00007
Winter mean.												
– ·00010	– ·00006	– ·00003	– ·00001	·00000	+ ·00002	+ ·00003	+ ·00004	+ ·00004	+ ·00004	+ ·00003	+ ·00003	+ ·00002
Annual mean.												
– ·00013	– ·00007	– ·00003	+ ·00001	+ ·00002	+ ·00004	+ ·00005	+ ·00007	+ ·00008	+ ·00007	+ ·00006	+ ·00006	+ ·00005

is above the mean.

Table V.—Magnetic Intensity. Absolute Observations. Falmouth Observatory, 1901.

1901.	C.G.S. measure. H or Horizontal force.	C.G.S. measure. V or Vertical force.
January	0·18692	0·43489
February	0·18705	0·43482
March	0·18698	0·43462
April	0·18700	0·43435
May	0·18695	0·43410
June	0·18723	0·43478
July	0·18714	0·43457
August	0·18724	0·43511
September	0·18697	0·43442
October	0·18712	0·43484
November	0·18716	0·43486
December	0·18717	0·43450
Means	0·18708	0·43466

Table VI.—Magnetic Inclination. Absolute Observations. Falmouth Observatory, 1901.

Month.		Mean.	Month.		Mean.
January	11	66° 43′·6	July	6	66° 42′·8
	23	66 45·3		13	66 42·9
		66 44·5		23	66 41·9
February	9	66 44·2		31	66 40·9
	23	66 42·5			**66 42·1**
	27	66 43·4	August	10	66 43·0
		66 43·4		17	66 45·0
March	9	66 43·3		28	66 43·0
	19	66 43·2		31	66 41·0
	30	66 43·4			**66 43·0**
		66 43·3	September	2	66 41·3
April	6	66 42·4		6	66 44·2
	27	66 42·9			**66 42·8**
	30	66 41·9	October	1	66 42·4
		66 42·4		11	66 43·6
May	7	66 42·4		22	66 43·6
	13	66 41·7		29	66 42·2
	17	66 41·9			**66 43·0**
		66 42·0	November	4	66 43·4
June	10	66 42·3		15	66 43·3
	21	66 41·8		29	66 41·8
	28	66 42·2			**66 42·8**
		66 42·1	December	6	66 41·7
				16	66 41·2
				31	66 42·2
					66 41·7