REPORT

OF THE

ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1923 *June* 2.

THE BOARD OF VISITORS.

The President of the Royal Society	Sir Charles Sherrington.
The President of the Royal Astronomical Society	Dr. J. L. E. Dreyer.
Nominated as Fellows of the Royal Society	Sir William Bragg. Prof. A. Fowler. Dr. J. H. Jeans. Sir Joseph Larmor. Sir Arthur Schuster. Sir Napier Shaw.
Nominated as Fellows of the Royal Astronomical Society.	Dr. J. W. L. Glaisher. Mr. E. B. Knobel. Sir Gerald Lenox-Conyngham. Prof. H. F. Newall. Mr. J. H. Reynolds. Col. F. J. M. Stratton.
Savilian Professor of Astronomy at Oxford	Prof. H. H. Turner.
Plumian Professor of Astronomy at Cambridge	Prof. A. S. Eddington.
Hydrographer of the Navy	Rear-Admiral F. C. Learmonth.
Secretary	Mr. W. E. Llewellyn.

REPORT OF THE ASTRONOMER ROYAL

TO THE

BOARD OF VISITORS

OF THE

ROYAL OBSERVATORY, GREENWICH.

Read at the Annual Visitation of the Royal Observatory, 1923 *June* 2.

The Report here presented refers to the year from 1922 May 11 to 1923 May 10, and exhibits the state of the Observatory on the last-named day.

I.—Buildings and Grounds, Movable Property, and Library :—

The external painting of the domes of the 28-inch, Astrographic and Sheepshanks equatorials and of the Transit Pavilion was completed on 1922 October 31. The inside of the 28-inch dome was painted in November.

The main gate to the Observatory which had been repeatedly repaired was taken down in January and replaced by a somewhat lighter one.

The painting of the external woodwork of the older part of the Observatory was commenced on February 28 and is nearly completed.

The Reflex-Zenith tube has been dismounted and placed in the lower Museum. The wood-work in the room has been dismantled and the floor repaired. It is proposed to use the room as a store for stationery, &c.

z (36)20150 Wt 4217—106 800 5/23 E & S

The instruments taken by the observers to Christmas Island reached the Observatory on December 4. The Astrographic equatorial was cleaned and remounted by December 30.

The instruments left at the Pulkovo Observatory in 1914 owing to the outbreak of war arrived back safely on 1923 April 17. The Quartz Spectroscope kindly lent by the Solar Physics Observatory has been returned to Cambridge. The Cœlostats belonging to the Eclipse Committee and the Royal Astronomical Society are being temporarily housed at the Observatory.

A new Rivett Precision Lathe, motor driven, has been supplied. With the $6\frac{1}{2}$-inch lathe and milling machine supplied in the spring of 1921, the workshop is now adequately fitted for the demands which are constantly made on it. At the present time a photometer of the Hartmann type is being constructed.

The principal movable instruments are thus distributed :—

At Greenwich—

Transits B, C, D, and E.—Transit B is fitted with an impersonal Micrometer.

Altazimuths D and E.

Equatorials (6-inch).—Cooke No. 2, Simms No. 1.

Photoheliographs Nos. 2 and 3 complete and the mechanical parts of Nos. 1 and 5.

Detached Telescopes (on tripod stands).—Three 4-inch (Simms Nos. 1 and 2 and R.O. No. 2).

Cooke 6-inch triplet Photographic Objective.

Two Hilger Chronographs.

A single-prism Spectroscope.

On loan—

Transit A, at the Cape Observatory.

Transit, with axis view, at the Science Museum, South Kensington.

Altazimuths.—A, at the Imperial College of Science and Technology, South Kensington ; B, at the Cape Observatory.

Equatorials.—Simms No. 2 (6-inch), at the Imperial College of Science and Technology.

Two Heliotropes at the Science Museum, South Kensington.

Photoheliographs :—

No. 1. Object-glass at the Cape Observatory.

No. 5. Object-glass on loan to Professor Newall, Cambridge.

Clocks.—Dent No. 1916 and Dent No. 2013, at the Cape Observatory; Dent No. 2011, at the Kew Observatory; Arnold 2, at the University Observatory, Oxford; Graham 2, for use in connection with the Time Ball at Rosyth.

Anemometer.—Whewell's Anemometer at the Victoria and Albert Museum, South Kensington.

On loan to the Royal Observatory—

The Cookson Floating Zenith Telescope from the Cambridge Observatory, for a further period of seven years from July, 1918.

A 7-inch Prism of 40° angle, from the Joint Permanent Eclipse Committee.

A Position Micrometer for measuring solar photographs, from the Solar Physics Observatory, Cambridge.

A Bendorff Electrometer, two Kelvin-White Multicellular Voltmeters, and a Flame Collector, from Dr. G. A. Carse, University of Edinburgh.

One seven-valve Amplifier and one C.W. Syntoniser, from the Royal Air Force.

One seven-valve Amplifier and two Condensers, from the Wireless Station at the Admiralty.

One three-valve Amplifier from Mr. Witt Burnham.

A battery of 72 Leclanché cells, from the Director of Scientific Research of the Admiralty.

The Standard Yard and Pound were taken away on 1922 June 7 for decennial comparison by the Deputy Warden of the Standards. They were returned on 1923 April 25, and replaced in their case in the Lower Record Room.

The large number of chronometers and watches which are not being regularly wound and rated have been transferred to the Lower Record Room. Here they are conveniently stored and are practically immune from any risk of fire.

A considerable number of old observing books and books of reductions extending from the years 1835 to 1886 have been destroyed. During this period the observations were printed in such detail in the Greenwich volumes that every figure from the original instrumental readings to the final result is either given or can be readily supplied. A number of bound volumes dealing with internal administration of purely routine character and some formal correspondence relating to chronometer business has also been destroyed. It is proposed to take an early opportunity of cleaning the room, dusting the records and comparing them with the Catalogue made in 1874. The valuable records which were in some danger of being misplaced in the over-crowded state of the room will be more accessible and at the same time less likely to be lost.

The annual examination of the Library has been made as usual, the books on the shelves being compared with the catalogue. Eight books are reported missing from the shelves and cannot be accounted for at present, including six books reported missing last year. Six of the books reported missing last year have been returned.

Further shelving accommodation has been obtained for the North Library, where Transactions and Proceedings of Societies and periodical Astronomical Literature are kept. Approximately a run of 250 feet of adjustable steel shelving has been added to the existing bays. To the East Library, which contains Magnetic and Meteorological Works, both books and serials, about 224 feet of adjustable steel shelving has been added.

II.—Astronomical Observations :—

Transit Circle.—The Sun, Moon, major planets and fundamental stars have been regularly observed as in previous years. The observation of all stars brighter than $8^{m}\cdot0$ between the limits of $+ 32^{\circ}$ and $+ 64^{\circ}$ declination, commenced in 1922, has been continued.

The total number of observations made during the year is as follows

Transits	9,660	Circle Observations	8,488
Collimation	287	Nadir point	577
Level	632		

The Sun was observed on 129 days and the Moon on 108 days.

The observations of transits and zenith distance are reduced as far as apparent place up to April 27. The reductions from apparent place to mean place 1925·0 have been computed in duplicate as far as 1922 July 28 and singly up to 1922 December 6.

The Planetary Ledgers for 1922 are complete.

The formation of a catalogue of stars, mainly in the list prepared by Dr. Backlund and Mr. Hough, observed during the years 1915–1921 is in progress. The mean positions for 1925·0 have been computed and the examination of these computations is about half finished. Precessions and Secular Variations have been calculated from $0^h \cdot 0^m$–$10^h \cdot 0^m$ and $13^h \cdot 46^m$–$22^h \cdot 30^m$, *i.e.*, for three-quarters of the stars.

As mentioned in the last report, differences amounting to as much as 2° Fahr. in the mean for certain nights were found between the thermometer in the Front Court and the Standard thermometer in the Magnetic pavilion. This led to a somewhat extensive investigation as to whether the thermometer in the Front Court gave a reliable indication of the temperature of the air in the neighbourhood of the transit circle. As a result of comparison with readings of a thermometer erected temporarily in the garden, south of the transit circle, and with the readings of an "Assman Aspirated Psychrometer" kindly lent by the Director of the Meteorological Office, it was found that the readings of the thermometer gave the temperature of the air correctly at night, but that in the day-time they were slightly affected by the direction of the wind.

In consequence of the differences of systematic character between time-determinations in different observatories revealed by the wireless time signals the bearings of the transit circle were examined. There are annual changes in the level and azimuth errors of the instrument which were larger than usual in 1922. It was anticipated that a slight want of alignment might accompany this. The bearings are very inaccessible, but an examination was made in 1923 January. A test was made by smearing the bearings with oil containing fine jeweller's rouge and after carefully lowering the telescope into its bearings, revolving it about 60°. It was found that the western pivot was bearing only on its eastern edge, but that the eastern pivot had a very good bearing all over. The western pivot was therefore taken out

and two sheets of tinfoil removed from under it. Tests were made with various thicknesses of tinfoil till a good bearing was obtained. During this adjustment of the bearings no attempt was made to influence the errors of the instrument, but the level error was greatly reduced.

Regular examination since this date show that the alignment was good till the beginning of May. It is too early to say whether the alignment will remain good as the weather becomes warmer, or whether its changes may offer an explanation of the anomalies found in the time-determinations. Incidentally it was found that the Eastern pier of the transit circle is of granite and the Western pier of Portland stone. This is a probable cause of the seasonal variation of the errors of the instrument.

Altazimuth.—This instrument has been used to supplement the observations of the Moon in the first and last quarters. Extra-meridan observations have been made on 8 nights.

In the year ended 1922 December 31 the Moon was observed with one or other of the instruments on 106 nights. The mean correction in right-ascension required by the *Nautical Almanac* is $+ 0^s\cdot870$, and by the *Connaissance des Temps* is $+ 0^s_{\cdot}212$. The following table gives the mean tabular error of the Moon's longitude as derived from Hansen's tables with Newcomb's corrections since the year 1883 :—

1883	-	$-0''\cdot03$	1893	-	$-0''\cdot06$	1903	-	$-3''\cdot08$	1913	-	$-11''\cdot93$
84	-	$-0\cdot16$	94	-	$-1\cdot20$	04	-	$-3\cdot16$	14	-	$-12\cdot86$
85	-	$-0\cdot09$	95	-	$-1\cdot47$	05	-	$-5\cdot29$	15	-	$-12\cdot58$
86	-	$-0\cdot11$	96	-	$-1\cdot68$	06	-	$-5\cdot91$	16	-	$-14\cdot05$
87	-	$+0\cdot21$	97	-	$-2\cdot77$	07	-	$-5\cdot96$	17	-	$-14\cdot03$
88	-	$+0\cdot76$	98	-	$-3\cdot03$	08	-	$-5\cdot97$	18	-	$-13\cdot05$*
89	-	$-0\cdot38$	99	-	$-2\cdot18$	09	-	$-6\cdot41$	19	-	$-12\cdot26$
90	-	$-0\cdot27$	1900	-	$-2\cdot69$	10	-	$-7\cdot85$	20	-	$-13\cdot11$
91	-	$+0\cdot72$	01	-	$-2\cdot77$	11	-	$-8\cdot34$	21	-	$-13\cdot38$
92	-	$+0\cdot79$	02	-	$-3\cdot15$	12	-	$-9\cdot79$	22	-	$-13\cdot26$

* Given erroneously as 14·05 in previous reports.

From the beginning of 1923, Brown's tables have been used in the *Nautical Almanac*. For comparing with observation the tabular diameter has been corrected

by $+0^s\cdot08$ in R.A. and $+1''\cdot2$ in N.P.D. The following comparisons for four lunations of this year shows that the new tables represent the motion very steadily :—

	Errors of					Errors of			
	R.A.	N.P.D.	Long.	E.N.P.D.		R.A.	N.P.D.	Long.	E.N.P.D.
	s	"	"	"		s	"	"	"
Jan. 2 -	—·64	—1·14	—9·2	—0·5	Feb. 25 -	—·60	—1·68	—8·6	—1·9
3 -	—·56	—1·81	—8·2	—0·4	26 -	—·64	— ·50	—9·2	+0·2
4 -	—·50	—2·19	—7·6	—0·2	Mar. 2 -	—·55	—2·37	—8·4	+0·9
8 -	—·44	—3·99	—7·6	—1·1	3 -	—·57	—3·47	—9·2	+0·3
9 -	—·48	—5·06	—8·5	—2·0	4 -	—·36	—3·49	—6·3	—1·1
10 -	—·45	—1·69	—6·8	+0·6	6 -	—·46	—3·91	—7·7	—1·7
20 -	—·38	+3·43	—6·6	+1·0	24 -	—·54	—1·34	—7·6	—1·8
23 -	—·34	+ ·86	—5·0	—1·2	26 -	—·59	—1·51	—8·6	—0·4
27 -	—·56	—1·02	—7·8	—2·3	27 -	—·50	—1·84	—7·5	—0·2
Feb. 4 -	—·51	—2·76	—8·1	+0·5	28 -	—·56	—1·96	—8·4	+0·6
5 -	—·46	—4·12	—7·9	—1·2	29 -	—·57	—2·37	—8·7	+0·8
6 -	—·32	—2·00	—5·2	—0·3	31 -	—·57	—2·50	—8·8	+1·1
8 -	—·56	—3·02	—8·6	—1·3	Apr. 1 -	—·52	—3·14	—8·4	+0·0
21 -	—·42	+0·12	—5·9	—1·9	2 -	—·56	—2·56	—8·7	+0·4

The mean error in longitude is $-7''\cdot8$. The mean discordance from this value is $\pm 0''\cdot81$, and may be reasonably attributed to observational error.

The differences between the observed and tabular longitudes of the Moon for the period 1851–1922, during which Hansen's tables have been used, will be published in the Greenwich volume for 1920. The tabular places were corrected for a number of terms where the error of Hansen was large by Dr. Cowell for the period 1851–1901, and similar corrections have been applied for later years. A discussion of the results by Sir Frank Dyson and Dr. Crommelin is given in the *Monthly Notices of the Royal Astronomical Society* for April, 1923.

The Cookson Floating Zenith Telescope. — During the year 209 photographs have been taken and measured for variation of latitude. The measurements are completed to the end of 1922 and the results published in the *Geophysical Supplement*

of the Royal Astronomical Society, No. 3. After the end of the first seven years of observations in 1919 June, the pairs of stars were modified owing to changes in position arising from precession. A discussion of the observations from this date to the present time has been made by Mr. Jones to improve the connections between groups of stars observed at different times of the year. Revised values of the variation of latitude have been derived.

Equatorial Observations.—Both phases of the occultation of Aldebaran by the Moon were observed on August 16 and November 6 and the disappearance on January 27. The times of occultation of four other stars were also observed on the latter date.

The 28-*inch Equatorial.*—Observations of double stars have been continued throughout the year and 655 observations of 371 double stars obtained. These comprise :

66	pairs with	separation	less than 0″·5.
105	,,	,,	between 0″·5 and 1″·0.
100	,,	,,	,, 1″·0 and 2″·0.
100	,,	,,	greater than 2″·0.

In January the Micrometer was modified by Messrs. Troughton and Simms so that one screw moves both the distance wires together and the second screw moves one wire relatively to the other. This makes observing easier when there is any irregularity in the driving of the clock, and there is also only one reading to make instead of two. The opportunity was also taken to redivide the micrometer heads and the position circle, which were much worn. In March for greater convenience in setting in declination a celluloid strip was graduated at the Observatory and fixed on the rough wooden setting-circle. This is read with a small telescope at the eye-end of the telescope and makes it possible for the observer to set in declination without assistance.

The observations of 227 stars which have been observed on three or more nights between 1919 August and 1922 December 31 are in the printers' hands and will be published in the Greenwich Volume for 1920.

Mr. Jackson's researches on "hypothetical" parallaxes have been continued and the results for the "Struve" stars published in the Monthly Notices for 1922 November.

Thompson Equatorial.—With the 26-inch Refractor 1,199 photographs have been taken for stellar parallax and 1,151 have been measured. During the year the parallaxes of 49 stars have been determined giving a total of 195 up to date with this telescope. Also 59 plates have been measured for the proper motion in declination. It is proposed to determine the proper motions of stars in right ascension and declination with a probable error of $\pm$ 0″·002 or $\pm$ 0″·003, a few additional photographs being taken when necessary so as to have an interval of 6 or 7 years.

With the 30-inch reflector 23 photographs have been taken for effective wave-lengths, and 13 of these have been measured, completing the area from the pole to 85° declination, while zones 83° and 84° are well advanced. Photographs of Skjellerup's Comet (*b.* 1922) were obtained on three nights.

With a prismatic camera and grating 19 photographs have been taken. In this instrument the prism is mounted behind the 30-inch reflector used as a Cassegrain whilst the grating covers the mouth of the telescope tube. A parallel beam passes through the prism and is condensed by a 6-inch lens of 28 inches focus on the photographic plate. This gives at a single exposure a principal spectrum bordered by diffraction spectra of known relative intensities, so that the *gamma* or density gradient of the plate is determined for all wave-lengths. A photometer for measurement of the photographs is being constructed in the workshop. It is designed for visual observation, and is of the Hartmann type with the modifications suggested by M. Jules Baillaud.

Astrographic Equatorial.—A series of plates of the alternate zones of the Greenwich Astrographic Catalogue is being taken with the plate reversed in the camera so that the photograph is taken through the glass. The new plate is placed in contact, film to film, with the corresponding plate of the original series, and the relative positions of corresponding images measured with a filar micrometer. Displacements amounting to 1″ arising from proper motion are readily detected. As the interval between the two series of photographs is from 20 to 25 years, the proper motions of all stars in the Greenwich section of the Astrographic Catalogue which amount to more than 5″ a century should be obtained, as well as a comparison with the proper motions determined from Meridian Observations and given in Vol. IV of the Greenwich Astrographic Catalogue. The work has been commenced with Zone 65° and up to the present time 31 fields have been photographed and 15 measured. A few duplicate plates have been taken in order to check the possible errors arising from photographing through the glass.

Three plates of the Praesepe cluster were taken at the request of Dr. van Rhijn and have been sent to him. Two plates have also been taken of the field of stars in the neighbourhood of the Sun during the forthcoming total eclipse of 1923 September 10.

Heliographic Observations.—In the year ended 1923 May 10 photographs of the Sun were obtained on 217 days. Of these, 402 have been selected for preservation, including 12 with double images of the Sun for the determination of the zero of position angle. This has also been determined regularly by visual observations of the transit of the Sun's limb over the cross-wires of the Photoheliograph.

H.M. Astronomer at the Cape has reported that the Sun was photographed there on 336 days in the year 1922, and on 90 days in the first three months of 1923. The Director of the Kodaikanal Observatory has reported that plates were taken there on 333 days in the year 1922, and on 79 days during the first three months of 1923.

Photographs have been received from the Royal Observatory, Cape of Good Hope, to 1923 January. Photographs have been received from the Kodaikanal Observatory, India, to complete the series for 1921 and part of 1922.

The measurement of the combined series has been made from 1920 November 3 to 1922 December 14.

The reductions of positions and areas of spot groups and their principal components have been completed from 1919 April 9 to 1922 June 30.

During the period covered by this report the general spot activity has very considerably declined, and it is evident that the Sun is near minimum phase. A large group was seen, however, from December 22 to January 4 in latitude 6° N., but as a probable indication of the approaching cycle, a small spot in latitude 41° S. was measured on the photographs of November 14 and 15.

Total Eclipse of the Sun on 1922 *September* 21.—As mentioned in the last report, Mr. Jones and Mr. Melotte arrived at Christmas Island on 1922 March 21. The erection and adjustment of the Astrographic Telescope were completed by the beginning of May. A series of comparison plates of the eclipse field were secured about the end of June: an auxiliary field at the same declination and about 10° away in R.A. was photographed on these plates. It was intended to photograph the same field during the eclipse on the eclipse plates and so increase the weight of the determination of the displacements of the stars.

Unfortunately, the weather throughout proved very disappointing. Owing to the prevalence of cloud, particularly of high cirrus, the photometry programme referred to in the last report had to be abandoned. The weather, which for some days previous to the eclipse had been generally fair, broke on the morning of the eclipse day; there were dense clouds and heavy rain showers. Throughout totality, the sky was almost completely cloud-covered and no observations of value could be secured.

The seismograph, lent by Mr. J. J. Shaw, was erected and left on the Island. Observations are being continued by members of the staff of the Christmas Island Phosphate Co.

Tentative arrangements were made for Mr. Jones and Mr. Melotte to observe the eclipse of 1923 September 10 in the event of any reasonable doubt being thrown on the results of 1919 by the observations made in Australia at the last eclipse. A cable message was received from Professor Campbell stating that the party from the Lick Observatory had closely verified the displacement predicted by Einstein. The expedition to California was accordingly abandoned.

III.—Magnetic Observations :—

The variations of magnetic declination, north force and vertical force have been observed photographically. Absolute observations of declination are made five or six times a week, of horizontal force twice a week, and of dip three times a week. The absolute observations and the photographic records are made in the two buildings in the Magnetic Enclosure.

The new thermostat installed on 1922 April 7 continues to work satisfactorily. The mean hourly ordinates of the declination and north force registers are read and reduced to the end of April. The vertical force registers are somewhat in arrears, but are now being dealt with. The absolute observations are all reduced. The mean values of the magnetic elements for 1922 are given below with those of previous years for comparison :—

	Dec. W.	Hor. Force.	Vert. Force.	Dip.
		(C.G.S. units.)		
	° ′			° ′
1919 - -	14 18·2	0·18454	0·43242	66 53·3
1920 - -	14 8·6	0·18454	0·43249	66 53·6
1921 - -	13 57·6	0·18449*	0·43183*	66 52·0*
1922 - -	13 46·6	0·18449*	0·43181*	66 51·9*

* Provisional values.

In 1922 August Mr. Parkinson of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington made a comparison of the Greenwich instruments with those of the Carnegie Institution. The differences in the sense Carnegie Institution—Greenwich are $2'\cdot4$ in declination, $-14\cdot7\,\gamma$ in horizontal force and $0'\cdot45$ in dip.

The Magnetic Charts referred to in last year's report have been utilized to determine the value of the potential of the Magnetic Force assumed to arise from magnetic material inside the Earth, and also to examine the question as to whether any part of Terrestrial Magnetic forces are to be attributed to vertical electric currents. The results are published in the Geophysical Supplement of the Royal Astronomical Society.

IV.—Meteorological Observations :—

The registration of atmospheric pressure, temperature of the air and of evaporation, pressure and velocity of the wind, rainfall, sunshine and cloudiness at night, has been continuously maintained.

The potential gradient of atmospheric electricity has been registered with a radium collector and Kelvin-White Quadrant Electrometer. Owing to the difficulty in damp weather of maintaining perfect insulation when the radium collector is supported in the open at a distance from the electrometer house, it is now suspended from the end of a cane, about 6 feet long, the other end of which is supported between sulphur insulators inside the electrometer house. This insulation has been tried for over four months and has proved satisfactory. Trouble has been experienced in obtaining a suitable suspension for the electrometer needle. With a suspension of phosphor-bronze strip, the zero was found to be very variable and difficulty has been experienced in procuring strip with the required torsion. Fine copper fuse wire is now being used and promises to be more successful.

The following details of the weather refer to the year ended 1923 April 30. The mean temperature was $49°\cdot8$, or $0°\cdot2$ above the average of the 75 years 1841–1915.

The highest temperature in the shade was $90°\cdot6$ on May 24. The temperature exceeded 80° on 9 days, and exceeded 90° on 2 days, both in May. The four days May 21–24 were remarkable as having attained higher temperature than ever previously recorded for the same period of the year. In no previous May has a temperature higher than $87°\cdot5$ been recorded (May 26 1880).

The lowest temperature was 24°·4, on October 26 and also on December 9. On 21 days the temperature fell as low as 32°·0. May, December and February were warm months, being respectively 4°·5, 2°·8 and 3°·5 above the average for 75 years (1841–1915), while July and August were below the average by 3°·9 and 3°·3 respectively.

The mean daily horizontal movement of the air was 276 miles, which is 8 miles below the average of the 50 years 1867–1916. The greatest daily movement, 648 miles, was recorded on February 1, and the least, 50 miles, on November 21. The greatest pressure was 17·8 lbs. to the square foot on April 26. The greatest velocity in one hour, 41 miles, was registered on December 20. The clock of the Robinson Anemometer was away for repair from March 16–27.

The duration of bright sunshine registered by the Campbell-Stokes instrument was 1,404 hours, out of a possible 4,457 hours, or 31·5 per cent.

The total rainfall was 22·26 inches, or 1·98 inches below the average for the period 1841–1915. The number of rainy days (0·005 inch or over) was 174. The wettest month was July, with 3·21 inches, and the driest month October, with 1·04 inches.

V.—Printing and Distribution of Greenwich Publications :—

The volumes for 1917 and 1918 and the separate results for these years have been distributed.

The printing of the volume for 1919 is completed, and, with the exception of the Meteorological section, the copy for 1920 is in the hands of the printers.

VI.—Chronometers :—

The number of chronometers and watches belonging to the Admiralty now at the Observatory is 2,959. Of this total, 205 chronometers, 139 chronometer watches, 180 hack watches, and 42 pocket watches are being rated. The remainder, consisting of 403 chronometers, 1,170 chronometer watches, 311 hack watches and 509 pocket watches, are kept in storage.

In addition to Admiralty chronometers, there are also 135 chronometers and 31 watches deposited at the Observatory for various reasons.

In connection with the purchase of chronometers by the United States Shipping Board, 35 new chronometers have passed the requisite tests satisfactorily and have been dispatched. This completes the contract made for the supply of 500 chronometers.

During the year ended 1923 April 30 a total of 2,056 chronometers and watches have been received and 2,075 issued. The number sent for repair was 1,156, namely 1,111 for the Admiralty and 45 for the Indian Government.

The annual trials of chronometers and watches have not been reinstated.

VII.—Time Service :—

The new Standard Clock, mentioned in the last report, which was delivered at the Observatory by Mr. Cottingham on 1921 February 26, was brought into use on October 24 and has performed quite satisfactorily.

The driving mechanism of the Transit Circle Chronograph was thoroughly overhauled and repaired during January and February.

Daily time signals have been sent to the General Post Office without failure.

The time-ball has been dropped correctly at 13^h, except on May 28, when it failed owing to improper working of the raising gear, and on June 14 owing to the failure of the signal current to release the trigger apparatus.

On six days, May 5, October 19, 29, February 7, 18, April 8, the Deal Time Ball was not raised on account of the violence of the wind. On six days, May 9, September 19, 20, December 10, February 4, March 29, the Greenwich signal failed to reach Deal. On these dates the ball was released by hand, except on September 19 and 20. From May 1–3 the ball was out of action on account of repairs, and on two days, May 20 and December 6, the ball was released by hand on account of telegraphic interruptions on the line.

The performance of the time balls at the Admiralty Signal stations and of the Westminster Clock is shown by the following table of the errors of the return signals :—

Error of Return Signal.	Portsmouth.	Portland.	Devonport.	Rosyth.	Westminster.
Not greater than $0^s{\cdot}2$ - - - -	204	255	254	41	48
$0^s{\cdot}3$ to $0^s{\cdot}5$ - - - - - -	8	4	4	11	58
$0^s{\cdot}6$ to $1^s{\cdot}0$ - - - - - -	5	2	1	3	97
Greater than $1^s{\cdot}0$ - - - -	0	0	0	0	90

During the period 1922 August to 1923 March only a few signals were received from Rosyth owing to difficulties in transmission and alteration in route of the telegraphic line.

Signals were received from the Westminster Clock on 293 days and the error exceeded $3^s.0$ on three occasions. The clocks at Portsmouth, Portland, Devonport and Rosyth are corrected daily by the 10^h signal; the Westminster Clock is not corrected daily.

Wireless time signals have been received regularly from the Eiffel Tower, Nauen, Bordeaux and Annapolis throughout the year, and from Moscow during the winter months.

Signals from the Eiffel Tower, Nauen, Bordeaux, and Moscow are automatically recorded on a syphon recorder operated by means of an oscillating valve relay system, and since the beginning of August records of the Annapolis signals have been obtained on fifty per cent. of the possible number of days.

The concluded monthly means of comparisons of the various wireless time signals, using automatic registration at Greenwich, for the year 1922 are as follows :—

Month.	Paris. 10^h Rhythmic.	Nauen (Noon).	Annapolis. 17^{hr}.	Bordeaux. 20^h Rhythmic.
	s.	*s.*	*s.*	*s.*
January	−0·01	−0·05	—	+0·06
February	+0·10	−0·02	—	+0·11
March	+0·09	0·00	—	+0·12
April	+0·05	−0·04	—	+0·09
May	+0·11	+0·01	—	+0·12
June	+0·12	−0·02	—	+0·20
July	+0·11	−0·01	—	+0·19
August	+0·14	+0·08	+0·05	+0·19
September	+0·13	+0·04	+0·07	+0·18
October	+0·12	+0·01	+0·01	+0·15
November	+0·16	+0·04	+0·02	+0·17
December	+0·11	0·00	0·00	+0·12
Average number of comparisons per month	21	21	16	17

The sign + means late on Greenwich.

VIII.—Personal Establishment :—

The Observatory has sustained a very severe loss by the death of Mr. Bryant, which took place on January 31. He was an enthusiastic observer with the transit circle, and to his example and influence the largely increased output with that instrument is due. He was also an excellent observer of double stars. After his appointment as Superintendent of the Magnetic and Meteorological Department he largely increased the number of absolute magnetic observations. He took a very keen interest in Meteorology and was very careful that all routine observations should be correctly made.

The permanent staff at the present time is constituted as follows :—

Chief Assistants.—Mr. Jackson, Mr. Jones.

Assistants.—Mr. Bowyer, Dr. Crommelin, Mr. Davidson, Mr. Witchell (promoted February 1).

Junior Assistants (Higher Grade).—Mr. Furner, Mr. Melotte, Mr. Stevens (promoted February 1).

Junior Assistants.—Mr. Acton, Mr. Barton, Mr. Chamberlain, Mr. Cullen, Mr. Jeffries, Mr. Martin, Mr. Newton, Mr. Rickett (appointed March 20), Mr. Symms and one vacancy.

Clerical Assistant.—Mr. Edney.

16 Computers, including 4 ladies, are employed at the Observatory.

The present arrangement of the staff under the general superintendence of the Chief Assistants is as follows :—

Branch.	Established Staff.	Unestablished Staff.
Transit Circle Altazimuth and Zenith Telescope.	Dr. Crommelin, Mr. Furner, Mr. Cullen, Mr. Acton, Mr. Symms.	Mr. Smith, Mr. Kinnear, Mr. Longley, Mr. Fellows, Mr. Davies.
Time Signals and Chronometers	Mr. Bowyer, Mr. Stevens, Mr. Rickett.	Mr. Scott, Mr. Alcock.
Thomson Equatorial	Mr. Davidson, Mr. Martin	Miss Faulkner, Miss Jeffries.
28-inch Equatorial	Mr. Furner	
Astrographic Equatorial	Mr. Melotte, Mr. Jeffries	
Photoheliograph	Mr. Newton, Mr. Barton	Miss Crommelin, Mr. Finch.
Magnetic and Meteorological	Mr. Witchell	Miss Clack, Mr. Wells, Mr. Tibbitts, Mr. Oliver.
Secretariat and Library	Mr. Edney, Mr. Chamberlain	Mr. Cox.

The staff of workmen now employed consists of a foreman of works, two joiners, a mechanic, a boy assistant mechanic, a gate porter, two messengers, a night watchman, a gardener, three labourers, and a charwoman.

IX.—General Remarks:—

The Observatory was honoured by a visit of the Crown Prince of Italy on September 30.

The Meeting of the International Union at Rome and the Centenary celebrations of the Royal Astronomical Society brought many astronomers to London, and in consequence we have had during the year the pleasure of seeing a large number of distinguished astronomers from all parts of the world.

Mr. Dodwell, Director of the Adelaide Observatory, made observations from May 22–June 23, with a small transit in connection with his determination of longitude of stations on the 129th meridian separating South and Western Australia.

Mr. Comrie and Mr. Greaves, Isaac Newton students at the University of Cambridge, spent some time at the Observatory taking part in the observations and calculations and obtaining a general insight into the work of the Observatory. Mr. Comrie was here from June 30 to August 19, and Mr. Greaves from August 28 to October 26. It was a pleasure to have the co-operation of these gentlemen, and it appeared instructive both to them and the staff.

Commander Reyne visited the Observatory a few nights in January, and with Mr. Jackson made some test observations with an astrolabe constructed for the Hydrographic Office by Commander Baker involving some modifications of the French design.

Mr. Gaythorpe was at the Observatory from May 1–10, examining and copying the Horrocks manuscript, in connection with a life of Horrocks on which he is engaged.

The Observatory is rapidly returning to its pre-war efficiency in observational work. The output of the different instruments, especially as the year was somewhat cloudy, reflects great credit on the staff. Measurement and reductions

are practically up to date. Considerable progress has been made in overtaking arrears of printing. The volumes for 1917 and 1918 have been distributed, the printing of the volume for 1919 completed, and that for 1920 is making rapid progress.

F. W. DYSON.

Royal Observatory,
Greenwich.
1923, May 23.